ACHIEVING SOCIOECONOMIC DEVELOPMENT IN THE ISLAMIC WORLD THROUGH SCIENCE, TECHNOLOGY AND INNOVATION

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ACHIEVING SOCIOECONOMIC DEVELOPMENT IN THE ISLAMIC WORLD THROUGH SCIENCE, TECHNOLOGY AND INNOVATION

Proceedings of the 19th IAS Science Conference on
Achieving Socioeconomic Development in the Islamic World Through Science, Technology and Innovation
organised in Dhaka/ Bangladesh;
5-9 May 2013

Edited by

Moneef R. Zou'bi
Najwa F. Daghestani

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The opening session of the 19th IAS Conference;
Dhaka/ Bangladesh; 5-9 May 2013.

Editors:

Dr Moneef R. Zou'bi is the Director General of the Islamic World Academy of Sciences (IAS). He has been an advocate of Science and Technology for Development for around 30 years. Born in Amman, Jordan, he studied for his undergraduate and postgraduate degrees in Civil Engineering Technology and Management at Brighton and Loughborough Universities in the United Kingdom, 1980 - 1987. He successfully pursued further post-graduate work at the Department of Science and Technology Studies at the University of Malaya.

Dr. Moneef joined the Islamic World Academy of Sciences (IAS) (an international scientific NGO based in Jordan and affiliated to the Organisation of Islamic Co-operation (OIC)) in 1990, embarking on a career in international scientific and technological collaboration. He also serves as the Science Advisor to the Interaction Council (IAC).

He has published over 60 publications on science and technology issues, science education and sustainable development, as well as on water issues from a Middle Eastern perspective. In 2010, he co-authored the ground-breaking Arab States Chapter of the 2010 UNESCO Science Report that foresaw the advent of the Arab Spring. In 2015, he was commissioned again to be lead author of same Report.

Dr. Moneef is a member of the World Academy of Art and Science and is a Founding Fellow, of the Academy of Engineering and Technology for the Developing World (AETDEW). He is also a member of the Advisory Committee of the Rosenberg International Water Forum, USA, since 2007.

Najwa F. Daghestani is a Programme Officer at the Islamic World Academy of Sciences (IAS). She earned her Master of Business Administration (MBA) from the German Jordanian University, Jordan, and her BSc in Computer Science from Princess Sumayya University, Jordan.

She previously worked at the Royal Scientific Society as an Applications Programmer.

PREFACE

The Organization of Islamic Co-operation (OIC), formerly known as the Organization of the Islamic Conference, was founded in 1969 as a political organization grouping Islamic countries. In 1981, the heads of state of the OIC decided to establish a number of specialized organs to enhance co-operation between the OIC-Member countries in the fields of culture, trade and science and technology. The science and technology role was assigned to the Islamabad-based COMSTECH; the Ministerial Standing Committee on Scientific and Technological Co-operation.

In 1984, the heads of state of the OIC approved the launch of the Islamic World Academy of Sciences (IAS) as an independent autonomous S&T Think Tank of the OIC to be based in Amman, Jordan. Of the issues that the IAS has been concerned with since its launch has been bridging the divide that has historically existed between the science community and the decision-making community in OIC-Member countries. Moreover, as an advocate for science, the IAS has always viewed science and technology – including the history of science – as an enterprise that can contribute to bridging divides between cultures and civilizations.

Bangladesh, which is among the most populous of OIC countries, is a country that is regularly affected by natural disasters. Yet, it is a country that has managed to develop the capacity to mitigate and manage natural phenomena effectively, and achieve a respectable level of food security for its vast population.

As a result of some obvious strengths in certain export-oriented industrial sectors, it has also managed to maintain high economic growth. And although there is limited interaction between public and private-sector actors and little university–industry collaboration, the country's ingenuity manifests itself in light engineering where it is producing import-substitution products that are creating employment and alleviating poverty. Endogenous technologies include those related to ferries, power plants, machinery and spare parts. Bangladesh is also developing the high-tech sector of pharmaceuticals, and is almost 97% self-sufficient in pharmaceuticals. To get first-hand experience of this particular sector, the conference participants visited one of the leading pharmaceutical companies of the country; Incepta Pharmaceuticals.

The above factors rendered Bangladesh a special case-study for the IAS and the OIC science community.

This publication includes the majority of the papers that were presented at the 19th IAS Conference, which was held in Dhaka, Bangladesh, during May 2013, under the patronage of the Bangladeshi Prime Minister. A conference in which over 150 participants including IAS Fellows and invited speakers from outside Bangladesh, academics, decision-makers, scientists, researchers as well as presidents/representatives of academies of sciences from all over the world, took part.

It is divided into ten parts.

Part One includes the statements of the two patrons of the IAS, the statements of IAS President as well as the statements of the officials of the host country during the inaugural session of the conference.

Part Two embraces keynote addresses by Adnan Badran FIAS, Former Prime Minister of Jordan and IAS Treasurer, who presented a paper entitled 'Excellence in Higher Education for Building S&T Proficiency: A Global Perspective;' one by Prof. Atta-ur-Rahman FIAS, former Coordinator General of COMSTECH, entitled 'Higher Education S&T Nexus: Outlook for Tomorrow' and a keynote by Dato. Lee Yee Cheong, Chairman, Governing Board of the International Science Technology Innovation Centre for South-South Cooperation (ISTIC), who presented an overview paper on 'Building S&T Proficiency in Developing Countries: Ideas on the Hands on Approach.'

Part Three is dedicated to the papers presented in the session on the topic of 'Excellence in Higher Education for S&T Proficiency,' in which three papers were presented; two from

Bangladesh, by Prof. A K Azad Chowdhury and Prof. Ahmed Abdullah Azad FIAS, and one presentation from Pakistan by Dr. Mohammed Ali Mahesar.

Part Four carries the title of ‘Energy for the Future’ and includes two presentations; by Dr Saifur Rahman, Director, Virginia Tech Advanced Research Institute, USA; and by Prof. Marwan Khraisheh, Dean of Engineering, Masdar Institute of Science and Technology, UAE.

Part Five addresses the topic of ‘Public Health’ and includes papers by Prof. Abdallah Daar FIAS on ‘Public Health Research, Policies and Funding Opportunities;’ a presentation by Prof. Ugur Dilmen FIAS that addressed the issue of ‘Public Health Research Funding and Policies in Turkey;’ a paper by Prof. Timothy Evans, Dean, James P Grant School of Public Health, BRAC University, Bangladesh on ‘Health Equity and Universal Health Coverage,’ and a paper by Prof. Muthana Shanshal FIAS on ‘Quantitative Detection of Carcinogenic Polycyclic Aromatic Hydrocarbons in Wheat Crops Infected with Tilletia Caries.’

Part Six is about ‘Drugs and Vaccines of the Future,’ and includes a number of presentations by IAS Fellows.

Part Seven is made up of the papers that were presented in the respective session including one which is entitled ‘Climate Change and the Environment.’ The same, included speakers such as Dr Michael Clegg, Foreign Secretary, US National Academy of Sciences, USA; Prof. Zeba Seraj, Department of Biochemistry and Molecular Biology, University of Dhaka, Bangladesh and Prof. Haseena Khan, Visiting Professor, South Asian University, India.

Part Eight includes presentations by Prof. Sandro Calvani, Director of the ASEAN Centre of Excellence on UN Millennium Development Goals, AIT, Bangkok, Thailand, on ‘Rethinking Sustainable Development in Least Developed Countries: The Politics Policies Nexus;’ and a joint paper on ‘Food Security Initiatives for the Social Well Being of the Farmers: How Science Helps,’ by Prof. Aini Ideris FIAS, Prof. Khatijah Yusoff FIAS as well as Prof. Abdul Latif Ibrahim FIAS.

Part Nine is entitled ‘Collaborative Research Case-Studies,’ and includes five presentations. The first is by Prof. Syed Qaim FIAS; Research Centre Juelich and University of Cologne, Germany. Another paper by Dr Peter Sundin, Head, International Science Programme (ISP), Uppsala University, Sweden, on ‘The International Science Programme in Bangladesh: Self Interest or Empowerment?’ This is followed by a presentation by Prof. Mohammad Abdollahi FIAS; Faculty of Pharmacy, Tehran University of Medical Sciences, Iran. A presentation by Prof. Feroz Alam Khan, Department of Physics, Bangladesh University, entitled ‘Structural and Magnetic Properties of Core-Shell Manganese-Oxide Nanoparticles Fabricated by Inert Gas Condensation Technique.’ The last paper is by Prof. M Asghar FIAS and carried the title ‘The Photovoltaic power.’

Part Ten of the book is the ‘appendices’ including the list of participants in the conference, the conference scientific and organising committees, names of IAS Fellows and Council members, as well as other details about the Islamic World Academy of Sciences (IAS).

Moneef R. Zou’bi
Najwa F. Daghestani

ACKNOWLEDGEMENTS

The Islamic World Academy of Sciences (IAS) is grateful to Her Excellency Sheikh Hasina, Prime Minister of Bangladesh, for her interest in the work of the IAS and her patronage of the 19th IAS Conference, and for Her Excellency Dr Dipu Moni, Minister of Foreign Affairs, Bangladesh. Also, the IAS appreciates the appearance and address of his Excellency Prof. Ekmeleddin Ihsanoglu, Secretary General, Organisation of Islamic Cooperation (OIC). The IAS is also grateful to Prof. AK Azad Chowdhury, Chairman (State Minister), University Grants Commission (UGC), Bangladesh, for his address at the opening ceremony and indeed for hosting all the preparatory meetings related to the conference.

The IAS extends its appreciation to all the organisations that have sponsored the conference, foremost among which is the Government of the People's Republic of Bangladesh; Prime Ministry of Bangladesh; Foreign Ministry of Bangladesh; Ministry of Science and Technology of Bangladesh; University Grants Commission of Bangladesh (UGC); Bangladesh Academy of Sciences (BAS); OPEC Fund for International Development (OFID), Vienna, Austria; Islamic Development Bank (IDB), Jeddah, Saudi Arabia; OIC Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan; Arab Potash Company, Amman, Jordan; Incepta Pharmaceuticals Ltd., Dhaka, Bangladesh; and last but not least, the Bangladesh University of Health Science (BUHS), Dhaka, Bangladesh.

The preliminary work done by the IAS Council, and the critical effort volunteered by IAS Fellow from Bangladesh Prof. Ahmad Azad FIAS were invaluable in realizing the conference.

The dedicated staff of the IAS in Amman including, Ms Lina Jalal, Ms Taghreed Saqer and Mr Hamza Daghestani, all deserve our thanks and appreciation.

Moneef R. Zou'bi
Najwa F. Daghestani

IAS 2013 CONFERENCE
on
Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation

SPONSORS OF THE IAS 2013 CONFERENCE

- Government of the People's Republic of Bangladesh;
- Islamic World Academy of Sciences (IAS), Amman, Jordan;
- Prime Ministry of Bangladesh;
- Foreign Ministry of Bangladesh;
- Ministry of Science and Technology of Bangladesh;
- University Grants Commission of Bangladesh (UGC);
- Bangladesh Academy of Sciences (BAS);
- OPEC Fund for International Development (OFID), Vienna, Austria;
- Islamic Development Bank (IDB), Jeddah, Saudi Arabia;
- OIC Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan;
- Arab Potash Company, Amman, Jordan;
- Incepta Pharmaceuticals Ltd., Dhaka, Bangladesh; and
- Bangladesh University of Health Science (BUHS), Dhaka, Bangladesh.

19TH ISLAMIC WORLD ACADEMY OF SCIENCES CONFERENCE

on

Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation (STI)

CONFERENCE DECLARATION

adopted at Dhaka, Bangladesh
on
28 Jumada II 1434
08 May 2013

PREAMBLE

1. The quest for knowledge is one of the seminal elements in the Islamic code of belief. For over a millennium, i.e., up to the turn of the seventeenth century, the Islamic civilization was a milieu *par excellence* for groundbreaking science; science which laid the foundation for the European renaissance and the Industrial Revolution;

2. The world economic uncertainty of the previous five years has been the source of serious difficulty for the Science, Technology and Innovation (STI) sector. The sharp declines in trade, foreign investment and access to financing have also had negative impacts affecting global value chains;

3. STI is still a tool of might and affluence and a tool at the disposal of governments. Leveraging STI at the national level is essential for the socioeconomic development of countries including OIC-Member States; achieving prosperity, food, water, energy security and national self-fulfilment; as well as addressing the challenges of human health and climate change;

4. In the wake of the financial crisis, STI will make a vital contribution to sustainable and lasting recovery and to long term growth prospects of most countries' economies;

5. Investment in science and technology and education has been a critical source of economic transformation. Such investment should be part of a larger framework to build capacities in STI. Improvements in higher education need to be accompanied by growth in economic opportunities so that graduates can apply their acquired capabilities in the fields of their preference;

6. The decision-makers and the science community in OIC-Member States have to appreciate the common view that science transcends political borders, enhancing cooperation and acting as a catalyst for consolidating stability in the Islamic world. Knowledge production and diffusion play a key role in the enhancement of innovation, sustainable economic development, and social well-being. To this aim, it is vital to strengthen regional cooperation in STI,

THE ISLAMIC WORLD ACADEMY OF SCIENCES (IAS), AT THE CONCLUSION OF ITS 19TH CONFERENCE HELD IN DHAKA (BANGLADESH), 6-8 MAY 2013, NOTES WITH SATISFACTION THAT AT THE LEVEL OF BANGLADESH AND THE OIC, RESPECTIVELY:

1. Bangladesh has achieved over 90% enrolment in primary education and drop out has been reduced considerably. Higher education has been gaining momentum in Bangladesh as the country has witnessed growth in tertiary level enrolment from 1.16 million students in 2008 to 2.65 million in 2012. The number of public and private universities has also gone up from 78 to 104 in the last four years and seven more public universities are in the pipeline;

2. Bangladesh has managed to take a number of actions to mitigate the negative effects of natural phenomena, attain a reasonable level of food security for its population and locally produce 97% of the medicinal drugs it requires;

3. Gross Expenditure on R&D (GERD) for OIC-Member States has quadrupled to an average of 0.8% for OIC-Member States from the 2005 average of 0.2%, and many OIC-Member States are investing heavily in the sectors of higher education and priority-focussed R&D;

4. Twenty-five OIC universities are ranked amongst the world's top 500 universities according to the QS World University Rankings 2012/2013, and OIC-Member States are making encouraging progress in terms of research publications with the number of research publications in international journals exceeding 90,000 in 2011 compared to around 20,000 in 2000; however,

TO RAPIDLY ACHIEVE SOCIOECONOMIC DEVELOPMENT THROUGH STI, THE IAS APPEALS TO THE DECISION-MAKERS IN OIC COUNTRIES TO:

1. Recognize the crucial role of STI and higher education in their respective country policies and strategies for socio-economic development and endeavour to heed the call towards increasing budgets for STI;

2. Encourage public understanding and awareness of science highlighting, in the process, gender equality, social inclusion and participation;

3. Organise programmes on leadership training for both domestic and regional research and innovation policy makers;

4. Evaluate the quality of statistical data on STI and the statistical system on research and development, as a prerequisite to developing sound and effective strategy in STI;

5. Further develop existing evaluation mechanisms for STI enterprises in order to assess progress on different levels; open national and transnational evaluation mechanisms to a diverse group of research and innovation stakeholders including civil society organizations, companies and investors;

6. Facilitate partnerships between public and private sectors in the field of STI and encourage both public and private R&D organizations and universities to use public research infrastructures;

7. Promote the central role of the university as an originator of scientific knowledge. To contextualize this role, universities should streamline their efforts not only to produce graduates in the various disciplines but knowledge workers. Knowledge production can be enhanced if universities segregate their research budgets from their administration budgets;

8. Increase utilization and enhance synergies and coordination between different instruments, initiatives and programmes for facilitating capacity-building and sharing of research infrastructures. Moreover, university-based R&D has to be directed not only at increasing humanity's pool of knowledge but also for developing products and services that can contribute to creating national wealth;

9. Create links between knowledge generation and enterprise development as this is one of the greatest challenges facing OIC and developing countries. Develop active partnerships with local and regional industries and come up with innovative ways to fund academic and industrial research and for commercialization of research outcomes;

10. Promote bilateral and regional cooperative agreements, within the OIC and at the South-South level; provide easy access to research facilities, infrastructures and science publications;

11. Intensify cooperation among developing countries, especially involving countries that have developed significant expertise in S&T policy development, S&T infrastructure, and the ever transformational areas of biotechnology, nanotechnology and information technology;

12. Focus on a limited number of priorities and regional smart specialization activities where some networks already successfully operate or some new ones may be developed; strengthen such networks with the view of making them attractive partners for neighbouring regions and states; support the best national research centres to enable them to participate in pan-Islamic/regional networks;

13. Further promote the development of local technology, partly by improving national incentive regimes including taxation, promoting the culture of technological innovation and generating markets for new products and services within their societies and internationally;

14. Increase investments in international STI projects; and take advantage of existing OIC organizations that are active in STI for research and innovation projects and for research infrastructure funding, and introduce measures that foresee the strategic inclusion of diaspora scientists;

15. Create a Brain Bank by tapping into the enormous expertise possessed by expatriate scientists and technologists originally from the OIC-region and develop conducive conditions to transform Brain Drain into Brain Gain and Brain circulation within the OIC-region;

16. Strengthen advisory structures across countries noting that in many countries science academies provide political leaders with advice. The advisory processes should be able to gauge public opinion about STI. At the level of the OIC, appropriate mechanisms should be worked out by the IAS to provide advice to OIC heads of state, parliamentarians and other decision-makers;

17. Recognize that it is important that OIC-Member States speak in one voice at the world level on specific commonly agreed issues, such as climate change. To this aim, they must commit themselves to increasingly coordinate common positions prior to international meetings and to use such meetings as platforms to further macro-regional agendas;

18. Develop partnerships with –for example- local pharmaceutical companies and utilize developed intellectual property to help develop a research-led pharmaceutical industry in the Islamic World,

FURTHERMORE, THE ISLAMIC WORLD ACADEMY OF SCIENCES (IAS):

In order to achieve the goal of 'Achieving Socioeconomic Development in the Islamic World through Science Technology and Innovation,' the IAS proposes the establishment of a consortium of existing and emerging centres of excellence in OIC-Member States. Such a consortium could focus on areas such as Drug Discovery and Development or Energy or Information Systems; and can serve as a model for international research and information sharing among academics, professionals and policy makers. Potential partners in this endeavour could be the International Centre for Energy and Information Systems (www.iceis.net) being developed at Virginia Tech, USA.

LASTLY, THE ISLAMIC WORLD ACADEMY OF SCIENCES (IAS):

Extends its appreciation to Her Excellency Sheikh Hasina, the Honourable Prime Minister of Bangladesh; Her Excellency the Foreign Minister of Bangladesh Dr Dipu Moni; His Excellency Yeafesh Osman, State Minister of Science and Technology; to the Bangladesh Universities Grants Commission (UGC) headed by Prof. A K Azad Chowdhury; to the Bangladesh Academy of Sciences (BAS) and the eminent Fellows of the BAS; to the Bangladesh University of Health Sciences (BUHS); Incepta Pharmaceuticals; for organising and sponsoring the conference; and to the Islamic Development Bank, COMSTECH, OPEC Fund for International Development (OFID), and the Arab Potash Company for generously co-sponsoring this international scientific congregation.

19TH ISLAMIC WORLD ACADEMY OF SCIENCES CONFERENCE
on
Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation (STI)

6-9 May 2013
Dhaka, Bangladesh

CONFERENCE REPORT[1]

Under the patronage of Her Excellency Sheikh Hasina, the Prime Minister of Bangladesh, the Islamic World Academy of Sciences (IAS) convened its 19th international science conference in Dhaka, the capital of the People's Republic of Bangladesh, during 6-9 May 2013. The theme of the conference was 'Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation (STI).'

Held at the Pan Pacific Sonargaon Hotel in Dhaka, the IAS Conference was an open activity in which over 200 local and international participants representing over 40 countries participated. Among the participants were Fellows of the IAS, local scientists from the various universities, young university students, expatriate Bangladeshi scientists as well as representatives of Asian, African and Western academies of sciences. Prior to the conference, the 20th Meeting of the General Assembly of the IAS as well as the 39th Meeting of the IAS Council were arranged.

The 19th IAS Conference was organised and sponsored by:

- Islamic World Academy of Sciences (IAS), Amman, Jordan;
- Prime Ministry of Bangladesh;
- Foreign Ministry of Bangladesh;
- University Grants Commission of Bangladesh; and
- Bangladesh Academy of Sciences.

It was co-sponsored by:

- OPEC Fund for International Development (OFID), Vienna, Austria;
- Islamic Development Bank (IDB), Jeddah, Saudi Arabia;
- Ministry of Science and Technology of Bangladesh;
- OIC Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan;
- Arab Potash Company, Amman, Jordan;
- Incepta Pharmaceuticals Ltd., Dhaka, Bangladesh; and
- Bangladesh University of Health Science (BUHS), Dhaka, Bangladesh.

[1] Prepared by Dr Moneef R. Zou'bi, DG, IAS.

The conference addressed a number of key issues in the domain of science, technology and innovation (STI) for development, and represented an attempt by the IAS to engage the Bangladeshi decision-making and science communities and draw possible lessons from the Bangladesh experience that could be of benefit to the wider community of OIC-Member States.

Bangladesh, which is among the most populous of OIC countries, is a country that is regularly affected by natural disasters. Yet, it is a country that has managed to develop the capacity to mitigate and manage natural phenomena effectively, and achieve a respectable level of food security for its vast population.

As a result of some obvious strengths in certain export-oriented industrial sectors, it has also managed to maintain high economic growth. And although there is limited interaction between public and private-sector actors and little university–industry collaboration, the country's ingenuity manifests itself in light engineering where it is producing import-substitution products that are creating employment and alleviating poverty. Endogenous technologies include those related to ferries, power plants, machinery and spare parts.

Bangladesh is also developing the high-tech sector of pharmaceuticals, and is almost 97% self sufficient in pharmaceuticals. To get first-hand experience of this particular sector, the conference participants visited one of the leading pharmaceutical companies of the country; Incepta Pharmaceuticals.

The above factors rendered Bangladesh a special case-study for the IAS and the OIC science community.

The objectives of the 19th IAS Conference thus were:

(a) To discuss the key areas of public health and higher education in Bangladesh to draw possible lessons relevant to other OIC countries, while showcasing some of the country's key S&T sectors;
(b) To analyse how science and technology can contribute to addressing real challenges in the domains of water and energy in populous underdeveloped countries, and analyse how linkages between the private sector and the science community in general may be strengthened;
(c) To review cases where research in the frontier areas of biotechnology and information technology could be transformed into commercial ventures;

The conference which was inaugurated by the Prime Minister of Bangladesh on Monday 6 May 2013, was preceded on Sunday 5 May 2013, by a ceremony which was organised on the premises of the Bangladesh University of Health Sciences (BUHS), to honour one of the Founding Fellows of the IAS from Bangladesh: Prof. Mohammad Ibrahim (1911-1989). During the ceremony, Prof. Liaquat Ali, an outstanding Bangladeshi medical researcher, was honoured as the recipient of the 2013 IAS Ibrahim Memorial Award.

The inaugural ceremony of the conference included an address by H E Mrs Sheikh Hasina, the Prime Minister of Bangladesh; a speech by H E Dr Mrs Dipu Moni, the Foreign Minister of Bangladesh; an address by H E Prof. Ekmeleddin Ihsanoglu, the Secretary General of the Organisation of Islamic Co-operation (OIC); the message of Prince El-Hassan bin Talal of Jordan, Founding Patron of the IAS, which was read by Dr Adnan Badran; the message of the President of Pakistan, IAS Patron, which was read by Dr M A Mahesar, Assistant Co-ordinator General, COMSTECH; and the opening address of Dr Abdel Salam Majali, former Prime Minister of Jordan and IAS President. The Chairman of the Bangladesh Universities Grants Commission, Prof. A K Azad Chowdhury; and Prof. A A Azad FIAS, IAS Fellow from Bangladesh who was the main local organiser of the event; also spoke during the session which was concluded with some closing remarks by H E Yeafesh Osman, State Minister of Science and Technology, Bangladesh.

The conference was divided into a number of main sessions: Thematic Keynotes, Excellence in Higher Education, Energy for the Future, Public Health, Drugs and Vaccines for the Future, Climate Change and the Environment, Rethinking Sustainable Development, Collaborative Research Case-Studies; as well as a panel discussion which was entitled 'Way Forward and Funding Strategies for the Future.'

The first academic session of the conference included keynote presentations by: Prof. Adnan Badran FIAS, Former Prime Minister of Jordan, whose presentation was entitled *Excellence in Higher Education for S&T Proficiency: A Global Perspective*; Prof. Atta-Ur-Rahman FIAS, President, Pakistan Academy of Sciences, who addressed the topic of *Higher Education S&T Nexus: Outlook for Tomorrow*; and Academician Dato Ir Lee Yee Cheong, Chairman of the Board of ISTIC in Malaysia, whose keynote was entitled *Building S&T Proficiency in Developing Countries: Ideas on the Hands on Approach*.

Prof. Badran indicated that a democratic environment of quality teaching and research based on merit, autonomous higher education institutions, appropriate funding and governance was an essential requirement for building S&T proficiency. Prof. Rahman, on the other hand, suggested that the three major players in the development of a knowledge economy were science and technology institutions (including universities), industry and the government. The development of a knowledge economy, he added, required a thorough understanding of the dynamic interplay between research, invention, innovation, and economic growth. Dato Lee's essential message was that building S&T proficiency was the raison d'être of the Inquiry Based Science Education programme (IBSE) of the InterAcademy Panel (IAP) as well as many science academies around the world.

The second working session of the conference included a presentation on the achievements of, and the difficulties faced by, the OIC Ministerial Committee on Scientific and Technological Co-operation (COMSTECH) by Dr M A Mahesar, Assistant Co-ordinator of COMSTECH. Also, the state of the higher education sector in Bangladesh was comprehensively described by Prof. A K Azad Chowdhury, Chairman of the UGC in Bangladesh, in his presentation.

Two world experts on renewable energy presented papers on renewable energy research in the third session of the day. The first, entitled *The Future of Renewables: Their Feasibility and Applications in Resource-Poor Countries*, was made by Prof. Saifur Rahman; Director, Virginia Tech Advanced Research Institute, USA. It focused on the future of renewable energy in "resource-poor" countries which were not endowed with significant extractable fossil-fuel energy resources. The second, by Prof. Marwan Khraisheh, Dean of Engineering, MASDAR Institute of Science and Technology, UAE, addressed the topic of *The Need for Multidisciplinary Research to Address Energy, Water and Climate Change Challenges,* and talked about the challenges of climate change, energy and water security, and how a dedicated response from the scientific and academic communities working in collaboration with industry and government, was required to develop innovative sustainable solutions to face up to such challenges.

The session on Public Health included a presentation by Prof. Abdallah Daar FIAS, Professor of Public Health Sciences and Surgery, University of Toronto on *Public Health Research, Policies and Funding Opportunities*, in which he emphasized the importance of mental health as an issue that should be addressed in many countries; a presentation by Prof. Ugur Dilmen FIAS, General Director of Health Research, Turkish Ministry of Health, and Editor of the Medical Journal of the IAS on *Public Health Research Funding and Policies in Turkey*; a presentation by Prof. Timothy Evans (Canada) of BRAC University, Bangladesh, which was entitled *Health Equity and Universal Health Coverage*; as well as a presentation by Prof. Muthana Shanshal FIAS, University of Baghdad, Iraq, on *The Public Health Food Safety Nexus: Carcinogenic Polyaromatic Hydrocarbons in Smut Wheat Infected with Tilletia Caries*.

The fifth working session of the conference represented an attempt to bridge the science and business community divide and addressed the topic of 'Drugs and Vaccines of the Future.' It included a presentation by Prof. Atta-ur-Rahman entitled *The International Centre for Chemical and Biological Sciences: An Example of the R&D Value-Chain*; a presentation by Prof. A A Azad FIAS, Incepta Visiting Professor, Bangladesh/ Australia, entitled *A Proposal for the Establishment of a Drug Discovery and Development Programme with Concomitant Capacity Development in the OIC-Member Countries;* as well as a presentation by one of Bangladesh's leading entrepreneurs, Mr Abdul Muktadir, the Founder and Chairman of Incepta Pharmaceuticals, who talked about his company which is one of the country's leading pharmaceutical manufacturers. The manufacturing facilities of Incepta were in actual fact visited by the participants in the conference on the afternoon of Tuesday 7 May 2013.

On the morning of Wednesday 8 May 2013, the session on 'Climate Change' included a presentation by Prof. Michael Clegg, Foreign Secretary, US National Academy of Sciences, who spoke on *The Climate Change Question: The Role of Scientists and Science Academies*. Prof. Clegg highlighted the pivotal role that science academies can play in bridging the divide between the science community and decision-makers.

That was followed by two outstanding research presentations by two of Bangladesh leading women scientists: Prof. Zeba I. Seraj, University of Dhaka; who presented a paper entitled *Production of Stress Tolerant Rice for Bangladesh by Use of Biotechnological Tools;* and Prof. Haseena Khan, South Asian University, New Delhi, India; whose presentation was entitled *From Marker to Gene: The Curious Case of a Putative vps51 Gene of Jute.*

The seventh session of the conference which was under the title 'Rethinking Sustainable Development' included a thought-provoking presentation by Dr Sandro Calvani, Asian Institute of Technology, Thailand, who talked about *Rethinking Sustainable Development in Least Developed Countries: The Politics Policies Nexus*. Dr Calvani talked about the new development vision that was emerging on the international arena which comprised eleven goals for global development, justice and peace. The goals include economic growth, food and water security as well as appropriate education, health, freedom as well as gender equality. That was followed by a presentation from Malaysia entitled *Food Security Initiatives for the Social Well Being of the Farmers: How Science Helps*, in which Prof. Aini Ideris FIAS, University Putra Malaysia; Prof. Khatijah Mohd Yusoff FIAS, Ministry of Science, Technology and Innovation; and Prof. Abdul Latif Ibrahim FIAS, University of Selangor (UNISEL), Malaysia; talked about the success of their long-term research project to develop efficacious vaccines, including one for Newcastle disease -which is a serious disease affecting poultry- that has led to an expansion of the village chicken industry in Malaysia.

The session on ‘Collaborative Research Case-Studies’ was chaired by Mr Yeafesh Osman, State Minister of Science and Technology, Bangladesh; and included a presentation entitled *Radionuclide Research and Development Studies Under Bangladesh-German Cooperation,* by Prof. Syed M. Qaim FIAS, Research Centre Juelich; in which he highlighted the long history of cooperation between the Institute of Nuclear Chemistry of the Research Centre Juelich, Germany, and the Bangladesh Atomic Energy Commission (BAEC).

Dr Peter Sundin, of Uppsala University, Sweden, and Ms Tatjana Kuhn, German Agency for International Cooperation, on the other hand talked about *The International Science Programme in Bangladesh: Self Interest or Empowerment?* Dr Sundin highlighted that the International Science Programme (ISP) was devoted to building capacity for scientific research and higher education in basic sciences in developing countries, since 1961, in physics, and since 1970 and 2002 in chemistry and mathematics, respectively. He added that the outcome of the ISP programme over the previous three decades was substantial and went on to cite actual examples of ISP’s collaboration with scientists in Bangladesh.

That was followed by a presentation by Prof. Mohammad Abdollahi FIAS, Tehran University of Medical Sciences, Iran; who spoke on *Ethical Issues in Scientific Publications, Role of the Committee on Publication Ethics (COPE),* and described the activities of the Committee on Publication Ethics (COPE) which was established in 1997 by a small group of medical journal editors in the UK, and yet in 2013 boasts a membership of 8500 from all academic fields.

Another example of research collaboration was presented by Dr Md. Feroz Alam Khan, Professor, Department of Physics, Bangladesh University of Engineering and Technology, who presented a paper under the title *Structural and Magnetic Properties of Core-Shell Manganese-Oxide Nanoparticles Fabricated by Inert Gas Condensation Technique.*

The last session of the conference was a very lively panel discussion chaired by Mr Yeafesh Osman, State Minister of Science and Technology of Bangladesh, and co-chaired by Dr Moneef R. Zou’bi, DG-IAS; in which Prof. Michael Clegg (USA), Prof. Bambang Hidayat (Indonesia), Prof. Abdallah Daar (Canada) and Prof. Khatijah Mohd Yusoff (Malaysia) took part.

The panellists discussed a number of issues including: science education, role of academies of sciences in raising awareness of scientific issues, the state of mental health in developing countries, climate change, how some countries such as Malaysia have adopted a national vision (Vision 2020), expanding the African Science Academies Development Initiative (ASADI) to include OIC countries, challenges of the 21st century including food security, climate change, funding science, young scientists and young entrepreneurs, nanotechnology for the future,…

The panel discussion was followed by the concluding session of the conference which was chaired by Prof. Mehmet Ergin FIAS, IAS Vice-President from Turkey.

At the conclusion of the 19th IAS Conference, the IAS adopted the IAS 2013 Dhaka Declaration on *Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation.*

The declaration stressed that the quest for knowledge is one of the seminal elements in the Islamic code of belief, and that up to the turn of the seventeenth century, the

Islamic civilization was a milieu *par excellence* for groundbreaking science; science which laid the foundation for the European renaissance. It also reiterated that the world economic uncertainty of the previous five years has been the source of serious difficulties for the Science, Technology and Innovation (STI) sector.

The declaration highlighted that STI was not a mere academic pursuit and that in the wake of the financial crisis, STI will make a vital contribution to sustainable and lasting recovery and to longer term growth prospects of most countries' economies. It invited the decision-makers and the science community in OIC-Member states to share the view that science transcends political borders, enhancing cooperation and acting as a catalyst for consolidating stability in the Islamic world.

The declaration noted that Bangladesh has achieved over 90% enrolment in primary education, has managed to take a number of actions to mitigate the negative effects of natural phenomena, attain a reasonable level of food security for its population, and locally produce 97% of the medicinal drugs it requires. It highlighted that Average Gross Expenditure on R&D (GERD) for OIC-Member states has quadrupled to an average of 0.8% for OIC-Member states from the 2005 average which was 0.2%, and that twenty-five OIC universities are ranked amongst the world's top 500 universities according to the QS World University Rankings 2012/2013.

The operative part of the declaration stated that it was important that OIC countries speak with one voice on the world level, and that the decision-makers within recognize the crucial role of scientific research and higher education in their respective national policies and strategies for socio-economic development. The declaration also made a special mention of the vital area of raising public understanding and awareness of science highlighting –in the process- gender equality, social inclusion and participation.

It also called for partnerships between public and private sectors in the field of science, technology and innovation and encouraged public and private R&D organizations and universities to use public research infrastructures and utilities fully.

It is essential, the declaration reiterated that OIC countries focus on a limited number of priorities and regional smart specialization activities where some networks already successfully operate or some new ones may be developed, and consider the quality of statistical data on STI and the statistical system on research and development, as precondition leading to the development of sound and effective strategy in STI.

The declaration further called for the promotion of scientific and technological cooperation among developing and OIC countries and for the creation of links between knowledge generation and enterprise development. To further promote the development of local technology, OIC countries need to improve their incentive regimes including taxation and must try to promote technological innovation and generate markets for new products and services within their societies, the declaration suggested.

The creation of a Brain Bank by tapping into the enormous expertise possessed by expatriate scientists and technologists from the OIC-region was another recommendation proposed in the declaration. Another was the establishment of a consortium of existing and emerging centres of excellence in OIC-Member states. Such consortia could focus on areas such as Drug Discovery and Development or Energy or Information Systems; and can serve as a model for international research and information sharing among academics, professionals and policy makers.

Lastly, the declaration expressed the appreciation of the IAS to Her Excellency Sheikh Hasina, the Honourable Prime Minister of Bangladesh; and its thanks and appreciation to the People's Democratic Republic of Bangladesh and all the organizations and agencies that organised and sponsored the conference.

As part of the follow-up action to the conference, the Academy will circulate the IAS 2013 Dhaka Declaration to concerned individuals and relevant agencies throughout OIC and developing countries, so that measures are taken to put into action the ideas proposed at the conference.

The IAS also intends to work further with the two Bangladeshi champions of science it identified as a result of the conference, the medical scientist Prof. Liaquat Ali and the entrepreneur industrialist Mr Abdul Muktadir, to disseminate the fresh and exciting ideas of these two role models to young researchers and aspiring entrepreneurs throughout the Islamic and Developing world.

The IAS will also publish the complete proceedings of the conference in a quality volume that will be distributed internationally.

Through IAS Fellows, personal contact and correspondence, the IAS will promote the concepts promulgated at the conference among the decision making circles of the Islamic world, and will provide whatever help it can to get the various recommendations implemented.

Message of Prof. A. K. Azad Chowdhury
Chairman (State Minister), University Grants Commission

It gives me immense pleasure to know that the Islamic World Academy of Sciences (IAS) is going to hold its 19th Conference in Dhaka from May 4-9, 2013. The IAS, an organization proposed by the OIC Standing Committee on Scientific and Technological Cooperation (COMSTECH) , approved by the Fourth Islamic summit at Casablanca in 1984 and formed in Jordan in 1986, has constantly been striving hard to promote the cause of science, technology and innovation in the Islamic World. The conference will provide ample opportunities to exchange views, share experiences and establish counterparts in Bangladesh. In today's world collaborative research bears far more significance in terms of publication and patenting in the realm of innovation compared to individualistic approach.

I believe that the conference will play an important role in promoting the research collaboration in science, technology and innovation in the Islamic world, a world which owns over 70% of the global energy reserve and much of financial strength but are lagging behind the innovations. The conference will help identify the priority areas of science & technology, especially the future technologies, and employ them to solve the problem that the Islamic World confronts to ensure better life and prosperity to their people in particular and to the mankind in general.

I wish the conference a grand success and hope that the objectives of the conference are achieved.

Address of
His Excellency Prof. Abdel Salam Majali FIAS
President of the
Islamic World Academy of Science

The Honourable Prime Minister of Bangladesh
Your Excellency the Secretary General, OIC
IAS Fellows
Excellencies
Distinguished Guests
Ladies and Gentlemen

السلام عليكم و رحمة الله و بركاته

- It is both a privilege and an honour to greet you all on behalf of the Islamic World Academy of Sciences, here in the city of Dhaka; where we meet at the invitation of the Honourable Prime Minister Sheikh Hasina, and the Bangladesh government. We are grateful to you Madame Prime Minister for your invitation and for your proactive stance vis-à-vis the OIC and OIC countries, in all spheres;

- I am also happy to welcome a dear friend; an eminent scientist in his own right; Professor Ekmeleddin Ihsanoglu, Secretary General of the OIC. A man who done so much over the past eight years to position the OIC on the world scene;

- Our assembly in this vibrant metropolis, with the scientists and the decision-makers of Bangladesh and the OIC, aims to address a number of scientific themes. The title of today's conference (Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation) clearly states our goal: to learn about the science and technology landscape of Bangladesh and expose the Bangladesh S&T community to aspects of the S&T landscape in OIC countries;

- We come here to learn. To learn how this populous OIC country has managed to develop the capacity to mitigate and manage natural disasters effectively, and achieve a respectable level food security for its vast population;

- Moreover, we are keen to understand how Bangladesh has managed to maintain high economic growth despite the common problem that most OIC countries face; namely, the weak linkage between public and private actors;

- One of the slogans proposed for this conference during the preparatory meetings was: 'Empowering People through Science.' I understand that in Bangladesh, there have attempts to promote S&T to bring about positive social change and balanced socioeconomic development. There are noteworthy attempts to leverage Information and Communications Technologies (ICTs) to raise the profile of the nation.

Excellencies
Ladies and Gentlemen

- Science and Technology is a tool of socioeconomic advancement. For science to blossom, it needs to be nourished and supported. This is not the case in the majority of OIC countries according to the latest UNESCO Science Report published in 2010. Nor are we building the human capital which is active in science. Indeed, the critical mass of researchers is not there in many countries. Furthermore, most OIC countries hardly export any high technology products;

- The Report shows that less than 25 OIC countries have a national academy of sciences or play host to a supranational academy. This is an astounding fact, as academies of sciences, as strong advocates of science and impartial advisory bodies have been at the vanguard of the scientific endeavour in many industrialized countries. They are also part of the S&T landscape in economically emerging economies such as Brazil, China, India, Malaysia and Mexico;

- The bottom line is that OIC countries face an uphill challenge in terms adopting science-based development policies to raise the socioeconomic level of our countries. More importantly perhaps, we are not using science to combat our immediate health, water and energy problems;

- Let me provide a time-line for some the difficulties that we have faced and have had to overcome in our history;

- For over a millennium, the Islamic world was a dominant global player in the domain of science and technology.

- The remarkable advancement made by the Islamic world in science ushered in the renaissance in Europe, yet during the 17th and 18th centuries, the Islamic world was dormant in terms of generating knowledge with emphasis -for a variety of reasons- placed on technology often imported from outside. Our patenting culture was non-existent and the decline of the use of Arabic (the language of the Qur'an) as the *lingua franca* of science contributed to our decline in science and technology;

- Unlike Japan, which enjoyed the Meiji Restoration of the 19th century which spanned from 1868 to 1912 and led to the transformation of Japan into a modernized nation; most of our countries have only enjoyed periods of short-lived reform;

- Suffice to say, a major factor that has contributed to the so-called 'Arab Spring' in our part of the world has manifested itself in the inability of economies to develop the appropriate value chain and create jobs required to meet the increasing number of graduates. That was further compounded by the inability of economies to achieve sustainable economic growth.

Your Excellency
Fellow Scientists
Dear Friends

- Clearly, there is a problem when it comes to the relationship between scientists and technologists – on the one hand- and politicians, on the other. Few politicians appreciate the possibilities of science, present distinguished company excluded of course, as Her Excellency the Prime Minister was married to eminent scientist; the late Dr M A Wazed Mia, and thus exposed to the trials and tribulations of a scientist's career;

- It is true that the majority of scientists do not understand the restrictions of political office or have a clear idea of the political processes. They do not appreciate the pressures or the time scales politicians work to. Both camps recognize the importance of each other but there is no natural dialogue between the two sides, because they come from different worlds;

- Bridging the gap the gap by creating better communications between the science and non-science worlds, between the scientific and the political communities, should be a priority;

- Some scientists are good communicators (Bruce Alberts of the US National Academy of Sciences and Ahmad Zewail are good examples) and they could be considered as role models and encouraged to share their expertise with others;

- Let me at this point also thank Her Excellency the Prime Minister for the support the government of Bangladesh has been providing to the Bangladesh Academy of Sciences and request her to tap further this reservoir of talent for science-based advice on issues that affect the development of Bangladesh;

Your Excellency
Dear Friends

- The IAS is slowly but surely trying to renew the *Ummah* its confidence back that things can change. The IAS does this on a shoe-string budget yet with dedication and confidence. We realize that we have long to go;

- We realize that the activities of academies of sciences are often appreciated long after they are implemented. Only recently did we realize this when the Royal Society of London celebrated its 350th Anniversary, and only recently have we begun to realize what the Academy of *Bait ul-Hikma* of Baghdad had achieved 1200 years ago;

- My late friend Abdus Salam, Nobel laureate of 1979, used to insist that *Bayt ul-Hikma* was the 'Institute of Advanced Study' of its day championing the cause of science in the court of *Al-Mamun;*

- As the academy of sciences of the OIC, the IAS is keen to champion the cause of science for development, especially through capacity-building, knowledge-sharing and promotion of international and regional cooperation;

- Let me conclude by again thanking Madame Prime Minister for your patronage, and you Madame Foreign Minister for your support in realising this activity. We are also grateful to all the Bangladeshi agencies and companies as well as our distinguished Fellows from Bangladesh who have helped the IAS in making this event a reality.

والسلام عليكم و رحمة الله و بركاته.

Message from Mr. Asif Ali Zardari
President of the Islamic Republic of Pakistan

(On the occasion of 19th Conference of Islamic World Academy of Sciences (IAS))

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I wish to congratulate the Islamic World Academy of Sciences (IAS) on organizing 19th Annual Conference on "Achieving Socio-Economic Development in the Islamic world through Science, Technology and Innovation". I also wish to appreciate the Government of Bangladesh for patronizing this important Conference. I welcome the eminent scientists of the Muslim world including the Fellows of IAS and all other participants and wish them productive deliberations during the course of this Conference.

Conferences like this provide a unique opportunity to scholars to learn from the knowledge and experience of their peers and also to highlight the latest advances made in conducting research and benefiting from it. The mutual sharing of the expertise and knowledge enriches the sum total of human knowledge and is of great benefit to the entire mankind. The pyramid of knowledge was not raised overnight. It was built brick by brick over the past centuries in which sharing of knowledge has played a pivotal role. Indeed conferences like this one are the building blocks of the pyramid of knowledge.

A great challenge that lies before us is the threat to environment and ecosystems posed by the over use of carbon-based energy resources. Climate change and global warming have already started taking a deadly toll on our continents, our wildlife, our food sources and on the life of every man, woman and child on our planet. The issue of climate change has posed even greater challenges to the member of OIC who are also faced with the challenges of rapidly growing populations and dwindling resources. The situation, therefore, calls for deploying our best brains so as to take full advantage of the scientific advances in confronting the challenges faced by us all. I am confident the IAS is cognizant of this challenge and is taking all necessary measures to address it.

The IAS can play an effective role in bridging the gap between the Islamic world and the West. Our scientists and the Fellows of the Islamic Academy of Sciences possess the abilities and have the potential to devise credible strategies and action plans for OIC member states to pursue their development agendas while protecting the environment at the same time. Many will look forward to the outcome of the deliberations of this important conference and its recommendations for helping the Muslim world use science for improving the quality of life of their citizens.

I wish the 19th Conference all success in its endeavour and pray for successful accomplishment of its goals.

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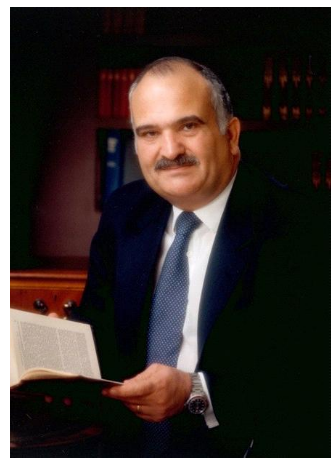
Message[1] of
His Royal Highness Prince El Hassan bin Talal of Jordan, Founding Parton of the Islamic World Academy of Sciences

بســــم اللـــــه الرحمـــــن الرحيـــم



Honorable Prime Minister Sheikh Hasina
Your Excellency, Prof. Ekmeleddin Ihsanogla, the Secretary general of OIC
Excellences, Distinguished Guests
Dear Fellows

- I am sorry for not being able to join you at this 19th IAS conference. My thoughts are with you and the families who lost their beloved ones in the recent factory building collapse.

- Bangladesh is a functioning democracy that has managed to achieve sustainable economic growth. This should be highlighted. Achievement linked to democracy should be recognized including its fight to eradicate poverty and unemployment, in an effort to achieve the millennium development goals (MDG's).

- Diversification in agriculture, fisheries, industries and hi-tech pharmaceuticals have provided sufficiency in food & health care to local markets, and increased export earnings abroad.

  Excellences, Fellow members:

- Education is vital in achieving socio-economical development. It empowers people to confront current and future challenges: to generate knowledge, through R&D, to provide technologies and innovations. These in turn will accelerate the wheels of growth and economy towards sustainable development.

- Bangladesh is well known for its human capital of sizeable expatriate community around the world, that is helping institutions and organizations at home. Connectivity and bridging with those could convert the "brain drain" to "brain gain" and "brain circulation". Then a wealth of national expatriates, if managed properly, will become the scientific backbone and technology transfer of the country.

[1] Delivered by Prof. Adnan Badran FIAS.

- Bangladesh has managed well so far to use science for mitigating the effects of natural disasters. An adequate infrastructure for quality and relevance of delivery of higher education, is essential to build a sustainable human capital for the advancement of science.

- Robust R&D requires inducing environment of democratic institutions based on equality, justice, merits, and quality human resources, technical capacity, managerial skills, hands-on entrepreneurs and innovators for transfer of technology…all of these are basics for a capacity building in k-economy.

- At the RSS "Royal Scientific Society" in Amman, we have developed a centre of excellence of R&D , fed to incubators and then to a techno park, financed by venture capital to help entrepreneurs of start-up companies. Also, at the Arab Thought Forum which I chair, we launched the Arab Social Charter which was charted by intellectuals and thinkers of the Arab region, which will be followed soon by Arab Economical Charter.

- Last but not least, I would call on my IAS fellows to identify centers of excellence and declare from Dhaka, the creation of network of centers of excellence in the Islamic World to undertake joint research programs, exchange of scientists, and training. This will strengthen South-South cooperation and build a strong base in disciplinary and interdisciplinary science for solving problems of development in our Islamic countries, and be at the frontier edge of knowledge in the Islamic society.

Thank you

HRH Prince Hassan

Address of
His Excellency Prof. Ekmeleddin Ihsanoglu

on

Achieving Socio-Economic Development in the Islamic World Through Science, Technology and Innovation

Honourable Prime Minister, Her Excellency Sheikh Hasina
Distinguished Foreign Minister of Bangladesh, Dr Dipu Moni,
Distinguished Council, Fellows and Staff of the Islamic World Academy of Sciences,
Representatives of national and global academies of sciences,
Scientists and Scholars,
Excellencies,
Ladies and Gentlemen,

It is a great pleasure for me to address the 19th International Conference of the Islamic World Academy of Sciences. I thank the government of Bangladesh and the Islamic World Academy of Sciences for inviting me as a special guest. The theme of this Conference 'Achieving Socio-Economic Development in the Islamic World through Science, Technology and Innovation' is extremely relevant in the context of contemporary challenges facing the Muslim world.

Progress in science, technology and innovation is crucial for the socio-economic development of the OIC Member States and addressing the contemporary challenges of development, poverty eradication, environment, climate change, human health, energy and water resources.

Being an affiliated institution of the OIC, the Islamic World Academy of Sciences has a significant role for promoting science and technology in the Islamic world.

Excellencies,
Ladies and Gentlemen,

There is general recognition of the crucial role that science and technology can play in the advancement of the OIC Member States. This recognition has translated into political commitment of the OIC Member States to work towards becoming a community that values knowledge and is competent in utilizing and advancing science and technology. The 10th OIC Summit Conference held in Putrajaya, Malaysia in October 2003, adopted the OIC Vision 1441H for Science and Technology. The Vision contained 26 recommendations pertaining to 7 key strategic areas for advancing Science and Technology with a view to enhancing the socio-economic well-being of the OIC Ummah. Likewise, the OIC Ten Year Programme of Action (TYPOA) adopted by the 3rd Extraordinary Summit, held in Makkah in December 2005, encouraged public and private national research institutions to invest in advanced technologies. I was personally involved in the preparation and adoption of the TYPOA wherein the Member States undertook to take steps to increase their national spending on R&D from the then existing level of 0.2% of the GDP to the level of 1%, i.e. at least half of the global average of 2%.
Since 2005, the OIC and its institutions have considerably strengthened their activities in science and technology through programmes for strengthening of R&D, conducting STI Foresight studies, and

promoting emerging technologies such as nanotechnology and biotechnology. Efforts by the OIC Member States and concerted action by OIC and its institutions have led to encouraging progress.

One major institutional reform which the OIC undertook to give impetus to Science, Technology and Innovation in the Member States has been the establishment of the Science, Technology and Innovation Organization (STIO) as a Specialized Organ of the OIC in accordance with Chapter XIII, article 24 of the OIC Charter adopted in 2008.

The STIO is conceived as an institution responsible for implementing the STI related decisions of the OIC policy making forums. Its objectives include the promotion of smart partnerships and pooling resources of the private and public sectors for research and development, maximum utilization of the scientific talent and technological potential of Member States, fostering technical competence and capabilities and launching specific bilateral or multilateral projects, involving industry, research and academic centers. So far 18 OIC Member States have joined the STIO. I call upon other Member States to join the STIO and strengthen our collective pursuit of excellence in science, technology and innovation.

I will give you a brief overview of the current status of science and technology in the OIC Member States with a view to identifying some challenges and ways to addressing those challenges.

Excellencies,
Ladies and Gentlemen,

In 2005, OIC Member States were on an average spending 0.2% of the GDP on R&D. This figure has now quadrupled to 0.81% which is in the vicinity of the target set by the TYPOA. Among the OIC Member States, Tunisia, Iran, Turkey, Malaysia, Pakistan, Gabon, Morocco and Uganda have met the target of 1% or above. Heavy investments in Higher Education, R&D and innovation by Turkey, Qatar, Saudi Arabia, UAE, Tunisia, Pakistan, Iran Nigeria and Malaysia all point towards a reawakening in the Muslim world.

Overall eighteen universities from the OIC Member States are now included in the top 400 World University Rankings Supplement of the QS for 2012.

The OIC Member States have also made encouraging progress in terms of research publications. In the year 2000 scientific publications in international journals by scientists and engineers from 57 OIC Member States numbered 20, 224. This number increased more than four folds to 92, 503 in 2011. Turkey's output increased to 23,157 in 2011 from just 5000 in the year 2000 while Iran's output increased to 21,485 papers in 2011 from 1300 in the year 2000.

In 2003, the number of researchers, scientists and engineers in the OIC countries engaged in R&D was around 250 per million i.e. one-tenth of the world average of 2532 per million. This number has now nearly doubled to 457 i.e. one-fifth of the world average. Despite the often negative headlines about the status of women in OIC Member States, women in the OIC represent around 33% of the total researchers. This is higher than the world average of 30.2% and slightly above the EU average of 32.8%.

According to the Global Innovation Index (GII) , which is published by the World Intellectual Property Organization (WIPO), is a composite indicator that ranks economies in terms of their enabling environment to innovation and their innovation outputs. According to the 2012 GII version, 9 OIC countries, Malaysia, Qatar, UAE, Bahrain, Oman, Saudi Arabia, Brunei, Kuwait and Jordan have GII above world average. Malaysia (32nd), Qatar (33rd) and UAE (37th) are the three best performing OIC countries.

Excellencies,
Ladies and Gentlemen,

Despite the encouraging progress, we need to bear in mind that the OIC Member States have a long way to go in order to catch up with the advanced knowledge-based Western economies. We need to adopt comprehensive strategies for the promotion of science, technology and innovation as driving force behind economic development. I will briefly indicate some of the key steps which need to be taken to ensure a transformation to knowledge economies.

Long-term STI policy planning

A meaningful transformation to knowledge-based economies requires long-term STI strategies and embedding technology development in the planning processes of the Member States. In this regard, the relevant OIC institutions such as COMSTECH and Islamic World Academy of Sciences, national science commissions and national academies of sciences can play an important role by strengthening their existing training programmes and capacity-building activities in the realm of STI policy planning and in the development of S&T as a matter of government policies.

Technology mapping and foresight

Documents on technology mapping and foresight can serve as important reference documents and guides for planning and prioritization of S&T projects and long term STI strategies. For this purpose, the OIC General Secretariat, in collaboration with the relevant OIC institutions and Qatar Foundation, and partners across Europe and North America (Royal Society, British Council, Nature Magazine and IDRC) initiated the Atlas of Islamic World Science and Innovation project. Under the Atlas project, country case studies on the status of STI and the future prospects and challenges have been launched on Malaysia and Egypt. Case studies on Jordan, Kazakhstan, Senegal and Indonesia are at various stages of preparation and are expected to be launched soon. For the obvious constraints of time and resources, the project could not cover all OIC Member States. OIC institutions like COMSTECH and SESRIC can assist other Member States in the conduct of similar mapping and foresight exercises.

Provision of enabling environment

Successful transformation to knowledge-based economies and flourishing of science and technology necessitates an enabling environment in a country that is conducive for knowledge to be used effectively for economic development. This includes development of relevant institutions, rules and regulations, favourable fiscal regimes, economic incentives and market reforms. The development of the necessary human capital is a major factor in this context.

Investment in education

In order to produce researchers, scientists and a trained workforce which can ensure sustainable progress in science and technology, strategic and sustained investment at all levels of the education system is required. Given the predominantly young population of all OIC Member States, the demand on higher education is expected to grow further in the future. This will require further expansion in higher education opportunities.

Private-sector participation and academia-industry linkage

In the technological advanced countries the private sector provides a strong driving force for innovation and technological advancement. OIC Member States need to pay special attention to private sector participation in R&D, public-private and academia-industry partnerships. With a few exceptions, R&D in a majority of OIC member States continues to be a public sector concern.

It is no coincidence that countries such as Malaysia, Turkey and Kazakhstan with highest concentrations of R&D in private sector among the OIC countries, and highest shares of business sector funding for R&D, also lead in terms of patents and high technology exports.

In this regard it will be helpful to focus on promoting technologies which have economic potential and socio-economic benefits and thus can attract private sector interest. Incentives for private sector investment in R&D can take the shape of tax exemptions, rebates and other financial incentives.

International partnerships and collaboration

The global nature of the contemporary challenges of development, poverty eradication, environment, climate change, human health, energy and water resources, necessitate collective responses. Collaboration and partnerships in science and technology at all levels have therefore become an imperative for the international community.

The OIC and its institutions are therefore focusing on promoting inter-OIC as well as broader international cooperation in areas such as human health, water security, food security, renewable energies, green technologies, nanotechnology, environment and climate change.

The first requirement for the success of any collaborative scientific undertaking is the clear definition of goals and targets for such a joint undertaking and careful choice of partners. Partnerships have to be based on realistic assessments of the strengths and comparative advantages of various partners, available resources and capabilities and expected value addition of such collaboration.

An OIC-level patent system, similar to the African Region Intellectual Property Organization or European patent Organization, should be considered to increase incentives for patent applications in the OIC Member States. Such a system can bring higher benefits for patent holders through the right of being granted patents in a larger geography and will also foster collaboration between OIC countries in R&D.

At the international level the OIC is seeking to strengthen and expand the scope of its partnerships. In the area of health, OIC is collaborating with the US in mother and child health projects in Bangladesh and Mali. We are also cooperating with the WHO and other partners for preventing and combating diseases and pandemics such as Polio, Malaria, TB, HIV/AIDS. We are seeking to establish similar partnerships for education and issues such as climate change, water security etc.

Excellencies,
Ladies and Gentlemen,

The future of science in the OIC Member States will depend on their ability to address the practical challenges in the way of scientific development and take the right policy decisions for fully exploiting technology's development potential.

Deploying science and technology to bring prosperity and change the daily lives of the people by addressing the basic needs such as water, education, health care, food and shelter will foster greater recognition of the value of science. Getting the scientific and technological developments to people requires an understanding of their social dimension and the context in which they must operate. This in turn necessitates participatory approaches to the development and finalization of policies and priorities.

The recent political development in the region provide a reason to hope that STI decision making will become more participatory. A lot will depend on how much knowledge and innovation are adopted as barometers of progress and the will of the governments to take steps to foster a culture of meritocracy and institutional supremacy. A stable political environment will be conducive to long-term planning and focus on S&T. It can help attract participation from businesses, private sector and diaspora networks of scientists and experts. Political instability and economic mismanagement on the other hand can sap resources needed to invest in science and technology.

Thank you.

Message of Dr Dipu Moni
Minister of Foreign Affairs, Bangladesh

We are delighted that under the patronage of Her Excellency Prime Minister Sheikh Hasina, the 19th International Conference of the Islamic World Academy of Sciences (IAS) is being organized in Dhaka on 6-9 May 2013. I extend my warm felicitations to the organizers for publishing this souvenir.

The conference is expected to bring together distinguished scientists from all over the Muslim world for exchange of ideas and views. It is my firm conviction that this will pave the way for achieving greater socio-economic development in the Muslim countries through optimum use of science, technology and innovation. My sincere thanks go to all concerned for devoting their time, energy and effort in preparing for the Conference.

I deeply appreciate the Islamic World Academy of Sciences (IAS) for its commitment to the endeavour of exchange and transfer of technology and scientific knowledge among the countries in the Muslim *Ummah*. With a view to facing challenges of the 21st century, IAS has been carrying the mantle of promoting the values of science and reason in the Muslim societies.

The Government, under the leadership of Her Excellency Prime Minister Sheikh Hasina, envisions a 'Digital Bangladesh' in the year 2021 when Bangladesh will celebrate its golden jubilee of her independence. Science and technology will play the pivotal role in the achievement of that cherished goals. In this context, it has been my privilege to have a role in organizing the 19th International Conference of the Islamic World Academy of Sciences. With deep respect, gratitude and admiration, I acknowledge the kind support and guidance provided by the Honourable Prime Minister in successfully holding this conference.

I hope that this Conference will not only facilitate the exchange of knowledge and expertise among the renowned academicians but also inspire greater quest for learning among the young scholars towards building an enlightened Muslim world.

I wish the Conference all success.

Address of
His Excellency Shiekh Hasina
Prime Minister of Bangladesh

The Chair,
Cabinet Colleagues,
His Excellency the Secretary General of OIC,
His Excellency the President of IAS,
Members of Parliament,
Excellencies,
Distinguished Guests and Participants,
Ladies and Gentlemen.

Assalamu Alaikum and a very good morning to you all.

I am privileged to be with you this morning at the 19th International Conference of the Islamic World Academy of Sciences on the theme "Achieving Socio-economic Development in the Islamic World through Science, Technology and Innovation". Allow me to warmly welcome all the participants to this congregation of scientists from all over the Muslim world.

Distinguished audience,

Bangladesh is proud to be an active member of the OIC and its subsidiary, specialized and affiliated institutions. Holding of this international conference in Bangladesh in cooperation with an OIC-affiliate body reminds me of the attachment that Father of the Nation Bangabandhu Sheikh Mujibur Rahman had with the OIC.

The historic participation of Bangabandhu Sheikh Mujibur Rahman in the Second Islamic Summit Conference in 1974 set the policy direction for Bangladesh towards widening its relationship with various institutions of the OIC.

He gave us the inspiration to work together with all other Muslim countries so that we can prosper together on the basis of noble Islamic values of unity and fraternity. It is in this spirit that, through the years, scientists of Bangladesh have been committed members of IAS in implementing various programmes that have contributed immensely to sharing of information and knowledge, replication of best practices, and creation of a network of experts.

I take this opportunity to express our gratitude to IAS for extending cooperation and assistance in the field of science and technology in Bangladesh.

Ladies and Gentlemen,

The quest for knowledge is one of the seminal elements in the Islamic code of belief. Indeed, the golden age of the Muslims was marked by excellence in the pursuit of pure and applied sciences.

Contribution of Muslim scholars to the evolution of science and technology is immense. Astronomy, mathematics and every discipline of physical science, including medical science, have been built upon the innovations and theories propounded by our great Muslim scientists.

For instance, Algebra was invented by the great Muslim mathematician Al-Khawarizmi. The great Al-Biruni opened a new horizon in Trigonometry. He has equally contributed to Geometry and Natural History, even Geology and Mineralogy.

It is the Muslims who invented the symbol of zero. The most precise solar calendar, the Jilali, was devised under the supervision of Umar Khayyam. After the fall of Rome in 476, during the Dark Age in

Europe, these were Muslim physicians who helped medical science grow for the human civilization. Ibn Sina, Al-Razi and Al Kindi were perhaps the greatest physicians that the world had seen until the modern era.

We have a rich history for which we all can be proud of. Our past generations have done their part well and it is now our job to build further on their achievements.

Scientific and technological advancement and socio-economic development are intertwined. Scientific and technological advancements have been the prime movers for development of the industrialized countries.

In the contemporary world, science has been assuming increasing importance in a technology-driven world. Huge majority of member states of OIC have to face daunting challenges in the economic and environmental areas.

Backwardness of Muslim countries in the areas of science and technology is one of the factors that aggravate our difficulties. Utilization of science and technology and innovation can help greatly in addressing challenges like food, water and energy insecurity.

Use of science and technology can also help realize the goal of growth and prosperity. Cooperation of Muslim countries in this area will be extremely useful.

In this spirit, Bangladesh has been hosting the Islamic University of Technology (IUT), a subsidiary organ of OIC that is contributing to human resource development of the member states. It is important that member states support and fully utilize its potentials.

As part of its ‘Vision 2021', my government aims to establish a knowledge-based and technology-dependent Digital Bangladesh by the year 2021 when Bangladesh will celebrate the Golden Jubilee of her independence.

Information and communication technology can indeed offer unprecedented gains not only in terms of saving cost but also in achieving faster, safer and more transparent methods of management.

Experience-sharing among the Muslim countries as well as undertaking projects towards capacity building in ICT may be a useful stepping stone in the right direction.

I am also pleased to know that IAS has managed to raise the profile of science in the OIC member countries and has become a propagandist for science and technology in political circles within.

I am also pleased to learn that IAS has become a house of expertise on matters related to higher education, natural resources development including water and energy as well as the environment at the level of the OIC, especially within the academia.

Ladies and Gentlemen,

I firmly believe that the meetings and interactions that participants will have during the next four days will contribute not only to further enrichment of their knowledge and expertise but also in fostering a friendly and enduring relationship of the foreign participants with Bangladesh as a country and as a people.

We hope that such an enhanced relationship will give them a stronger reason to visit Bangladesh again in the future for business or pleasure.

I wish the conference all success. I thank you all.

Message of His Excellency Yeafesh Osman
State Minister for Science and Technology of Bangladesh

Science and Technology plays the main role as driving force for socioeconomic development in the modern world. Organizing the 19th IAS Conference with the theme of 'Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation' is a time worthy initiative. Bangladesh is one of the Islamic countries which has given greater emphasis on science and technology for achieving objectives of vision 2021. We are extremely happy to organize this event jointly with IAS in our country.

I am also pleased to know that some of the most prominent scientists, managers and policy planners of the Islamic world have gathered on the occasion. Sharing experiences, this conference will help us for our betterment. I sincerely hope that important recommendations will come up from this conference to move the Islamic World forward into the future,

I wish great success for this conference.

Excellence in Higher Education for Building S&T Proficiency: a Global Perspective

ADNAN BADRAN FIAS
Former Prime Minister
Chancellor, University of Petra

1 ABSTRACT

Human capital is the driving force for k-economy in a competitive global marketplace. Higher Education institutions are the incubators of quality and relevance in producing the R&D workers and entrepreneurs dealing on daily bases with avalanche of information, for the construction of knowledge (K). Therefore, flexible value-added competitive higher education which trigger innovation and creativity and create science-based R&D is a must for releasing the human potential to new horizon of new frontier areas of science and technology. However, democratic inducive environment of quality teaching and research based on merits, competitiveness, autonomous higher education institutions, appropriate funding, governance, accreditation and quality assurance of delivery of graduates and R&D outputs are essentials for policy of building excellence in S&T proficiency.

Higher Education provides the basics to capacity building and empowering people in “problem-solving” and confronting challenges of the “marketplace” and quality of life. It generates brain-intensive knowledge and skills through delivery of quality and relevance of human resources and R&D to turn the wheels of development to generate wealth and alleviate poverty.

But what type of higher education are we talking about… Education is an ongoing process of development of skills and pedagogy. It is an evolutionary process and never stops. It should be flexible to meet the emerging needs and to initiate new materials and technological packages and services. It mutates to renew itself. It is truly the vehicle for economy, growth and development. But what growth are we moving to…. we’re moving toward globality of the “market economy”, in a world of “interdependence”, where the corporate has no “distinctive nationality” and with business outreach. Comparative advantage gives an edge of shifting brain-intensive workers, S&T and innovations across the globe. This is where excellence of higher education becomes the edge of those shifts for producing well-prepared human resources to meet the needs of global economy.

It is imperative that the higher educational system should be “flexible” to respond to changes, and build an endogenous capacity to steer human resources to new opportunities, it has to do that quickly and efficiently, or otherwise higher education may become “obsolete” and has no meaning for the social and economical developmental of the nation, and has no value-added for the society.

2 CAPACITY BUILDING FOR EXCELLENCE

Endogenous sustainable development is possible at the national level. An adequate infrastructure for quality education, training and research for industrial and knowledge-driven economy and adequate trained capacity, teachers, researchers, technicians, engineers, bureaucrats, managers and hands-on entrepreneurs and innovators for technology transfer are a prerequisite for endogenous development.

Robust R&D requires an inducing environment for research and science advancement. Democratic environment where equality and justice and good governance based on merits prevail across the cadre of the society; through such an environments, the potential of the brain will be unleashed to higher orbits of knowledge and creative thinking and innovations. Competitiveness will rise high in the framework of equal opportunity for all.

3 START WITH THE YOUNGS

We should be realistic, tertiary education alone cannot do it, without reforming continuity of secondary, elementary and KG schoolings.

The spark of education starts at the pre-schooling and primary years, where critical thinking, logics and the analytical mind are created at early childhood of education. The old theories on learning, overloading the poor child, are becoming obsolete.

We should not underestimate the power of the brain at the critical period and the brain has the absorbing acquiring capacity of the right skills, attitudes, concepts, behavior and motivation.

The youngs should be trained in math for logics, in science for the analytical mind and scientific methods, in languages to dialogue with other cultures, to live and work with others, in computation to navigate through the daily avalanche of information to construct knowledge, and in ethics and behavior to build teamwork, for sound societal democratic structure. To achieve that, classrooms have to change from traditional teaching to blended interactive learning, where the teacher has to be trained to be facilitator, participant in the interactive learning process rather than disseminator.

Through such reform in skills and pedagogy at pre-schooling and in primary and secondary cycles, higher education would have outstanding inputs from the first cycle of motivated students by “inquiry about life”, about “environment” and “love of discovery” through scientific research and development, at the tertiary cycle.

4 POLICIES FOR BUILDING EXCELLENCE IN EDUCATION FOR S&T PROFICIENCY

The drive for procurement of excellent scientists by competitive universities and the corporate, to stay ahead in the global market place, will push for the human capital. Citizenship will give away to excellence and efficiency. The phenomenon of brain drain and brain gain will not exist anymore, but will be replaced by brain circulation of high quality human capital for high-tech industries and low cost human capital for R&D.

The market-driven and multidimensional process of globalization may overcome the division of the world into developed and developing, and will penetrate countries of the South intensifying interactions with local conditions, in diverse ways, and producing a hybrid system of behavior. A conflict may arise between the “old” and the “new”, between tradition and modernity, between being freely open to the outside, or feeling insecure and close arbitrary to the new winds blowing from the North. Education has an important role to play here.

Therefore, quality of human resources to meet the challenges of tomorrow has to be put in place to prepare for building a knowledge society leading to sustainable research-based k-economy.

Developing countries that have progressed fastest in recent years are the ones that have adopted policies to promote science, technology and innovation and have contributed to global R&D. They invested in science, and that investment turned the wheels of development and shifted the society from poverty and ignorance into enlightment.

5 LEARNING FOR THE FUTURE

Decades ahead will bear so many challenges in a competitive k-economy. Therefore, learning has to be flexible to meet and initiate demands. Blended integrated interdisciplinary curriculum with strong component of online lectures put on the web by outstanding universities, free of charge should be utilized to bring the cutting-edge of science into the learning process. MIT, Stanford, Columbia, Harvard and other distinguished institutions placed their lectures of courses they offer on the internet.

Interactive learning is used by scholars to bring critical thinking to the classrooms. Computing technology and communication suited for every students level were brought to the classroom to activate and catalyze creativity, inquiry, research and new skills. Textbooks are replaced by a mix of hardcover and wide range of software, videos, CD-Rom, and interactive cyberspace educational media. New role of the teacher through in-service and out-service training has emerged as constructors of knowledge. Teachers became facilitators rather than disseminators of knowledge.

Students will become the future researchers and K-producers and life-long self-learners. They become more involved in outreach programs in the business community. They are truly the vehicles of development in the K-societies.

They will constitute the future of human capital in the competitive marketplace. Diversity of education away from the current traditional lines which were born after the industrial revolution will be in place as an innovative approach to interdisciplinary and trans-disciplinarily to develop intelligence in problem-solving and ability to explore, inquire and discover in a dynamic environment.

This will lead to new generation of entrepreneurs who innovate from data mining on the web. Research projects become part of the graduation requirement, and participation in workshops and seminars will shape up the thinking of the graduates.

To follow the proceeding lines of modern learning to deliver quality and relevance of human resources is not an easy job. It requires persistence, quality assurance, assessment and evaluation. It requires set of policies to nurture the process of learning from childhood to maturity. Those sets of policies will be elaborated on, in the following paradigms.

6 POLICY ONE: LITERACY IN SCIENCE

Science has changed our life style. It has brought the technology we enjoy of new digital information and communication, internet, mobile phones, electrical appliances, energy, automotives, transport, food and agriculture, medicine, pharmaceuticals, health etc...

Literacy in science is becoming so necessary as reading and writing for a living in a healthy society. Scientific literacy implies “the ability to respond to technical issues in our daily life”. Science fuels technology; and “technology” is the engine of economic growth: create jobs, builds new industries and improve our standards and quality of life.

Workers are required to understand complex instructions in order to operate equipment, and to understand the vast information disseminated by the mass media about technological matters. It is needed at home to operate electrical appliances and to enjoy the fruits and appreciations of science discoveries.

1. Science education should reach all students and start in early stages of childhood and continues through all years of compulsory basic education (10 years).

2. Also, it must train students in the secondary cycle, to prepare students to study science and engineering, in technical schools and universities to become the scientists and engineers who occupy critical positions in industrial and economic development. Schools must also prepare the workforce demanded by science-based industries requiring technically skilled workforce.
3. Science in schools is largely taught as a reading subject from textbooks. However, science is much better learned, when is taught by illustrating principles with practical observations and experiments, derived from the daily experience and local environment.
4. The last point, is that dedication of teachers as “constructors of knowledge” is crucial to motivation of students toward science education. The mass media, can play an important role here.

To cope with all those advances made by science, k-society will be in the making. So literacy in science, is crucial to deal with green economy and interact with change.

7 POLICY TWO: STRENGTHENING SCIENCE, MATH, COMPUTATION AND LANGUAGES AT THE NATIONAL LEVELS.

To overcome the negative symptoms of out-dated teaching of science, math, ICT, and English and other languages in schools, SMED centers are recommended, to be created. These centers will deal with the development of curricula, teacher training in science, math, computation and English and other languages. It will be composed with workshops, language labs, seminar rooms and highly equipped labs staffed with high level professionals to undertake a major task of preparing teachers of science, math, IT and English in schools from KG until the end of the secondary cycle. The centre may be organized around three pillars (departments) as shown in Figure 1.

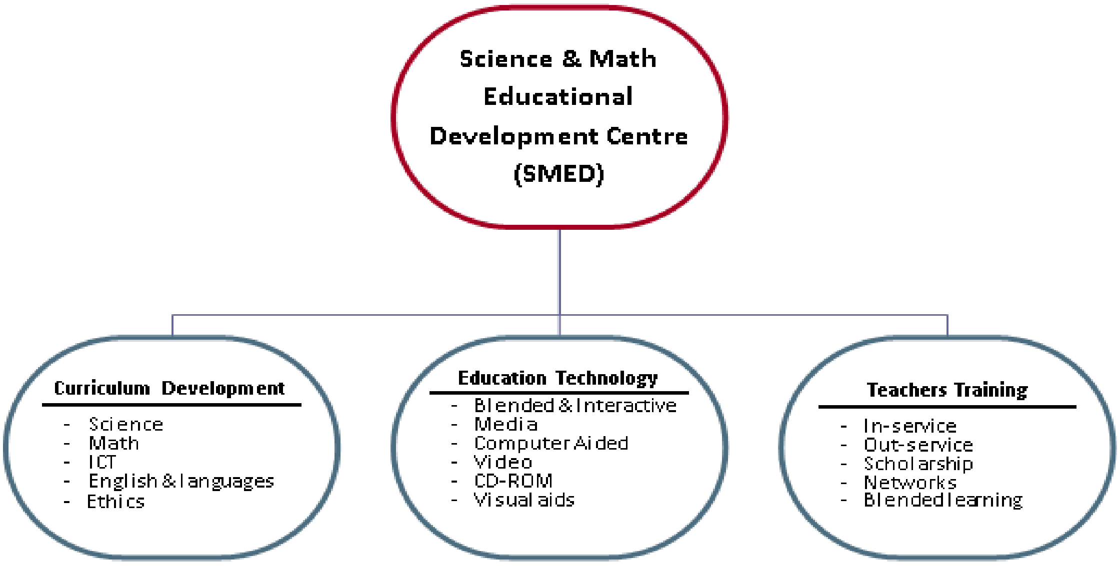


Figure 1: Proposed schematic SMED for teachers training in science, math, ICT, & languages at the national level.

It is apparent from Table (1a) that trends of teaching math and science in OIC countries is poor and way behind. Turkey and Iran came close to the international average, when taking a comparative study of TIMSS results (2011) on the level of science and math in the Arab countries, Abu Dhabi and Dubai came first as shown in Table (1-b, 1-c) and Figures (2&3). The problem lies in untrained teachers in those disciplines at the pre-university schooling. Therefore, is highly recommended that OIC countries create SMED at the national levels.

Table 1-a. Trends international study (TIMSS) OIC countries are lagging behind OECD in teaching math and science (Average performance in science and mathematics of the participating countries in the TIMSS 2011)

Math		
average	*Country*	
613	Korea	1
611	Singapore	2
609	Taiwan	3
586	Hong Kong	4
570	Japan	5
539	Russia	6
516	Israel	7
514	Finland	8
509	United States	9
507	England	10
505	Hungary	11
505	Australia	12
505	Slovenia	13
502	Lithuania	14
498	Italy	15
488	New Zealand	16
487	Kazakhstan	17
484	Sweden	18
479	Ukraine	19
475	Norway	20
467	Armenia	21
467	The international average	
458	Romania	22

Science		
average	*Country*	
590	Singapore	1
564	Taiwan	2
560	Korea	3
558	Japan	4
552	Finland	5
543	Slovenia	6
542	Russia	7
535	Hong Kong	8
533	England	9
525	United States	10
522	Hungary	11
519	Australia	12
516	Israel	13
514	Lithuania	14
512	New Zealand	15
509	Sweden	16
501	Italy	17
501	Ukraine	18
494	Norway	19
490	Kazakhstan	20
483	Turkey	21
477	The international average	
474	Iran	22

Table 1-b. Arab countries average performance in science (TIMSS) 2011.

	Country	Ave.
1	Abu Dhabi	461
2	Dubai	485
3	Morocco	376
4	Lebanon	406
5	Qatar	419
6	Oman	420
7	Palestine	420
8	Syria	426
9	Saudi Arabia	436
10	Tunisia	439
11	Jordan	449
12	Bahrain	452
13	Emirates	465

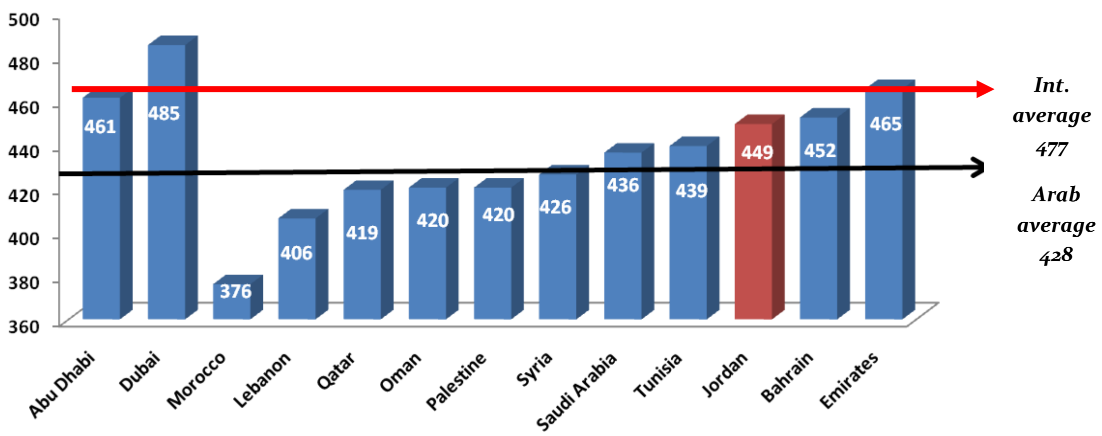


Figure 2. Performance of Arab countries in Science, 2011.

Table 1-c. Arab countries average performance in math (TIMSS) 2011

	Country	Ave.
1	Abu Dhabi	449
2	Dubai	478
3	Oman	366
4	Morocco	371
5	Syria	380
6	Saudi Arabia	394
7	Palestine	404
8	Jordan	406
9	Bahrain	409
10	Qatar	410
11	Tunisia	425
12	Lebanon	449
13	Emirates	456

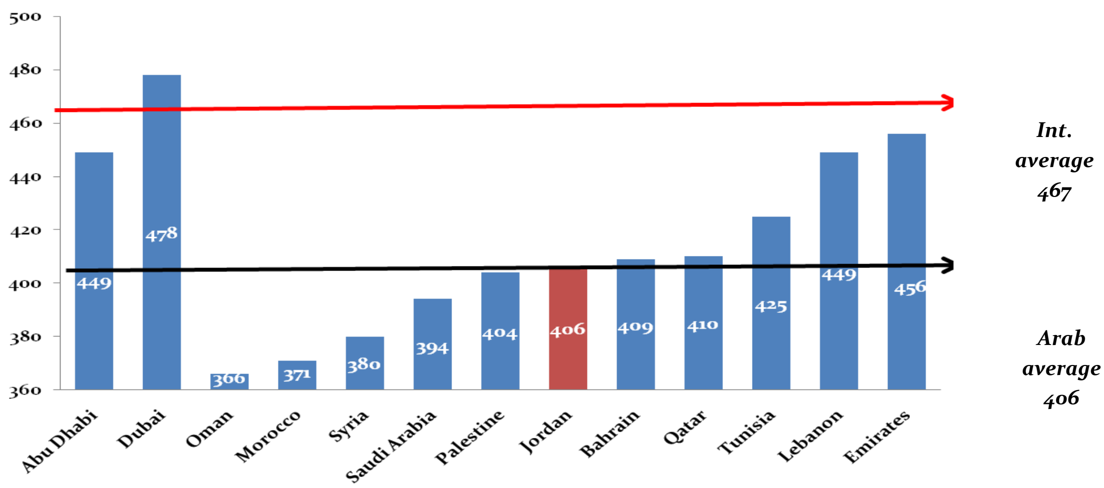


Figure 3. Performance of Arab countries in Math, 2011.

8 POLICY THREE: RELEVANCE AND QUALITY

Universities should create an inducive environment, and create a new culture of R&D and teaching excellence. Universities as creators and disseminators of knowledge should create ties with government and industry to foster indigenous innovation, human capital and knowledge development, and entrepreneurship for global competitiveness. Therefore, universities should weave the fabrics of quality, relevance and critical peer reviews and assessments.

8.1 The 'Fabric' of Quality in Education

One recent illustration of the 'fabric' of quality in education (Nikel and Lowe 2010)[1], proposes seven conceptual dimensions: effectiveness, efficiency, equity, responsiveness, relevance, reflexivity, and sustainability (Figure. 4) arranged to emphasize the quality of education 'fabric': strongest when 'stretched' or maintained in tension.

Figure 4. The Fabric of Quality of Education.

[1] *Source*: Nikel & Lowe (2010).
UNESCO education Research and Foresight, No. 2 October 2011
Nikel, J. & Lowe, J. (2010). "Talking of fabric: a multi-dimensional model of quality in Education. Compare: A Journal of Comparative and International Education, 40(5), 589-605.

The model represents a radical departure from the input–process-output model, in education to create tensions between different dimensions and on different systemic levels, so quality of education has to integrate with historical, socioeconomic, political and cultural contexts. Quality education needs an interactive learning environment with an inducing policies linked to enabling environment at school, home, and local community as shown in Figure 5.

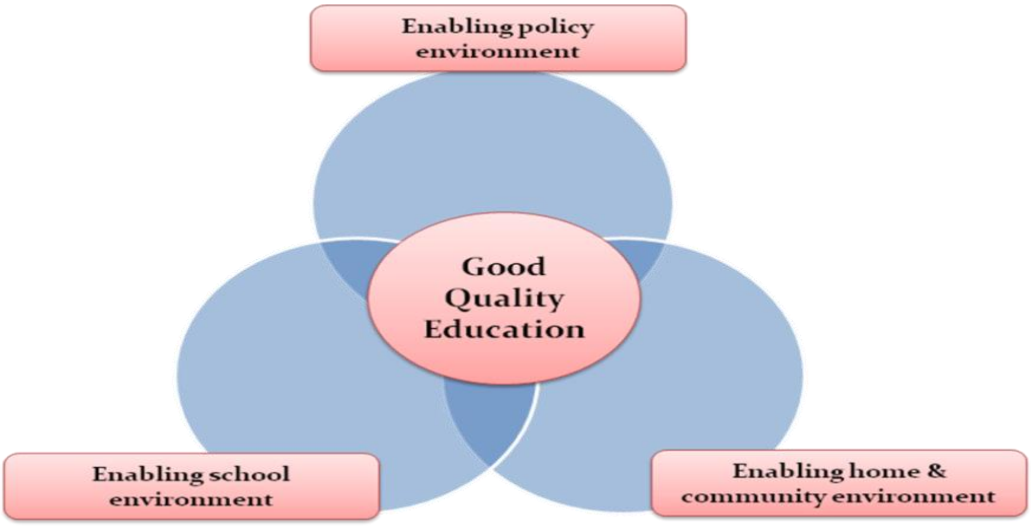


Figure 5. Enabling Interactive Learning Environment for Quality of Education.*

8.2 Quality of Education: Five Dimensions

1. **Relevance**: This is to relate education to real life. Education should empower people to attain the quality of life. The four pillars of education are well spelled out in UNESCO Delors report on education (1996). They are: learning to be, learning to know, learning to do, and learning to live with others.
2. **Pertinence**: Education has to be flexible to meet the newly demands of society and solve problems. It should value diversity and respect other value-systems.
3. **Equity**: Right to education is effective for all, in view of the creation of more just societies. Education should be democratic and should not marginalize minorities or others. It should respect human rights.
4. **Effectiveness**: Education should be effective in responding to social needs, and should ensure learning excellence and achievements.
5. **Efficiency**: Education should be efficient in utilizing public resources and delivery of quality graduates and well-rounded citizens.

* Source: Tikly (2010).

8.3 Relevance of Education: Four Pillars of Learning

The Santiago model proposes the four pillars of learning, as outlined in “Learning: The treasure within” (UNESCO 1996), as a reference to gauging the relevance (and “pertinence”) of educational processes. “Learning to be” is conceptual of identity as individual. It is about a capacity building and empowering citizenship of being an active productive component of the society.

In doing so, the context of learning highlights the “learning to be” or individualization function of education and “learning to live together”, as coherent social group or the “learning to know” to form the K-society or the “learning to do” (working together), to be productive.

9 POLICY FOUR: INVESTMENT IN HIGHER EDUCATION

Human capital and building skills are the building blocks of economic and social progress. Brain-intensive capital is sustainable through quality and relevance of education. Progress is driven by innovations and technological knowledge. Basic science should be embedded in the human brain from childhood to develop logics and rationale of thought. Research to create cutting-edge knowledge is the vehicle for progress and sustainable development, for the benefit of society at large.

Higher Education plays a central role of the k-economy; and should be given a priority on the national agenda. Governments should reform its system of higher education to be competitive. There is no doubt that we are witnessing an evolution of higher education unprecedented in the last three decades. No more higher institution reserved for few “elites”, and no more universities living in an ivory tower with a big gap from their societies. We are witnessing new players in higher education, with new programmes, broader and flexible concepts, e-learning, online education, interactive and blended education, internationalization and democratic education, R&D linked to industry and community, contractual research, patents and intellectual rights. New venues and forms of financing higher education, less reliance on governmental funding, and increasing emphasis on performance, quality, relevance and accountability.

There is a dramatic expansion in higher education within the last fifty years. In 1970, the UNESCO Institute for statistics (UIS) estimated 32.5 million students enrolled in higher education worldwide. In 2000, the number enrolled has risen to 100 million students and in 2010, the enrolment of higher education students rose to 178 million students (see Figure 6).

This vast expansion in higher education in late 20th century and 1st decade of the 21st century is due to many underlying factors. Foremost is the public demand due to growing delivery of the secondary cycle, democratization and the growth of K-economy which is dependent on brain-intensive human resources. Also, social status build up, urbanization and more female participation in the marketplace. Educated workforce of the white-collar was more demanded by both public and private sectors.

The science and technology, particularly the information and communication technology heightened the demand for software technology professionals. Higher education expanded across continents with the multinational corporates in a globalized world. Altbach et al. (2009) noted that United States and Canada were first to achieve mass higher education in 1960’, followed by Western Europe and Japan in the 1980’s, then spread to Australia and New Zealand, Korea, Malaysia, China, India, Latin America and emerging regions.

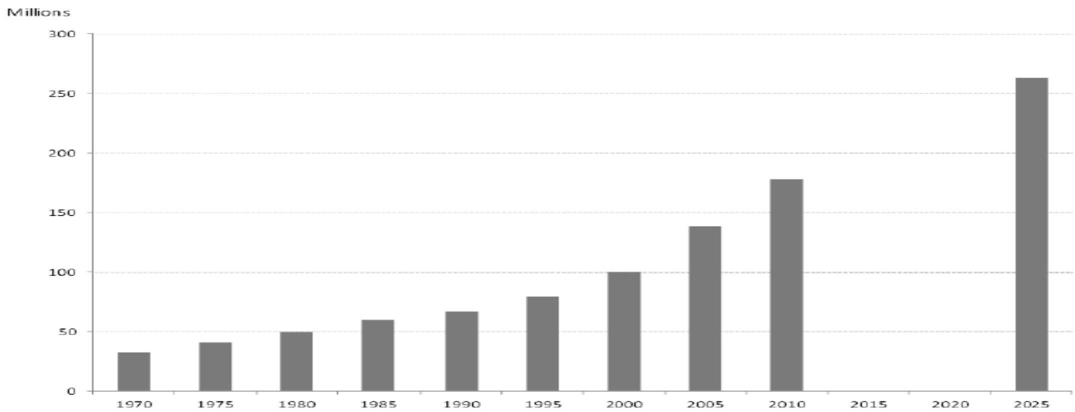


Figure 6. Trends in Higher Education Enrolment.
Trends in higher education enrolments worldwide, 1970-2025.[2]

New trends in expansion in higher education and increase students enrolment are shown in Figure 6. Subsahara Africa achieved 8.4% growth annually, Arab States 7.4% annually, East Asia and Pacific 7%, Latin America and the Caribbean 6.4% and South & West Asia 6% annually. New trends were seen currently in China and India which will achieve half of the global increase in higher education enrolment in the decades to come. It is expected that by 2020, they will achieve 40% of young adults enrolled in higher education, according to OECD (2012).

The lifelong learning perspective is considered as a process initially highlighted in the landmark of “learning to be” by UNESCO (1972). It is a concept heightened by the value system of Islam “to seek learning from birth to eternity”.

Also, distance learning was conceptualized in Islam “to seek learning as far as China” since China was considered in the old world the most distanced point of humanity. So lifelong learning is about allowing every individual to participate in society and making our society more cohesive. Learning enables people to develop to their full potential and to play an active role in their environment. It allows them to try new things and to harness untapped talents. Along with enhancing employment opportunities and professional standing, learning lays the groundwork for fulfillment in life[3].

This translates into 4.3% average annual growth in higher education enrolment, a very rapid growth when compared to the 1.6% average annual growth in the world population over the same period (UNDP, 2012). Figure 6 also shows an accelerating expansion starting in the mid-1990s, with a 5.9% average annual growth of higher education enrolments in the first decade of the 21st century. The number of higher education students is forecast to further expand to reach 263 million by 2025 (British Council and IDP Australia, cited in Davis, 2003 and Daniel, 2009)

10 POLICY FIVE: RESEARCH-BASED UNIVERSITY

In globalized world, cutting-edge knowledge is the way for progress. Universities became the centers of creating knowledge through orientation of R&D and research-based graduate programs.

Technical knowledge and a system perspective are achieved through research and education guided by the organizing principle of sustainability. They are aligned with three strategic areas; Technology, Policy and Systems. These interrelated foundational areas are defined as follows[4]:

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[2] Source: UNESCO Institute for statistics Data Center for 1970-2010 and Daniel (209) for 2025 forecast
[3] ELLI: European Lifelong Learning Indicators. Making lifelong learning tangible. Bertelsmann Stiftung 2010.
[4] Source: Masdar Institute 2012

1. **Technology**: Models, devices, structures and materials that can be applied toward advanced and sustainable technologies;
2. **Policy**: Plans to guide national or industrial decisions and strategies related to advanced and sustainable technologies; and
3. **Systems**: Integrated networks of sustainable technologies and policies.

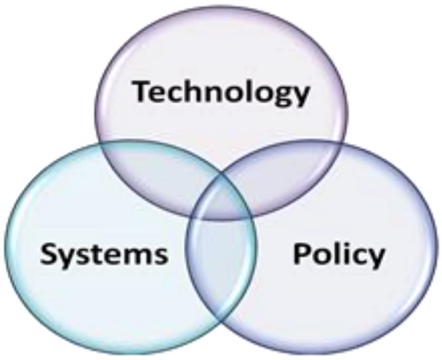

Figure 7. The Organizing Principles of Sustainability.

After the success stories of the silicon valley adjacent to Stanford in California, the business park of Cambridge, MIT and Harvard in Boston the triangle in Toronto, Bangalor in India, Science corridor in Malaysia, Masdar institute and Masdar city of S&T in Abu Dhabi, KAUST in S.A. Science foundation in Qatar and incubation and innovation center at University of Petra, Amman and the Chinese Academy centers surrounded by mass startup companies and Samsung at Sungkyunkwan university in Korea, and many others in the world, are contributing to knowledge, R&D, innovation and creativity.

10.1 MASDAR Institute & (MIT)

Model of collaboration in research-based university system between North and South for excellence. Masdar Institute was created as research – based university for graduate work (M.Sc & Ph.D) for R&D, innovations and entrepreneurship, so Abu Dhabi may continue as a world leader in producing energy, but a clean source of energy. Interdisciplinary approach of various disciplines and fields around creating alternative sources of energy yielding zero carbon emission was envisaged as:

- High tech in producing alternative sources of clean energy.
- Managing and finding intelligent solutions for rationale of using present energy resources and reducing Co_2 emission.

Masdar Institute of science & technology (MI) is affiliated and modeled around the MIT, for academic and research excellence, to create a strong human capital and K-base in the region. to adhere to standards of excellence, to grasp what MI is trying to play in Abu-Dhabi, is what MIT has achieved in 2009 survey report of MIT alumni, entitled "Entrepreneurship Impact": the role of MIT, of how most of MIT graduates are starting up companies.

"*The 25800 currently active companies founded by MIT alumni employ about 3.3 million people and generate annual global sales of USD 2 trillion, producing the equivalent of the 11-largest economy in the world. An estimated 6.900 MIT alumni companies with worldwide sales of approximately USD 164 billion are located in Massachusetts and represents 26% of the sales of all Massachusetts companies. MIT alumni-founded companies make a far-reaching impact on their local economies, because so many of them are engaged in* *manufacturing, instruments, machinery, biotech and electronics, including semiconductors, computers, and software. The MIT alumni high-technology firms in software, electronics and biotech form a special subset of companies that spend a significant portion of their revenues on research and development, and tend to export a higher percentage of their products."*

In its first five years, Masdar institute has been recognized for the quality of its R&D, for its patent applications, and for the number of publications and citations by professors and students. Several local and international firms have entered into R&D contracts with Masdar institute, to build endogenous S&T capacity. Admission policy and procurements are based on merits.

11 POLICY SIX: INVESTMENT IN SCIENCE

11.1 R&D Expenditure Worldwide

It is clear that the more nations invest in science and R&D, the more they attain progress and quality of life. Figure 8 shows the world total R&D expenditure in term of billions of dollars, from 1996 until 2009.

In the year 1996, worldwide expenditure on R&D was around $522 billion and rose gradually to reach around $1.28 trillion in 2009, most the increase came from OECD countries, to cope with competitive markets.

Year	Dollars (billions)
1996	**522.5**
1997	**564.0**
1998	**594.2**
1999	**641.4**
2000	**704.5**
2001	**752.4**
2002	**782.1**
2003	**822.2**
2004	**872.1**
2005	**951.0**
2006	**1,048.4**
2007	**1,144.5**
2008	**1,234.8**
2009	**1,275.2**

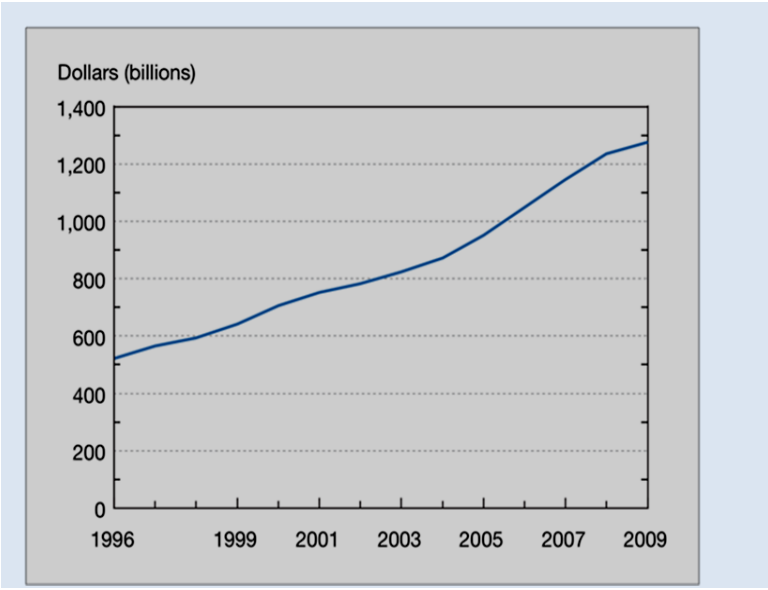

Figure 8. Estimated R&D expenditures worldwide: 1996–2009.[5]

[5] Sources: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2011) of Organization for Economic Co-operation and Development, Main Science and Technology Indicators (2011-1 and previous years) and United Nations Educational, Scientific and Cultural Organization Institute for Statistics, http://stats.uis.unesco.org.
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Table (2): location of estimated worldwide R&D expenditures: 1996 & 2009 (%)

Year	North America	Europe	Asia/Pacific	Rest of world
1996: $522 billion	40.2	31.0	23.9	4.9
2009: $1.28 trillion	35.6	24.4	34.9	5.1

The growth and distribution of expenditures on R&D of various regions in the world in Table (2) where Asia/Pacific exhibited growth, from 23.9% in 1996 to 34.9% in 2009. North America came down from 40.2% worldwide expenditure on R&D in 1996 to 35.6% in 2009. Europe from 31% in 1996 to 24.4% in 2009, while the rest of world rose from 4.9% in 1996 to 5.1% in 2009. So the table shows the expenditure on R&D mostly done by developed and emerging economies of the world.

Figure 9. shows clearly expenditure on R&D as percentage of the GDP of countries of the world. But only those who spend more than 100 million per year are included. The more the country invests in R&D, the more advanced on the world economic landscape. South Korea spends 3.74% of GDP on R&D, Japan spends 3.67%, Sweden 3.3%, Israel 4.2%, Finland 3.1%, US 2.7%, China 1.97% Canada 1.8%, Austria 2.5%, Switzerland 2.3%, Singapore 2.2%.

It is worth mentioning that OIC countries spend less than the world average of 1.7% as shown in Figure 9; Turkey of 0.7%, Iran of 0.7%, Malaysia 0.63%, Tunisia 0.86%, Morocco 0.6%, Jordan 0.4%, Egypt 0.23%, Algeria 0.07%, Saudi Arabia 0.05%.

OIC countries should put a target of 1% of GDP expenditure on R&D by 2020, to bridge S&T gap between OIC and OECD countries. Also, we should remember that what is spent on R&D in the laboratories of the west has higher impact and multiplying effect on the economy and quality of life, than those spent in the labs of OIC countries. Delivery of R&D finds its way to innovations and startup companies much faster in the West and emerging economies than in OIC countries.

Also, it should be noted that most of the expenditure on R&D in Arab & Islamic world is governmental (Public sector), and very often is cut from the fiscal budget easily for the sake of building roads or other requests by MPs or decision makers who do not value the impact of investing in science and scientists. On the other hand, we find that the private sector contributes, most expenditure on R&D in the developed world as shown in Table 3. This is why R&D enjoy continuity and sustainability in OECD countries as compared to OIC countries.

Figure 10. shows the R&D expenditure growth for the big economies of the world from 1996 to 2009. U.S. has risen from $197 billion to $400 billion, EU from $ 144 billion to $298 billion. The Asia -10 countries (China, India, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand) from $126 billion to $399 billion, while the rest of the world from $45 billion to $76 billion.

When we translate those absolute figures to percent of GDP of those regions, we find that the expenditure on R&D: US 2.9% of GDP, EU 1.9% of GDP, China 1.7% of GDP, South Korea 3.4% of GDP as shown in figure 11.

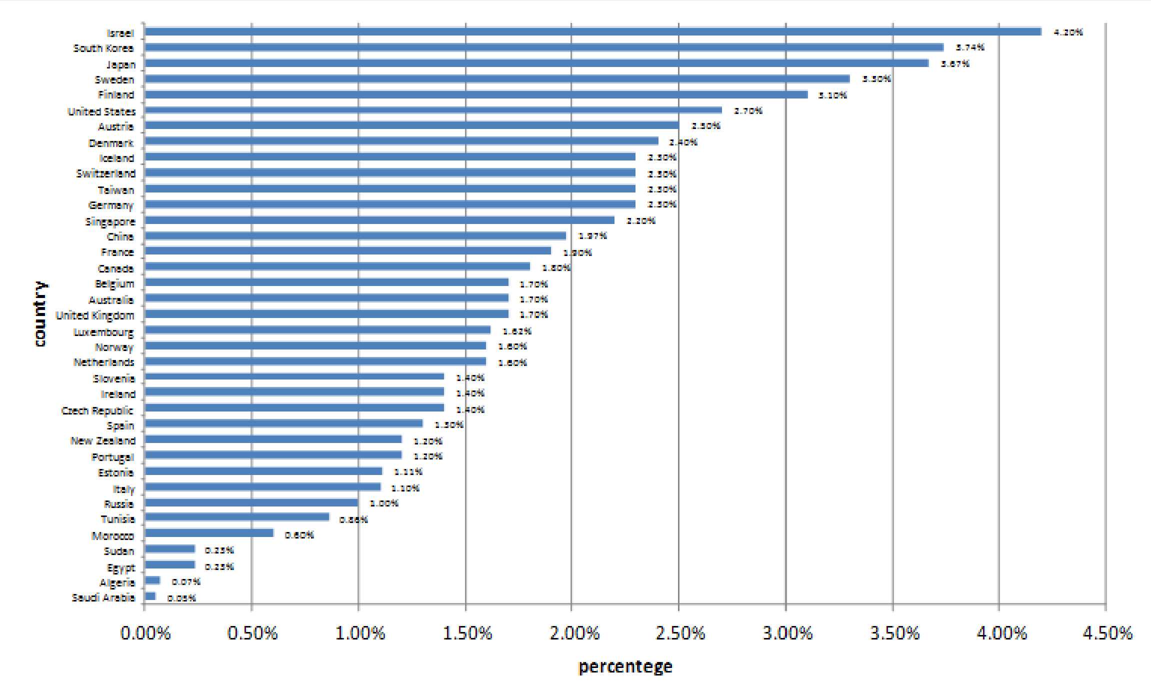

Figure 9. Expenditure on R&D as % of GDP (PPP).[6]

Only those nations which annually spend more than 100 million dollars have been included. World's total nominal R&D spending was approximately $ 1.28 trillion in 2010.

Table 3. Expenditure on R&D:
The contribution of private sectors vs. public sector

Country	Spending on R&D(% GDP)	The contribution of private sector (% GDP)	The contribution of public sector (% GDP)
Sweden	3.37	2.79	0.94
Japan	3.39	2.62	0.77
Finland	3.37	2.46	0.91
USA	2.61	1.84	0.77
Germany	2.53	1.77	0.76
France	2.09	1.34	0.75
EU (27 countries)	1.84	1.11	0.73
China	1.42	1.01	0.41
Italy	1.9	0.54	0.55
Spain	1.20	0.67	0.53

[6] Source: Wikipedia 2010
PPP: Purchasing Power Parity

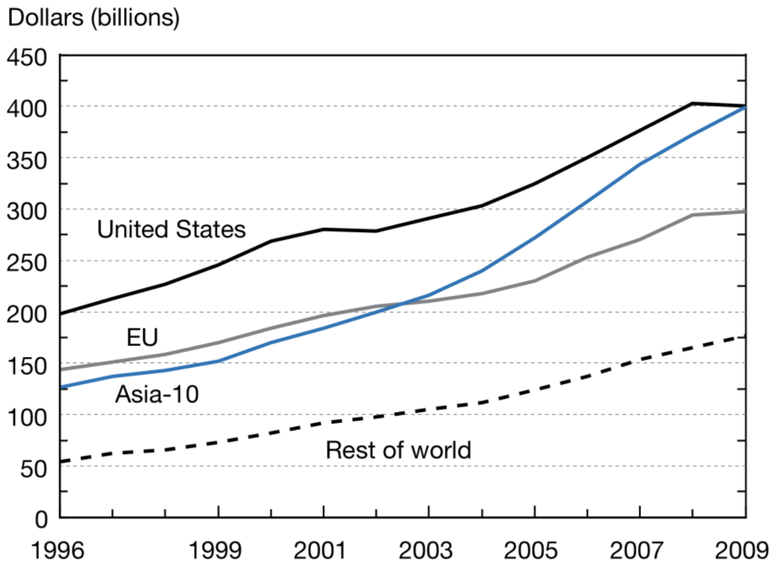

Figure 10. R&D Expenditures for United States, EU & 10 Asian Economies: 1996-2009.[7]

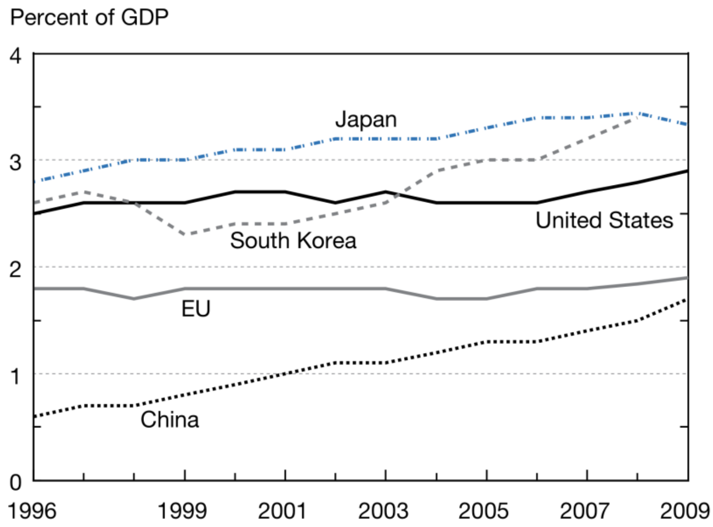

Figure 11. R&D Expenditures as a Share of Economic Output of Selected Regions/Countries: 1996-2009.[8]

[7] Asia-10 = China, India, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand; EU = European Union

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2011) of Organization for Economic Co-operation and Development, Main Science and Technology Indicators (2011-1 and previous years) and United Nations Educational, Scientific and Cultural Organization Institute for Statistics, http://stats.uis.unesco.org.

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[8] EU = European Union; GDP = gross domestic product

NOTE: 2009 data unavailable for South Korea.

SOURCE: Organization for Economic Co-operation and Development, Main Science and Technology Indicators (2011-1 and previous years).

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11.2 Investment in Science: Workforce of Researchers

The number of researchers in the industrialized and growing economies is grown particularly in China where the growth jumped from (6.5%) annually (1995-2002) to (11.9%) annually (2002-2009) and South Korea has shown a growth from 5.1% to 8.9%, Taiwan from 7.3% to 7.9%, EU from 3.2% to 3.5%. While number of researchers climbed slightly in Japan from down -1.1% to 0.7%. Russia started to pick up from down of -3.0% to -1.5% due to transition of governing system, from the soviet communist era to the current free –economy era. Russia has experienced a vast migration of scientists abroad. The U.S. annual growth slowed down from 3.8% to 1.0% and Singapore from 13.0% to 7.7%. So China and S. Korea are leading in investing in researchers as compared to other countries. (Table 4)

Table 4. Investment in science: Workforce of researchers
Average annual growth in number of researchers, by region/country/economy: 1995–2002 & 2002–2009 (%)[9]

Period	United States	EU	Russia	Japan	Singapore	Taiwan	South Korea	China
1995–2002	3.8	3.2	-3.0	-1.1	13.0	7.3	5.1	6.5
2002–09	1.0	3.6	-1.5	0.7	7.7	7.9	8.9	11.9

11.3 Investment in Science: Science & Engineering Publications as Cited Research Papers

The number of published articles in science and engineering has grown in China from 9000 publications in 1995 to 74000 in 2009, and Japan has increased their level from 47000 publications in 1995 to 74000 in 2009. If we add those two countries to India, Indonesia, Philippine, Singapore, South Korea, Taiwan and Thailand (Asia-10), then the number of publications has risen from 76000 in 1995 to 187000 in 2009. U.S has shown growth of from 173000 in 1995 to 208000 in 2009. European Union (EU) has shown growth of 195000 in 1995 to 248000 in 2009; while the rest of the world has shown growth from 99000 in 1995 to 143000 in 2009 (Figure 12).

Table (5) shows International cooperation among more active selected regions in term of coauthors, where EU has shown 41.7%, U.S 31.3%, South Korea 28.1%, Japan 26.7%, China 25.6% and Taiwan 23.9%.

Figure 13 shows the increase /decrease of International cooperation-coauthors in scientific and engineering articles between 1989-2009 where EU & U.S were the highest in coauthoring among nations.

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[9] EU = European Union
NOTE: Growth rates through last available year in range indicated.
SOURCE: Organization for Economic Co-operation and Development, *Main Science and Technology Indicators* (2011-1 and previous years).
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National Science Board, Science and Engineering Indicators, 2012

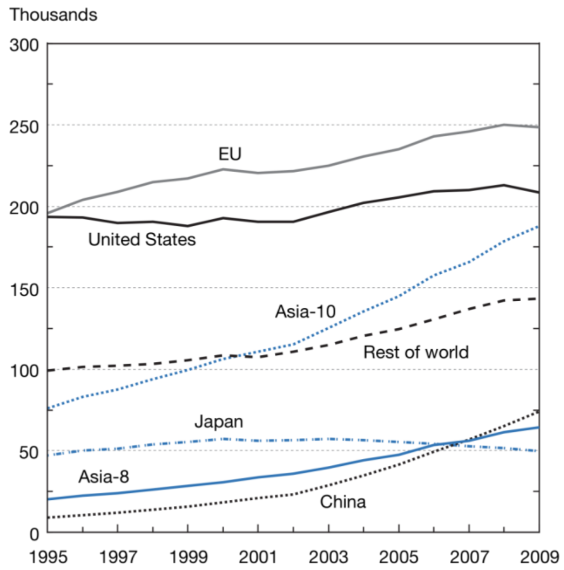

Figure 12. Research-Capacity in Science and Engineering Citation
S&E Journal Articles Produced, by Selected Region/Country: 1995–2009.[10]

Table 5. International cooperation's- co-authors citations Research articles with international co-authors, by selected region/country/economy: 2005–2009 (%)

Year	United States	EU	Japan	China	South Korea	Taiwan
2005	26.6	36.8	23.0	24.8	27.6	20.6
2006	27.2	37.6	24.2	24.9	28.4	19.9
2007	28.7	39.0	24.6	24.8	28.5	21.7
2008	29.8	39.9	25.7	25.0	28.7	23.1
2009	31.3	41.7	26.7	25.6	28.1	23.9

[10] Asia-8 = India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand; Asia-10 = Asia-8 plus China and Japan; EU = European Union
SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2011) of Thomson
Reuters, Science and Social Sciences Citation Indexes, http://thomsonreuters.com/products_services/science/, and The Patent BoardTM.
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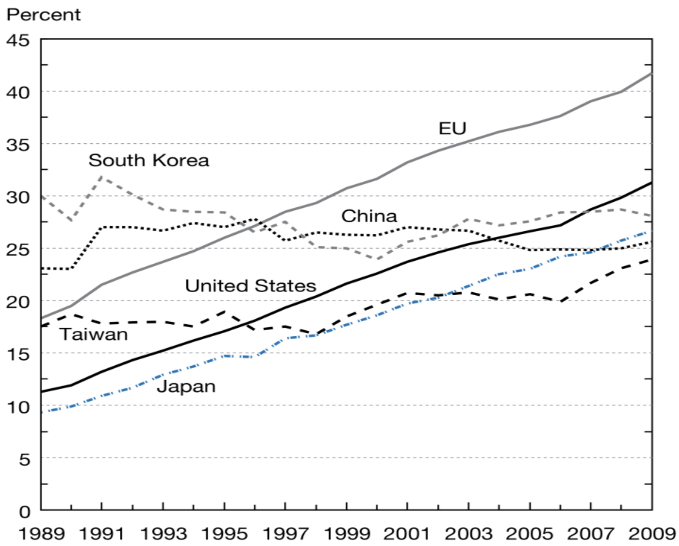

Figure 13. Research articles with international coauthors, by selected region/country/economy: 1989–2009.[11]

12 POLICY SEVEN: TECHNOLOGY TRANSFER

12.1 Patents

Technology transfer is measured by patent which is an indicator of the transfer of knowledge created by research into technologies. Incubators of R&D and the turn-in into science business parks for startup high tech companies are shown in Table (6) for the global high-value patents of selected regions in the world. The U.S share of global hi-value patents is 30%, EU is 30.3%, Japan is 28%, Asia-8 is 5.2%, and the rest of the world is 6.5%.

Table (6): Global high-value patents, by selected region/country: 2000–2008 (%)[12]

Year	United States	EU	Japan	Asia-8	Rest of world
2000	30.7	29.4	32.3	2.0	5.6
2002	31.6	28.8	30.6	3.3	5.7
2004	31.6	29.0	28.6	4.8	6.0
2006	30.5	29.7	28.1	5.4	6.2
2008	30.0	30.3	28.0	5.2	6.5

[11] EU = European Union
Sources: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2011) of Thomson Reuters,
Science and Social Sciences Citation Indexes, http://thomsonreuters.com/products_services/science/, and The Patent Board™.
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[12] NOTE: Asia-8 = India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand; EU = European Union
Source: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2011) of Organization for Economic Co-operation and Development, OECD.StatExtracts, patent statistics, http://stats.oecd.org/index.aspx.
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12.2 Value-added Manufacturing (Hardware)

The U.S has shown the highest value-added, hi-tech manufacturing industries-hardware. It has grown from $247 billion in 1998 to $386 billion in 2010, EU from $183 billion in 1998 to $273 billion in 2010, Japan from $142 billion in 1998, to $178 billion in 2010.
China has shown the fastest growth among nations from $24 billion in 1998 to $236 billion in 2010, Asia-8 has grown from $58 billion to $164 billion and rest of the world growth has grown from $67 billion to $134 billion in 2010 (Table 7).

Table (7): Value-added Hi-Tech Manufacturing (Hardware)
Value Added of High-Technology Manufacturing Industries, by Selected Region/Country: 1998–2010 (Billions of Dollars)[13]

Year	USA	EU	Japan	China	Asia-8	Rest of world
1998	247.5	182.5	141.8	23.5	58.4	66.7
2000	275.3	184.4	185.1	35.0	90.6	75.5
2002	251.0	184.2	123.5	46.4	85.7	70.8
2004	283.3	242.9	164.0	82.3	117.9	85.0
2006	342.5	276.0	152.9	128.6	144.9	109.6
2008	355.2	317.6	153.7	194.5	144.4	139.4
2010	385.9	272.9	177.9	263.0	163.6	133.7

12.3 Knowledge Intensive Hi-Tech (Software)

The growth in hi-tech knowledge services has grown in the U.S from $108 billion in 1998 to $311 billion in 2010. EU from $142 billion to $412 billion, Japan from $37 billion to $85 billion and China has shown the fastest growth from $26 billion in 1998 to $144 billion in 2010. Also, Asia -8 has shown remarkable growth from $46 billion to $236 billion and the rest of the world exhibited a respectable growth from $94 billion in 1998 to $276 billion in 2010 (Table 8).

12.4 Hi-Tech Exports

China exhibited the highest growth in hi-tech export among all nations from $60 billion in 1998 to $476 billion in 2010.
U.S hi-tech export increased from $188 billion in 1998 to $325 billion in 2010. EU from $153 billion to $335 billion, Japan from 114 billion to $140 billion, Asia -8 from $224 billion to 576 billion and the rest of the world has grown from $112 billion to $ 285 billion in 2010 (Table 9).

12.5 China Hi-Tech Exports

China has dominated the world in hi-tech exports. This was due to a determined policy from the top by decision-makers of renovating their higher educational system for vibrant higher educational system and dynamic research centers in the public sector, particularly those under the chinese academy of sciences and the private sector. They have provided the funding and the inducive competitive environment and managed R&D in business-like teamwork.

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[13] Asia-8 = India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand; EU = European Union
NOTE: Industries defined by Organisation for Economic Co-operation and Development.
SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2011) of IHS Global Insight, World Industry Service database.
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Figure 14 shows clearly China's hi-tech exports to selected regions and countries in the world and how it enjoyed a progressive steady growth from 1998-2010. Most exports were to U.S and EU, followed to Asia-8 and Japan.

Table (8): Knowledge intensive services (software)
Exports of commercial knowledge-intensive services, by selected region/country: 1998–2010[14]
(Billions of dollars)

Year	USA	EU	Japan	China	Asia-8	Rest of world
1998	107.8	142.1	36.8	26.1	46.0	94.5
2000	129.7	142.8	39.3	31.9	54.3	109.7
2002	142.2	183.9	37.4	37.1	61.4	107.4
2004	180.3	254.6	51.5	53.0	99.9	148.7
2006	229.0	331.0	69.0	75.1	149.6	201.6
2008	300.4	456.5	88.8	115.0	216.1	280.9
2010	310.9	411.4	85.4	144.0	236.0	276.0

Table (9): High-technology Exports, by Selected Region/Country: 1998–2010 [15]
(Billions of Dollars)

Year	United States	EU external	Japan	China	Asia-8	Rest of world
1998	187.9	153.1	113.5	59.7	223.5	112.2
2000	215.3	174.7	148.9	88.8	330.8	143.4
2002	176.8	176.6	113.2	119.8	303.5	129.4
2004	190.8	248.2	151.1	237.7	423.5	167.5
2006	265.1	300.2	150.2	358.8	528.2	211.4
2008	298.7	343.7	143.7	429.0	540.7	267.4
2010	325.1	335.2	139.6	475.9	576.3	285.3

[14] Asia-8 = India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand; EU = European Union
NOTES: EU excludes internal trade. China includes Hong Kong.
SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2011) of World Trade Organization, International Trade and Tariff database.
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[15] Asia-8 = India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand; EU external = European Union trade excluding intra-EU exports
NOTE: Industries defined by Organization for Economic Co-operation and Development.
SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2011) of IHS Global Insight, World Trade Service database.
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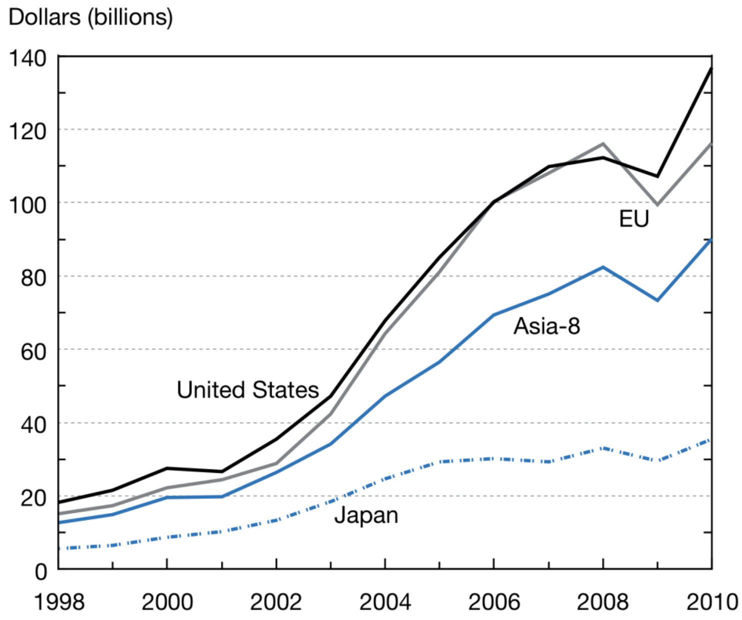

Figure 14. China's High-technology Exports to Selected Regions/Countries: 1998–2010.[16]

13 CONCLUSION

An Arab summit held in Kuwait in 2009, called on Arab States to spend at least 7% of their GDP on education, including science and technology teaching programs. An increase in the ration of students enrolled in Science and technology at the undergraduate level from 30 to 45%, to provide the private sector with the skilled scientific workforce. The private sector needs to increase funding of higher education and research; currently stands at only 1% of total support of higher education and research.

Also, a call by the Arab summit to promote all ways of learning, including e-learning, distance and online learning.

Reforming science and technology to be included at all levels of education with focus on basic sciences and mathematics and enhance biotechnology, information technology, nanotechnology and renewable energy.

Although there are about 1000 institutions of R&D, 200 universities, 50,000 science and technology faculty members and 700,000 engineers and 4 million graduates of S&T in the Arab world, but a wide gap of discrepancies exist with advanced nations. Policies on building capacity in S&T and promote the quality in science and modernize higher education to build science –based institutions to create knowledge and technology transfer and involve the private sector in R&D and network centres of excellence for R&D among universities and develop a roadmap of well-defined strategy of science, technology, higher education for quality and relevance are crucial for the future of Arab and OIC countries.

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[16] Asia-8 = India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand; EU=European Union
NOTE: Industries defined by Organization for Economic Co-operation and Development.
SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2011) of IHS Global Insight, World Trade Service database.
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Achieving excellence in higher education is closely linked to productivity in scientific research and to the development of sustainable knowledge-based economies in Arab countries. Arab students must be exposed to the culture of research throughout their education, at the primary, secondary, tertiary, and other graduate levels.

Geopolitical shift in knowledge creation published by Canada-based metrics, that Middle East is growing in science at a rate comparable, or slightly higher than the world average in science for the first time. Iran and Turkey are leading the scientific advancement. Its scientific outputs having grown 11 times higher than the world average from 1980 to 2010. The advancements were in aerospace, nuclear, medical sciences, agriculture development and stem cell and cloning research. Malaysia and Indonesia. Also, exhibited a remarkable growth in higher education and advancement of science as shown in cited publications and patents registration.

Science and technology plan of action (STPA) by the Arab league summit to build a triangle of science advancement, namely, higher education, R&D, and innovation on priority areas of water, energy, food and agricultural development, has been declared.

REFERENCES

- AHELO Consortium (2011), AHELO Contextual Dimension Assessment Framework, Melbourne, ACER, CHEPS & Indiana University, http://www.oecd.org/officialdocuments/displaydocumentpdf?cote=edu/imhe/ahelo/gne (2011)21/ann1/final&doclanguage=en.
- Altbach, P. (2009), "The Giants Awake: the Present and Future of Higher Education Systems in China and India", Economic and Political Weekly, Vol. 44(23), Mumbai, pp. 39-51.
- Altbach, P. et al. (2009), *Trends in Global Higher Education: Tracking an Academic Revolution*, Report prepared for the UNESCO 2009 World Conference on Higher Education, UNESCO Publishing, Paris. http://unesdoc.unesco.org/images/0018/001831/183168e.pdf.
- Badran, A. (2005). "*S&T in the Arab region"* chapter UNESCO world Science Report 2005, UNESCO, Paris.
- Badran. A & M. Zoubi (2010): "Science in *Arab State: UNESCO World Science Report 2010".* Chapter 13: pages 251-274.
- Badran. A. (2011), *"The Science & Technology & Human Rights Nexus in the Arab World".* Paper presented at 18th IAS conference, 22th October, 2011, Doha.
- Badran A. (2013): "*Excellence in Higher Education for Building S&T Proficiency: a Global Perspective."* Paper presented at the 19th IAS conference, 6-9 May 2013, Dhaka, Bangladesh.
- Bennell, P. and T. Pierce (2003), "The Internationalisation of Tertiary Education: Exporting Education to Developing and Transitional Economies", *International Journal of Educational Development*, Vol. 23, Amsterdam, pp. 215-232.
- Bologna Secretariat (2012), Making the Most of Our Potential: Consolidating the European Higher Education Area - Bucharest Communiqué of the European Ministers of Education, Bucharest, http://www.ehea.info/Uploads/%281%29/Bucharest%20Communique%202012.pdf
- Bologna Secretariat (1999), *Joint Declaration of the European Ministers of Education*, 19 June 1999 http://ec.europa.eu/education/policies/educ/bologna/bologna.pdf
- China Government (2010), *Outline of China's National Plan for Medium and Long-Term Education Reform and Development 2010-2020*, Beijing, Government. http://planipolis.iiep.unesco.org/format_liste1_fr.php?Chp2=Chine
- Cheng, Y.C. (2009), "Teacher Management and Educational Reforms: Paradigm Shifts", *Quarterly Review of Comparative Education*, Vol. 39(1), Springer, Netherlands/UNESCO, pp. 69-89.
- Daniel, J.S. (2009), *Highlights of the UNESCO Global Forum on Rankings and Accountability: Uses and Misuses*, closing presentation, Paris. www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/ED/pdf/RANKINGS/Stamenka-JohnDaniel.pdf
- Davis, T.M. (2003), *Atlas of Student Mobility*, Institute of International Education, New York.
- Elaine Allen, I. and J. Seaman (2011), Going the Distance: Online Education in the United States 2011, Babson Survey Research Group, Babson Park. www.babson.edu/Academics/centers/blank-center/global-research/Documents/goingthe-distance.pdf
- ELLI: European Lifelong Learning Indicators. Making lifelong learning tangible. Bertelsmann Stiftung 2010.
- European Commission (2010), *Europe 2020 - A European Strategy for Smart, Sustainable and Inclusive Growth*, European Commission, Brussels.

http://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20- %20Europe%202020%20-%20EN%20version.pdf

- International Association of Universities (2013), *International Handbook of Universities 2013,*
- Palgrave Macmillan, London.
- Kanter, M. J. (2011), "American Higher Education: First in the World", *Change Magazine*, Vol.
- 43(3), Taylor & Francis Group, Philadelphia, pp. 7-19.
- Loris, M. (2010), "The Human Journey: Embracing the Essential Learning Outcomes", *Liberal*
- *Education*, Vol. 96(1), AAC&U, Washington, DC, pp. 44-49.
- Masdar Institute 2012, Abu Dhabi.
- Nikel, J. & Lowe, J. (2010). "Talking of fabric: a multi-dimensional model of quality in Education. Compare: A Journal of Comparative and International Education, 40(5), 589-605.
- Obama, B. (2009), *State of the Union Address to Joint Session of Congress*, February 24, 2009. www.whitehouse.gov/the_press_office/Remarks-of-President-Barack-Obama-Addressto-Joint-Session-of-Congress/
- OECD (2012a), "How is the Global talent Pool Changing?", *Education Indicators in Focus*, Issue 2012/05, May 2012, OECD Publishing, Paris.
- OECD (2012b), *Education at a Glance 2012: OECD Indicators*, OECD Publishing, Paris.
- OECD (2008), *Tertiary Education for the Knowledge Society*, OECD Publishing, Paris.
- www.oecd.org/edu/tertiary/review
- OECD (2007), *Giving Knowledge for Free: the Emergence of Open Educational Resources*, OECD Publishing, Paris. www.oecd.org/edu/ceri/38654317.pdf
- Reichert, S (2010), "The Intended and Unintended Effects of the Bologna Reforms", *Higher Education Management and Policy*, Vol. 22(1), pp. 59-78, OECD Publishing, Paris.
- Shanghai Jiao Tong University (2011), *Academic Ranking of World Universities 2011*, Institute of Higher Education, Shanghai Jiao Tong University. www.shanghairanking.com/ARWU2011.html
- Swail, W.S. (2011), "In Search of a Better Mousetrap: A Look at Higher Education Ranking
- Systems", *College and University*, Vol. 86(4), AACRAO, Washington, DC., pp. 28-33
- Tikly (2010).
- Tremblay. K. & Lalancette. D & Roseveare. D (2012): "*Assessment of Higher Education Learning outcomes, AHELO".* OECD 2012.
- TSL Education (2011). *World University Rankings 2011-2012* www.timeshighereducation.co.uk/world-university-rankings/.
- UNDP (2012), World Population Prospects: The 2010 Revision http://esa.un.org/unpd/wpp/index.htm.
- UNESCO Institute for Statistics (2011), *Global Education Digest 2011*, UNESCO Publishing, Montreal. http://stats.uis.unesco.org
- Vught, F. Van, Ed. (2009), Mapping the Higher Education Landscape, towards a European Classification of Higher Education, Springer, Dordrecht.
- Wikipedia 2010.

Higher Education S&T Nexus: Outlook for Tomorrow

ATTA-UR-RAHMAN FIAS
Former Federal Minister of Science & Technology and
Former Chairman (Federal Minister) of Higher Education Commission
Former Co-ordinator General, COMSTECH
President, Pakistan Academy of Sciences
Pakistan

We live in an age where innovation determines progress. Truth has indeed become stranger than fiction. The remarkable manner in which innovation is transforming our lives is illustrated by the following examples. The blind can today see with their tongues. How do they do that? A company, Wicab, in Wisconsin, USA has developed a device that comprises a camera fitted on the glasses worn by the blind person. The optical signals captured by the camera are converted into electrical signals and then transmitted into a lollipop like device in the mouth of the blind person. These signals are then transmitted to the brain through the nervous system in the tongue, thereby restoring partial eyesight. Almost miraculously, the blind person can then differentiate between a knife and a fork and see the lift buttons!

In another development a cap fitted with certain sensors has been invented that allows a completely paralysed person to move his wheel chair just by thought control. Our brain emits four types of thought signals, one of which is the command signal. This can be recognized by the sensors on the cap linked to a computer and the paralysed person can thereby move his wheelchair in any direction purely by giving a thought command through a computer to the wheel chair. A car was driven around Germany last year just by thought control using the same technology.

There have been other striking developments too. The "disappearing cloak" in the Harry Potter books is now a reality! This is the result of the development of "metamaterials" that have the ability to bend light around them. Objects cloaked with this magical material actually disappear! The technology is now being applied by defense agencies for cloaking tanks, submarines and airplanes. Bullet proof paper has been invented using nanotechnology. Genes of luminescent deep sea jelly fishes have been transplanted into orchids, thereby affording flowers that glow like fire flies in the dark! 3D printing has come into the fore, and many objects are being manufactured using this exciting new technology. Tomorrow you may well be driving a car most of the components of which may have been printed on a 3D printing machine. Anti-aging compounds have been discovered, and when these were administered to old mice, the mice became younger (work of David Sinclair at Harvard, http://www.hms.harvard.edu/agingresearch/pages/faculty.htm). A small building was constructed last year in China with flying robots working in unison. Airplanes have been developed that can fly without internal fuel. These are scramjets. When they reach 12 times the speed of sound, they can capture oxygen from the stratosphere and use that as fuel. A robotic fly has been invented that is alive but fitted with cameras and sound systems. It can be remotely manipulated and guided. It can sit on the desk of your Prime Minister or President and send all the pictures and conversation to the foreign embassy of a super power a few miles away. A car has been invented in France that can run purely by compressed air. The first synthetic life was experimented with and a cell has been developed that is fitted with a completely synthetic genome. It replicates and exhibits the features of life. A completely synthetic cell is now being built (work of Craig Venter in Maryland, http://www.guardian.co.uk/science/2010/may/20/craig-venter-synthetic-life-form).

These are just a few examples of the strange and wondrous world of science and innovation that we live in. Countries that have invested massively in quality education, science & technology, and have then linked the research to the development of innovative products through fostering entrepreneurship are cashing in from the brain power of their youth. Some 4000 companies have emerged from the graduates of just one institution, MIT, that have annual sales of about $250 billion and employ over a million people. Stanford, with the silicon valley that emerged around it, is one of many examples how the strengthening of the triple helix, government, academia and the private sector, can result in huge benefits to those countries that have the will and passion to travel on the "knowledge road" to socio-economic development.

The world population has crossed 7 billion and it is expected to reach 10 billion by 2050. This is going to pose huge challenges for the next generation in terms of access to water, food and education. Tens of thousands of new colleges and universities will be needed to cope with the needs of the growing number of young seeking opportunities for education in various fields. While it may be possible to construct large numbers of new campuses, a major bottle neck will be the availability of sufficient numbers of highly qualified faculty. Technology has however opened up new opportunities in the last decade. With the advent of information technology and high speed internet services, we are all connected and distances have lost their significance. We can communicate across huge distances and even send holographic 3D images so that we may be in one place but appear to be in another!

The single most important problem in providing quality higher education in the developing world is the lack of highly qualified faculty. However now with advances in technology, it is possible to benefit from lectures and courses delivered from thousands of miles away. There are two broad types of such programs. One is the live interactive courses delivered through video-conferencing or through a special software on your laptop. The other is the so called Massive Open Online Courses (MOOCs) that are recorded courses that can be delivered through the internet. Pakistan today is a world leader in both these fields, due to the efforts that were undertaken in my leadership during the last decade. Currently I am involved in a program that has the potential to change the entire landscape of higher education in Pakistan and the developing world.

In this new era, a paradigm shift has occurred in the manner that courses can be delivered in colleges and universities. Thousands of excellent recorded courses are now available free of charge from a number of sources. The challenge is to have knowledge of what is available where, and then to have rapid access to them without being lost in the jungle of information that we encounter when carrying out a search in Google for the desired materials. For this purpose we in Pakistan have refined a search engine in my institute (International Centre for Chemical and Biological Sciences at University of Karachi) that targets only selected sources and comes up in seconds with the materials that we are searching for. Students thus have access to thousands of excellent recorded courses. They can thus come prepared to the lectures and the lecture rooms will be undergoing a profound change ---- they will be transformed to discussion sessions between the teacher and students, so that the students can clarify concepts. This is a revolution in higher education that I am a part of, and it is probably the most important project that I have undertaken during my life time--- one that can have a profound impact on the younger generations of Pakistan and other developing countries. An agreement has recently been signed between International Centre for Chemical and Biological Sciences at Karachi University and Pi Pakistan to launch Pakistan's free education channels on television and internet to make tens of thousands of these courses available completely free of charge to students in Pakistan and abroad. This programme can be readily extended to other Islamic countries. I am the Chairman of the Advisory Board and this exciting and historic project is being implemented under the supervision of Prof. Iqbal Choudhary and me. These thousands of excellent courses delivered by top world professors in science, engineering, social sciences and other disciplines provide a treasure chest of information and are expected to become available in an integrated and organized form within a few weeks across Pakistan. They include MIT Open Courseware, Coursera (from Stanford), Udacity, EdX (Harvard), Khan Academy and others.

HEC had established a mirror web site of MIT Open Courseware in Pakistan in 2005. This was done to facilitate the rapid downloading and access to these courses. MIT was the first to open up its courses to the world through the MIT Open Courseware initiative. After careful vetting of these courses some 10,000 CDs were prepared and distributed to the computer science departments of various universities in Pakistan. These MIT courses are those that are delivered by MIT faculty to their undergraduate and postgraduate students. The courses are available free of charge and an astonishing 110 million users worldwide have accessed and benefited from these materials. Indeed there are over 20 million web site visits annually from 215 countries.

A very fast growing distance learning initiative "Coursera" is also being integrated into our program. Coursera was co-founded a couple of years ago by Andrew Ng and Daphne Koller, two computer science professors at Stanford. The enrolment in Coursera has exceeded two million and more than 200 courses are offered. Harvard University was not to be left behind in this race to dominate the distance learning scenario. The recent free online learning program of Harvard University with MIT, named "edX" was initiated with each of these two universities providing $30 million towards this massive open online course. The University of California and another company, 10Gen, will be business partners with EdX.

"Udacity" represents another exciting initiative. It began somewhat serendipitously when an eminent artificial intelligence researcher at Stanford University, Dr. Thrun, along with Google's Director of Research began to offer introductory online courses on artificial intelligence. They were surprised to find that an astonishing 160,000 students registered for these classes and the number keeps growing. Two other courses initiated by Stanford attracted more than 100,000 students to each course which led the scientists to start the company "Udacity" for providing online courses to college students. Recently Udacity has joined hands with San Jose State University. This has allowed the induction of instructors who provide support through online interactions to the students taking these courses. Another important program that Pakistan will be benefiting from is the online courses offered by the Khan Academy based in California. About 8,000 courses at school and college level are available through this program, many of which have been dubbed into other languages including Urdu, Arabic and French. Permissions have been given to us by these organizations to integrate these courses and make them available on a non-commercial basis to students in Pakistan and other countries. They are therefore being down loaded, and arranged according to their subjects and levels before being made available to students in Pakistan. Our universities need to integrate these courses into their ongoing programs and then hold exams and award credits to the students passing the courses so that maximum benefit accrues to the students in our country.

Another related program that was initiated by HEC in 2004 was to set up video conference facilities in universities across Pakistan. Known as The Higher EducatioN project (THEN), it has already delivered over 2,000 live lectures by top professors in USA, Europe, Australia, and Japan to students in universities in Pakistan.

The first major steps to enter into the new IT age were taken in Pakistan when I was the Federal Minister of Science & Technology in 2000-2002. The Ministry of Science & Technology included the Information technology and Telecommunications Division. This short period of 2.5 years from March 2000 to September 2002 witnessed incredibly fast progress of IT infra-structure and services as well as of mobile telephony in Pakistan. Internet access was confined to only 29 cities till early 2,000. It was rapidly expanded to cover 2,000 cities, towns and villages during the next two years. Fiber was expanded from 40 cities to over a 1000 cities and towns. Bandwidth had been priced ridiculously high till then ---$ 87,000 per month for a 2 MB line per month. This had strangled the growth of IT in Pakistan. It was sharply reduced initially to about $3,000 per month and later brought down to $ 900 per month so that Pakistan became one of the cheapest in the world. Mobile telephony was static at about 300,000 mobile phones only. To boost this important sector, prices were dropped sharply, U-Fone was brought in as a competitor and all charges for receiving a call were removed. This had been a major hurdle in expansion of mobile telephone services since common people were reluctant to have a phone in which they had to pay for a call being made to them by someone else. The introduction of the “Calling Party Pays” (CPP) regime in Pakistan along with other measures resulted in a huge boost to the mobile telephony sector and the mobile telephony boom started and continues till this day. We have about 120 million mobile phones in Pakistan, as compared to 300,000 in the year 2001! To use these new technologies in education, a satellite was placed in space (PakSat 1) and a couple of transponders were set aside for distance learning courses of the Virtual University that we established in Lahore. Today the Virtual University provides quality education to over 100,000 students and has teaching programs across Pakistan and abroad.

The rapid improvements in the IT infra-structure allowed me later as Chairman Higher Education Commission to use them for the benefit of the higher education sector. A digital library that provided free access to 25,000 international journals and 65,000 text books and monographs from 220 international publishers to our university students was established, thereby bringing a huge repository of knowledge to our students.

The courses delivered online or live through video-conferencing are huge and powerful initiatives that promise to change the face of higher education and allow developing countries to leap frog and catch up with the West. The improvements in the quality of education will also open up wonderful new job opportunities to our youth, as they will be adequately prepared to meet the challenges of today and tomorrow. The sky is the limit!

Pakistan too had embarked on this road to developing a knowledge economy in 2002 when the Higher Education Commission was established with a clear mandate to strengthen our universities and research centers so that innovation and entrepreneurship could flourish. By 2008, we had several universities ranked internationally (Times Higher Education UK rankings) among the top 300,300 and 500 of the world. The research output has grown from only 600 research publications in international journals in the year 2000 to about 8,000 research publications last year, placing us at par or slightly ahead of India on a per million population basis. Universities and degree awarding institutes grew from 59 institutions in the year 2000 to 137 institutions last year. Enrolment in universities grew from 270,000 in 2002 to about a million presently. PhD output grew from only 3,600 PhDs produced during the 55 year period during1947 to 2002, to about 6,000 PhDs in the subsequent 10 years. This was described as a “Silent Revolution” in a World Bank report on the higher education sector of Pakistan.

Building S&T Proficiency in Developing Countries: Ideas on the Hands on Approach

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ABSTRACT

Building S&T proficiency was the raison d'etre of the Inquiry Based Science Education programme (IBSE) of the InterAcademy Panel (IAP). Indeed the Science Education Programme (SEP) is one of the flagship programmes of IAP. Despite vigorous advocacy and promotion by member academies of sciences and its success in some countries, IBSE has yet to take root in most developing countries. The author will give his opinions as to why IBSE has not been successful in obtaining the buy-in of government and society in South countries. Meanwhile, the decline in enrolment in science, engineering and technology courses in universities even in the developed world continues apace. In USA, this has caused major concern on its adverse impact on the innovative competitiveness of the nation. With the patronage of President Obama, there is a national initiative in science, technology, engineering and mathematics (STEM) education in US schools based on the hands-on approach to stimulate the interest of students to pursue science and engineering careers through undertaking science, engineering and technological curses in institutions of higher learning. With US and the rest of the developed world stirring and most of the South countries slumbering, the science, engineering, technology and innovation gap between North and South will widen. In this presentation, the author gives some ideas on how IBSE or STEM can be made to work in developing countries.

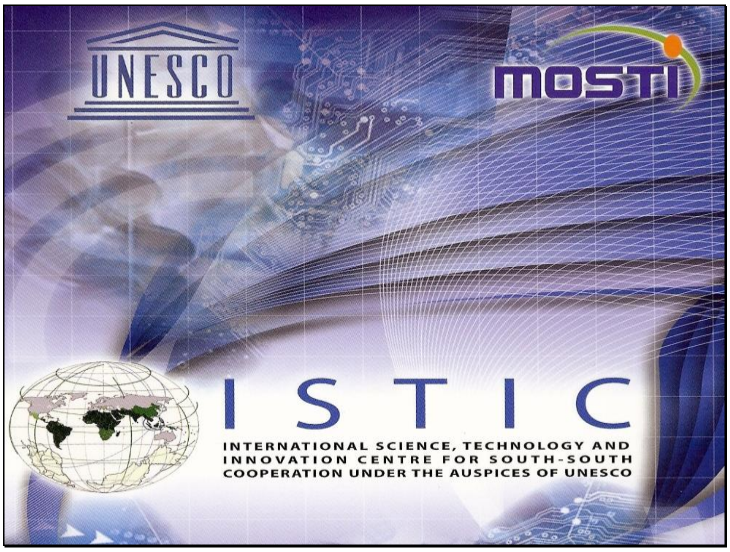


Figure 1. ISTIC.

ISTIC

- **A successful follow-up of the Second Summit of G77 in Doha, 2005.**
- **UNESCO approached Malaysia to host the Centre in 2006. Malaysian government agreed.**
- **ISTIC was formally launched on 22 May 2008.**

One of ISTIC's Priority Agenda is the "Hands-On Inquiry Based Science Education" (IBSE) or "Learning by Doing" under IAP Science Education Program (SEP) with LAMAP Foundation Paris And Regional Education Centre for Science and Mathematics (RECSAM) Penang Malaysia, South East Asia Ministers of Education Organisation (SEAMEO) and Future University Sudan as Partners

Figure 2. ISTIC.

Figure 3. ISTIC IBSE Education Conference 2010.

Professor Dr. Bruce Alberts, US President Science Envoy to Indonesia and Pakistan Addressing Conference

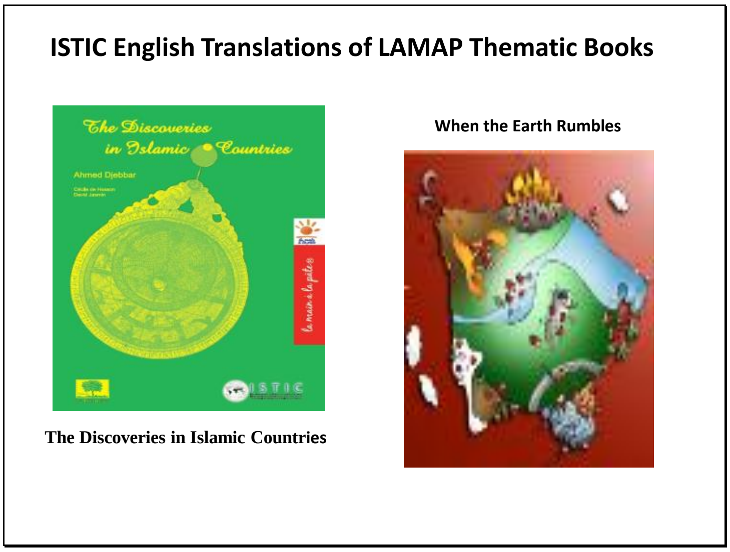


Figure 4. ISTIC English Translation of LAMAP Thematic Books.

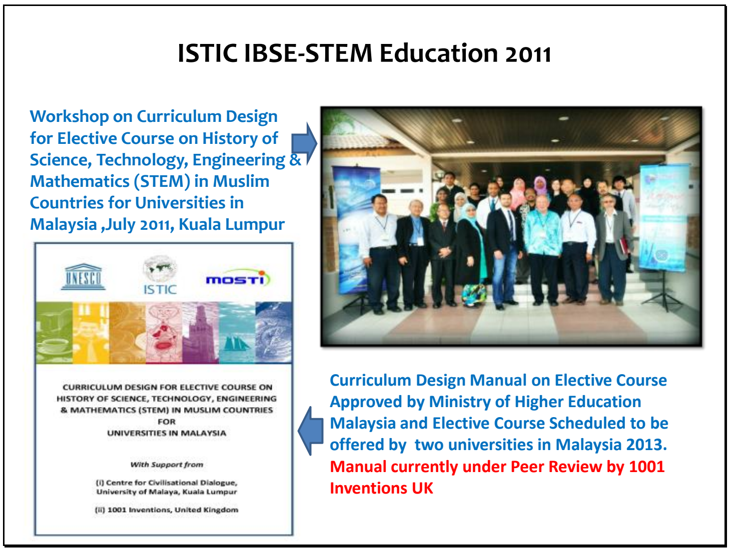


Figure 5. ISTIC IBSE-STEM Education 2011.

Figure 6. ISTIC IBSE Education Roundtable 2012.

ISTIC/Future University Sudan IBSE Roundtable Khartoum 16-17 April 2013

Figure 7. ISTIC Future University Sudan IBSE Roundtable Khartoum 16-17 April 2013.

ISTIC/Future University Sudan IBSE Workshop Khartoum 14-18 April 2013

Figure 8. ISTIC Future University Sudan IBSE Training Workshop Khartoum 14-18 April 2013.

Arab Academy of Sciences/Future University Sudan MOU on IBSE 17 April 2013 Khartoum

Figure 9. Arab Academy of Sciences and Future University Sudan MOU Khartoum on IBSE 17 April 2013.

The Global IAP Science Education Program

In 1994, the International Council for Science (ISCU) established the Capacity Building Committee under Nobel Laureate Dr. Leon Lederman to promote "Inquiry Based Science Education" (IBSE) or "Hands On" Education Program in Schools to help build S & T human resource capacity. IAP was a partner.

In 2003, IBSE became the anchor of Interacademy Panel (IAP) Flagship Science Education Program (SEP).

Chairman of SEP Global Council

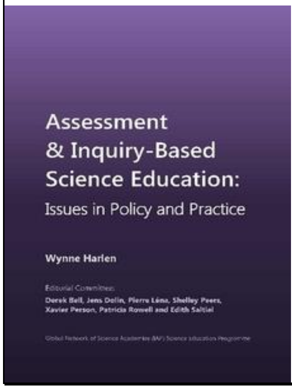
- **Professer Jorge Allende Chile 2003-2008**
- **Professer Pierre Lena France 2008-2013**
- **Dato Lee Yee Cheong Malaysia 2013-**

More information of SEP activities to date:
http://www.interacademies.net/Activities/Projects/12250/18276.aspx

Figure 10. The Global IAP Science Education Program.

Under IAP SEP, IBSE has spread and grown, especially in Europe.

As pointed out in the latest IAP SEP Publication. IBSE's remaining challenges in developed countries are in assessments of the outcomes, students, teachers and the programs themselves.



http://www.lulu.com/shop/wynne-harlen/assessment-inquiry-based-science-education-issues-in-policy-and-practice/ebook/product-20882381.html

Figure 11. Under IAP SEP, IBSE has spread and grown, especially in Europe.

In IAP SEP Biennial Global Conference in Helsinki 30 May-1 June 2012, it was even expressed that without proper assessment, there is still the doubt whether IBSE is really the right approach!

I find such doubt surprising. I would have thought IBSE is well accepted by the global STI Community for the following reasons:

- **IBSE promotes classroom and laboratory practices which encourage students in making sense of events and phenomena in the world around.**

- **IBSE enables students to develop the concepts, skills, attitudes and interests needed for life in societies increasingly dependent on applications of S&T.**

- **IBSE engenders evidence based thinking processes and learning strategies that are necessary for continued learning throughout life.**

Figure 12.

If you are still not convinced, I would like to refer you to the Review (1991-2004) of the Teachers Academy for Mathematics and Science (TAMS) Chicago, founded by Dr. Leon Lederman. TAMS focused its IBSE work in the poorest schools in Chicago with majority African American students. The Review Findings are very positive!

A Review of The Teachers Academy for Mathematics and Science 13 Year Experience: Implementing Inquiry Based Learning in Illinois Public Schools

By Nicholas A. Ciotola , Anthony J Ragona and Darlene Ulrich
Teachers Academy for Mathematics and Science
Chicago, IL
June 3, 2004

http://ehrweb.aaas.org/UNESCO/pdf/RevTchrAcad_Ciotola.pdf

Figure 13.

The TAMS Review Noted:

1. Teachers attempt lessons that they would not have tried before.
2. Teachers give students more time to explore and understand the importance of hands-on activities.
3. Teachers learn to take time to think, let the students think, slow down, and let the students inquire without too much interference.
4. Teachers see their students become more lively and excited when involved in hands on activities. Conversations that are focused on the activities are observed and notes taken down.
5. Students that were not interested in any classroom activities, are now interested in these inquiry based lessons.
6. Teachers move from having a low comfort level with implementing new activities to being eager to try a new activity.
7. Cooperative group skills adopted in mathematics and science activities are used in other subject areas.

Figure 14.

8. Teachers incorporate graphing and sketching in more areas of their science and mathematics lessons.
9. Students extend their own knowledge by replicating investigations or rebuilding models at home.
10. Teachers begin to create different ideas for analyzing information for the science kits that they are using.

The above 10 Qualitative changes were matched by Quantitative improvement in Illinois State examinations in science and mathematics subjects by TAMS schools and students. This resulted in State, Community, Parent and Teacher Buy-In.

The above 10 attitudinal changes are well known to IBSE trainers everywhere as they observe the joy of school children in learning by doing, instead of the traditional book and rote learning of science and mathematics.

Figure 15.

With Nobel Laureate Dr. Leon Lederman in Fermi National Accelerator Laboratory Chicago 2004

Figure 16. With Nobel Laureate Dr. Leon Lederman in Fermi National Accelerator Laboratory Chicago 2003.

I would now offer my opinion why IAP SEP IBSE Program has not taken root in most developing countries:

- The IBSE Program too dependent on National Academies of Sciences;
- Academies of Sciences are poorly resourced and too independent;
- Academies relate to Ministries of S&T whereas schools are under Ministries of Education; Their advocacy of IBSE is indirect and ineffective;
- Priority in Education is "Education for All" in primary education, not IBSE;
- Even when "Goal of Education for All is met" primary school curriculum in some developing countries tends to emphasize subjects that are perceived as character building or useful, for example in Indonesia "Religion, Indonesian Language, Civics and Mathematics." or Language of Instruction, English/Malay in Malaysia.
- Parents swear by examination results as they assure entry to higher education and later good jobs.

Figure 17.

My Proposed Solution for IBSE, STEM, "Hands On" or "Learning By Doing" for Developing Countries:

- Make IAP SEP truly multi-stakeholder by admitting TAMS, SEAMEO organs like RECSAM Malaysia and QITEP Indonesia, Academies of Engineering with STEM programs, Universities like SUNY with STRIVE "Cradle to Career" program and the like.
- Get Ministries of Education buy-in to own IBSE program in Schools.
- Start Hands On program in lower secondary schools and work upwards and downwards as most MOEs are committed to Science and Mathematics education in secondary schools.
- Get Science Centres and Foundations like "1001 Inventions" as proactive partners of IBSE.
- Get UNESCO to be the Intergovernmental hub for IBSE. If UNESCO agrees, it will assure the buy-in of all member states in the developing world, especially their Ministries of Education.

Figure 18.

I will make proposal to UNESCO Director-General HE Irina Bokova during ISTIC 5th Anniversary International Conference 22-24 May 2013 Kuala Lumpur:

A three-tier governance structure under UNESCO:

- **A Global Hub in LAMAP Foundation Paris supported by ISTIC Kuala Lumpur for South countries.**
- **Regional Centres like IAP SEP Regional Hubs, SEAMEO Centres in South East Asia and similar centres in other regions of the world.**
- **National Centres under MOE in collaboration with Academies and TAMS etc.**

The global governance structure will be supported by multi-language website of comprehensive global IBSE data base.
http://www.fondation-lamap.org/

If you agree, please lobby your Government missions in UNESCO through your National Commissions for UNESCO.

Figure 19.

Our advocacy of IBSE should have much wider impact than exciting children about the wonders of S&T so that they will pursue S&T courses and careers.

World population has exceeded 7 billion. Already we consume 1.5 times the earth's resources. World population is expected to rise to 9-10 billion by 2050. Its economic growth is predicated on consumption.

Human fascination with "modern lifestyle" like fast automobile and luxury apartment and high living etc continues to increase the demand for energy and oil. S&T is unfortunately on hand for advanced drilling, causing the disastrous oil spill in the BP Gulf of Mexico disaster, the shale oil pollution in Canada and defiling Global Common like the Arctic.

Figure 20.

What is to me even worse is our ICT savvy youths changing smart phones, pads and pods every few months like costume jewelry. What a travesty for ICT, the jewel in the crown of modern S&T!

Driven by massive and incessant advertising in every medium of public communication, the world, especially the Western world, is consuming beyond our means. What is worse, this is emulated by the high income large population developing countries!

This is not sustainable.

Figure 21.

As Professor Yves Quere, former IAP co-chair and co-founder of LAMAP frequently remarks "IBSE enables students to question and doubt every proposition of the so-called "prophet" unless his proposition is supported by experiment and borne out by evidence. IBSE trains good citizens."

In the face of "prophets" of greed in banking, advertising moguls and vendors of mass consumption using the latest advances in S&T, the only effective defence, in my opinion, is a discerning and rational global citizenry, starting with IBSE trained students.

It is my hope that through UNESCO, IBSE will eventually be embraced by all education.

For a sustainable world, we must broaden "Inquiry Based Science Education" (IBSE) into " Evidence Based Education for All".

Figure 22.

Excellence in Higher Education for Building S&T Proficiency: A Perspective from Bangladesh

A K AZAD CHOWDHURY
Chairman
University Grants Commission of Bangladesh
Dhaka, Bangladesh

ABSTRACT

Science, technology and innovation are the driving force for the economic growth of a country in today's world. Higher education for growth through generation of skills and innovations is the slogan of the day. The R&D allocation of a country has a strong relationship with its growth. In the economic field Bangladesh has achieved a steady growth of over 6.5% of GDP per year, third fastest growing economy in Asia, for last few years. The strength of Bangladesh's economy comes from its unskilled and semiskilled work force, a demographic dividend of 85 million people of the age of 18 to 35 years. If skill could be infused in them the growth would have been much faster.

Bangladesh has achieved over 90% enrollment in primary level education but the enrollment in tertiary level was only 12%. Recently it has witnessed a tremendous growth in tertiary level enrollment, from 1.16 million in 2008 to 2.65 million in 2012. Number of public and private universities has also gone up from 79 to 104 (35 Public + 69 Private) in last four years and 7 more public universities are in the pipeline. The newly established public universities are mostly S&T, Engineering and Agriculture oriented. Private Universities are market driven and there is preponderance of business school, pharmacy, computer science, ICT and English departments. There has always been a concern for quality of education and research in the HEIs in the country. The University Grants Commission of Bangladesh (UGC) has been implementing 'Higher Education Quality Enhancement Project' (HEQEP), funded by Ministry of Education and the World Bank, for improvement of quality of education and research through 'Academic Innovations Fund' (AIF) projects and establishment of high speed internet network 'Bangladesh Research and Education Network' (BdREN). The BdREN connects all the universities of the country to 'Trans Eurasian Cable Network' (TEINC) for giving access to the stakeholders to the world pool of knowledge. The HEQEP is an icon of progress in nation's tertiary level education and research now stepping into fifth year of its implementation with laudable success and achievement. It has improved the quality and relevance of teaching and research through encouraging both innovation and accountability in HEIs. Over 80% of total allocation of Academic Innovation Fund (AIF) is being spent on Science, Technology, Engineering, Biological and Agricultural education and research, and only 10% goes to the self assessment projects. Digital Library has been established in UGC initially with a total of 2500 e-journals and few thousand e-books books of globally renowned providers. The UGC has been setting up 'Higher Education Management Information System' (HEMIS) for monitoring the quality of education and research in over 100 universities of the country and also to generate a data base on higher education and human resources for national use.

The government has enacted Private Universities Act 2010 to improve the quality of higher education in the private universities, evolve system of management and establish accountability of the boards of trustees of these universities. The UGC has formulated the rules and regulations for the Accreditation Council and also for the Cross Boarder Higher

Education (CBHE). The Ministry of Education is giving final touch to those before enactment. These efforts have brought in significant improvement in the quality of education and research especially in the area of science and technology, engineering, mathematics, agriculture and biology.

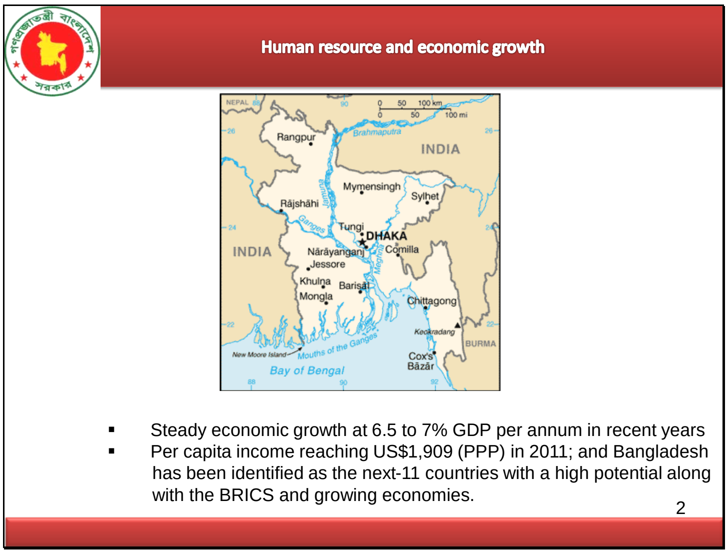


Figure 1. Human resource and economic growth.

Figure 2. Human resource and economic growth (Contd.).

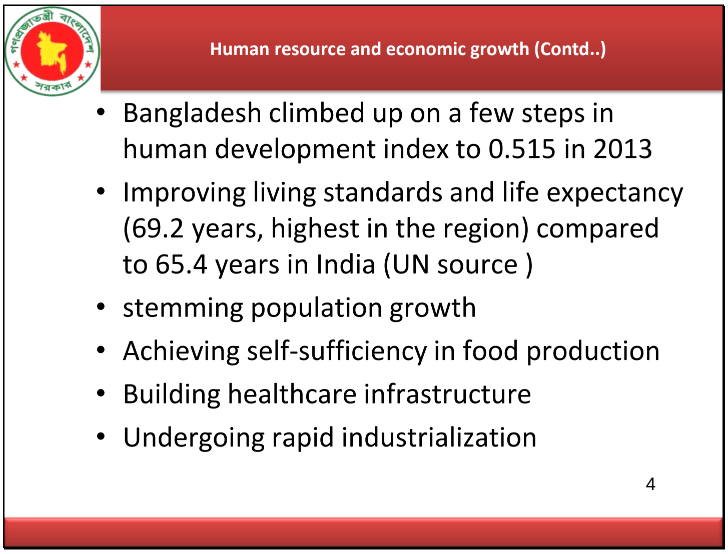


Figure 3. Human resource and economic growth (Contd.).

Figure 4. Human resource and economic growth (Contd.).

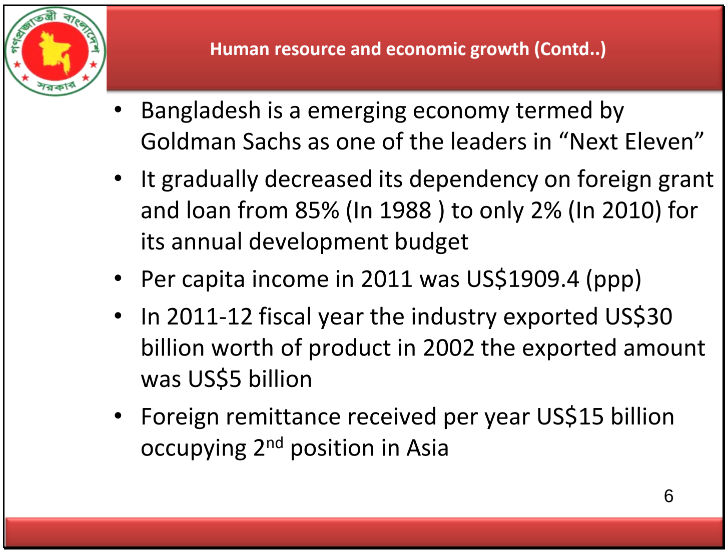


Figure 5. Human resource and economic growth (Contd.).

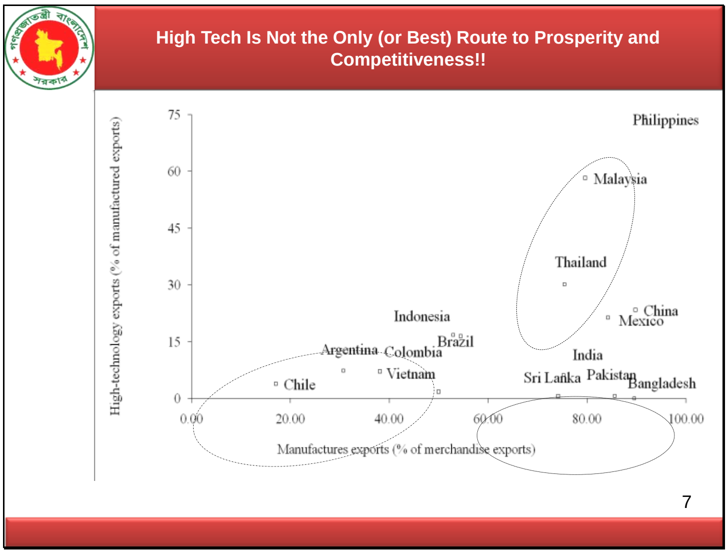


Figure 6. High Tech is not the only (or best) route to prosperity and competitiveness.

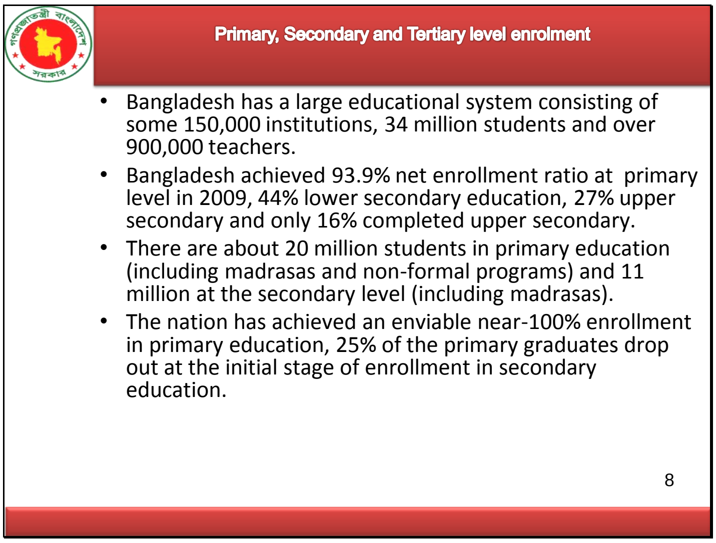


Figure 7. Primary, Secondary and tertiary level enrolment.

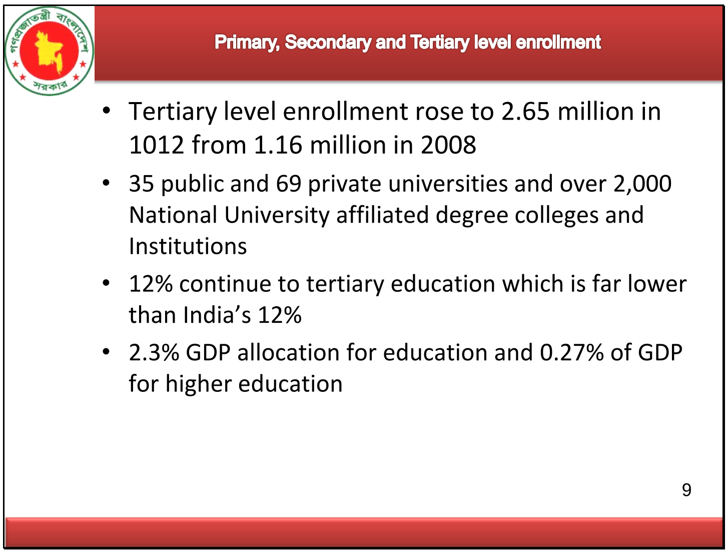


Figure 8. Primary, Secondary and tertiary level enrolment.

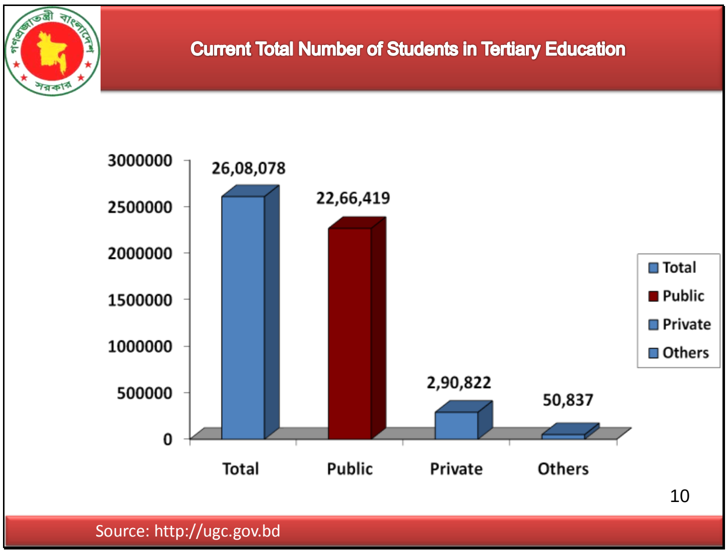
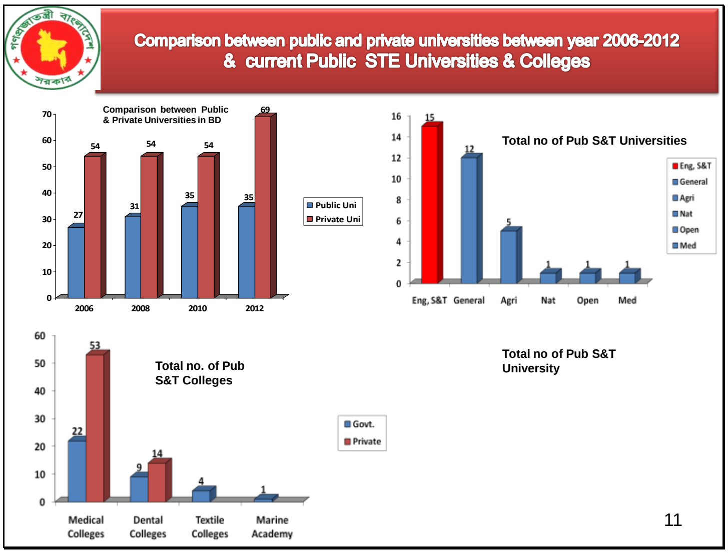


Figure 9. Current total of students in tertiary education.



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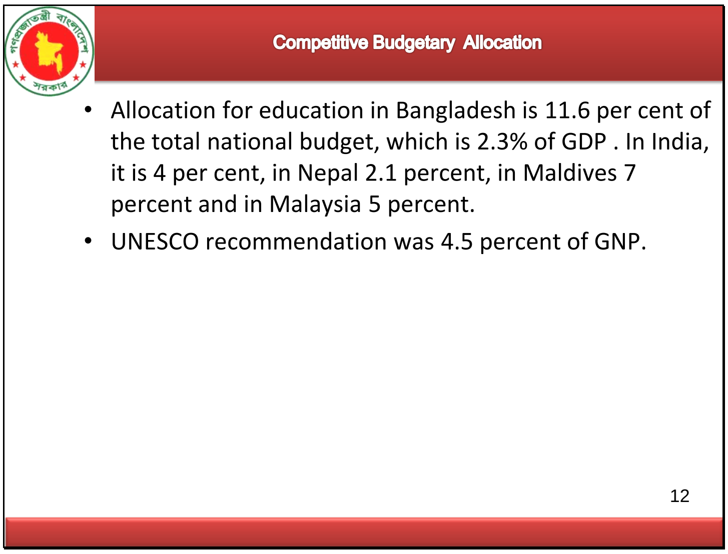

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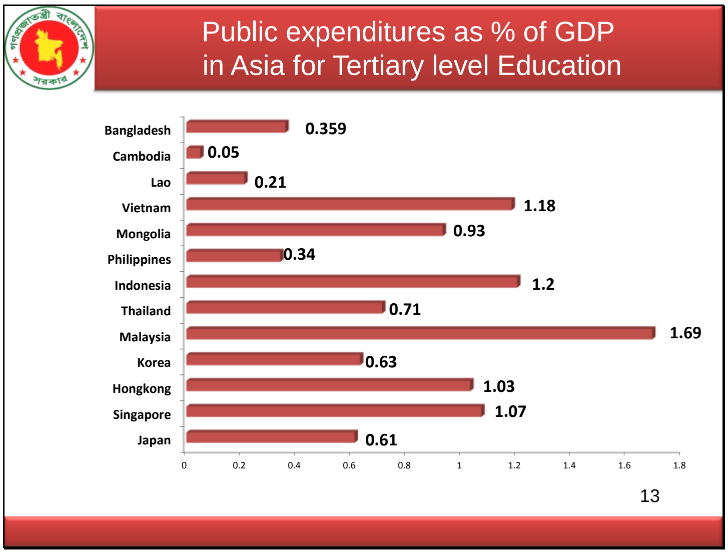

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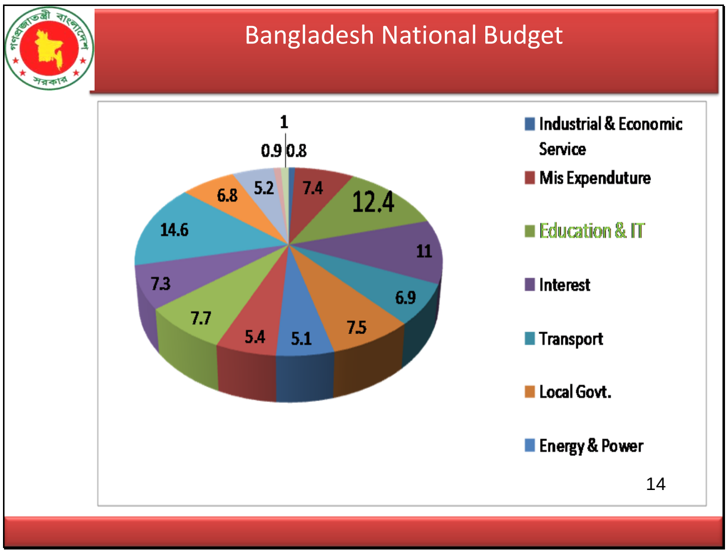
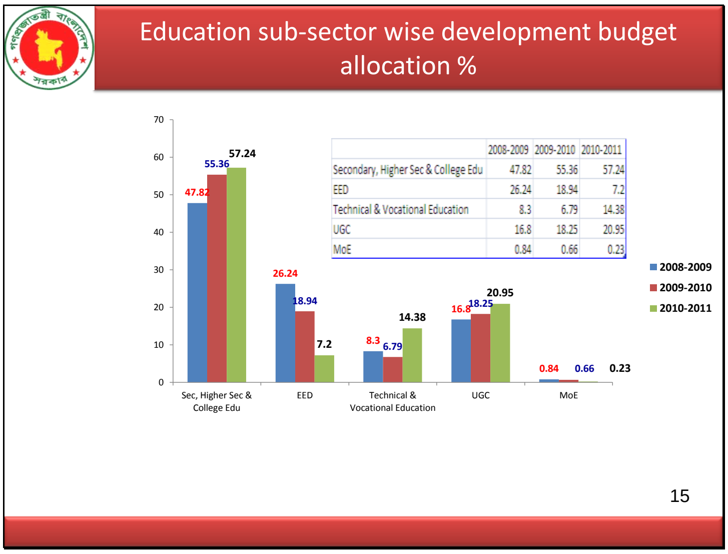


Figure 13. Bangladesh National Budget.



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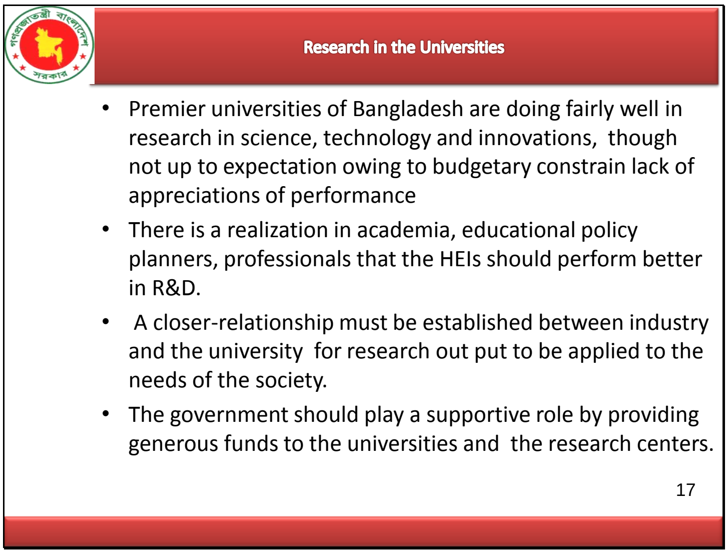

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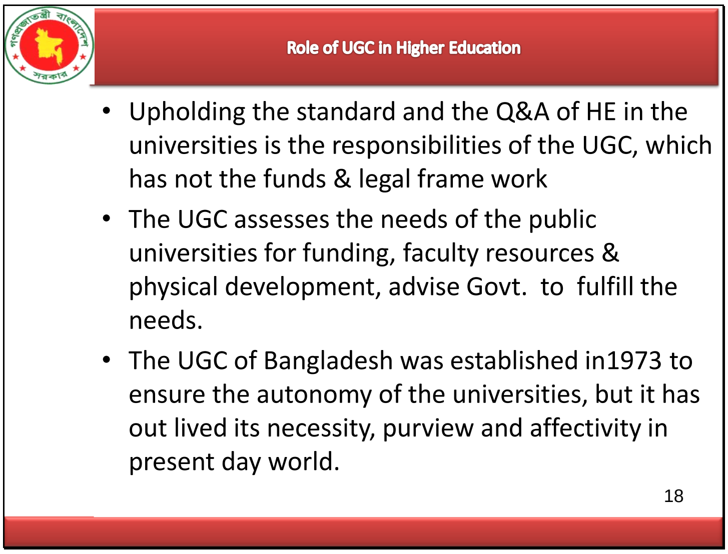

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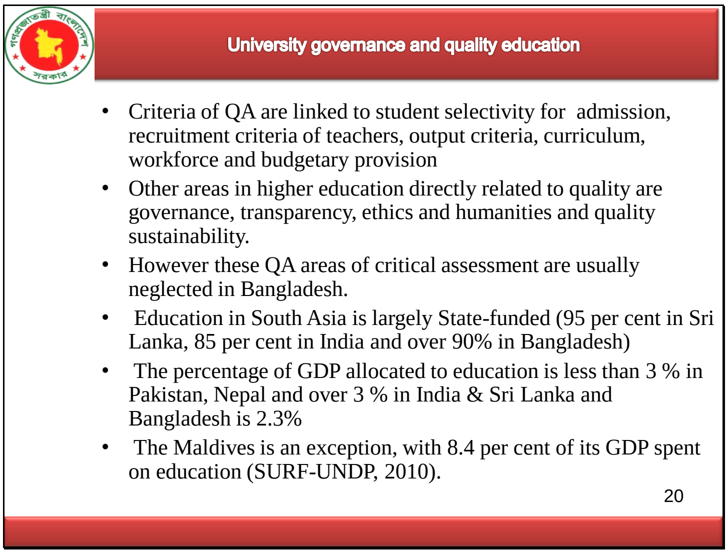
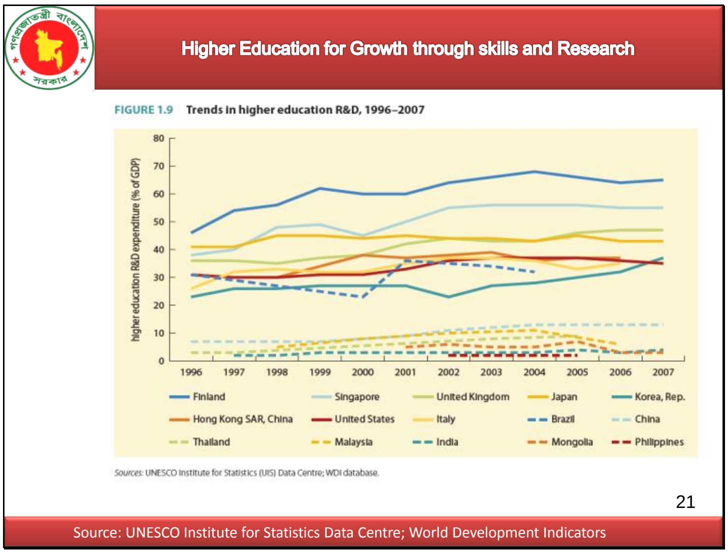


Figure 19. University governance and quality education.



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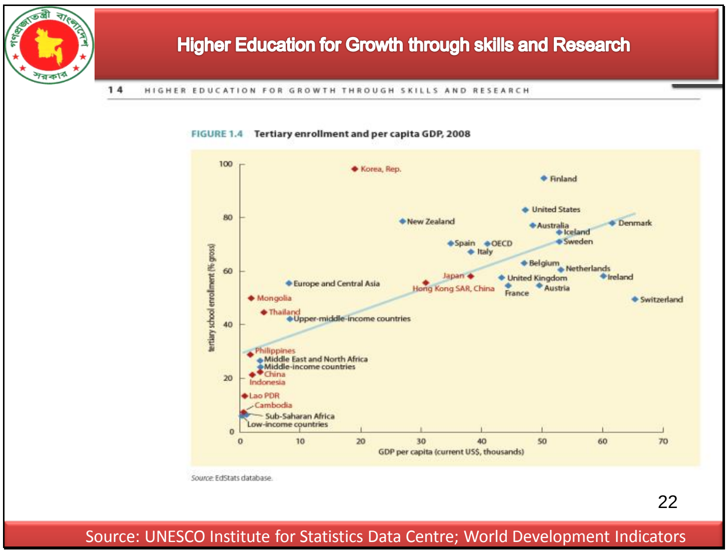


Figure 21. Higher education for growth through skills and research.

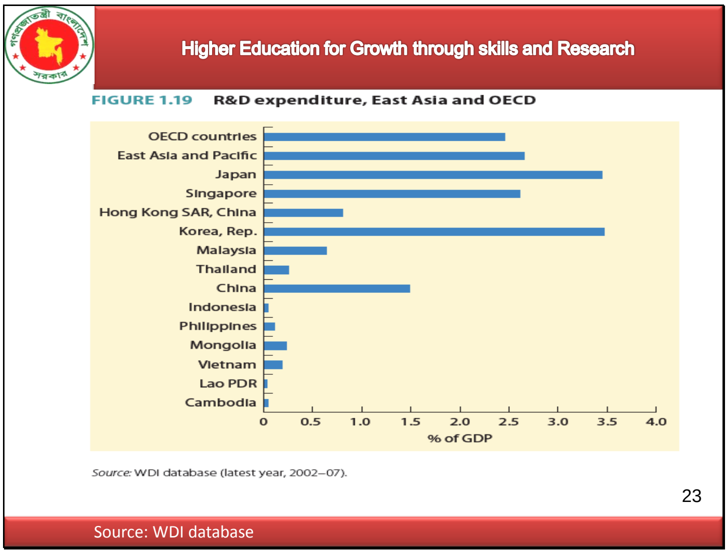
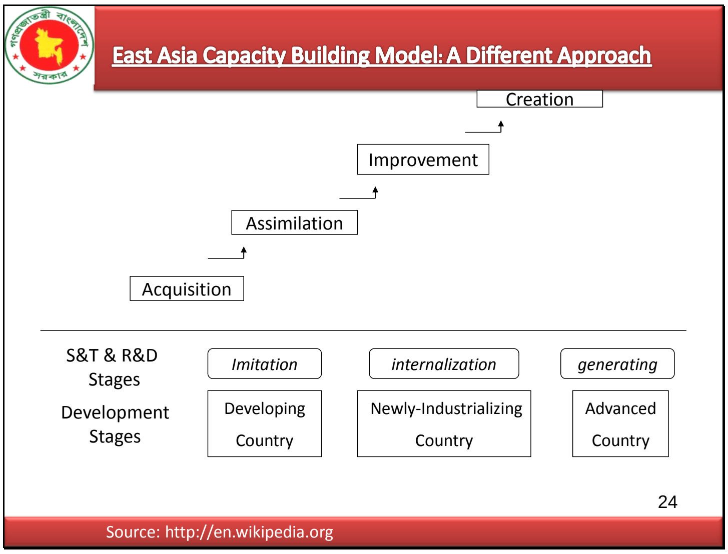


Figure 22. Higher education for growth through skills and research.



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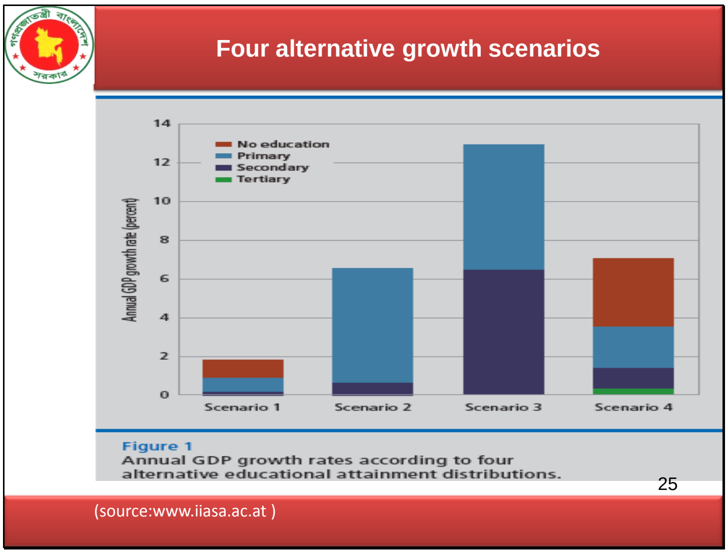

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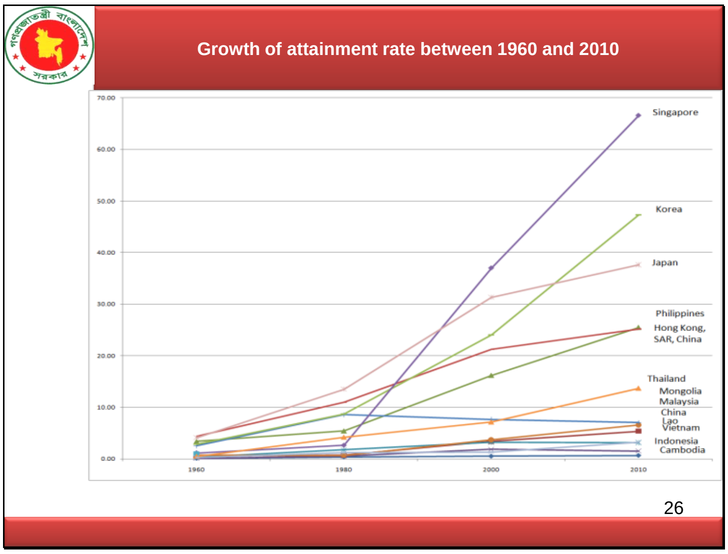

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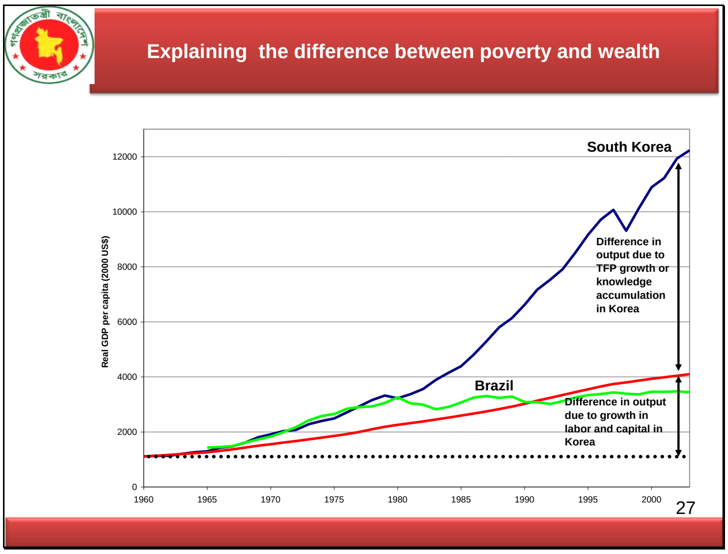

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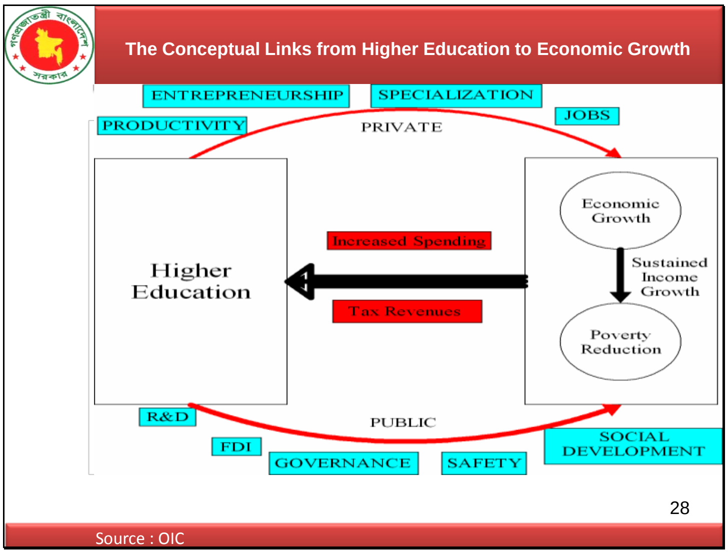

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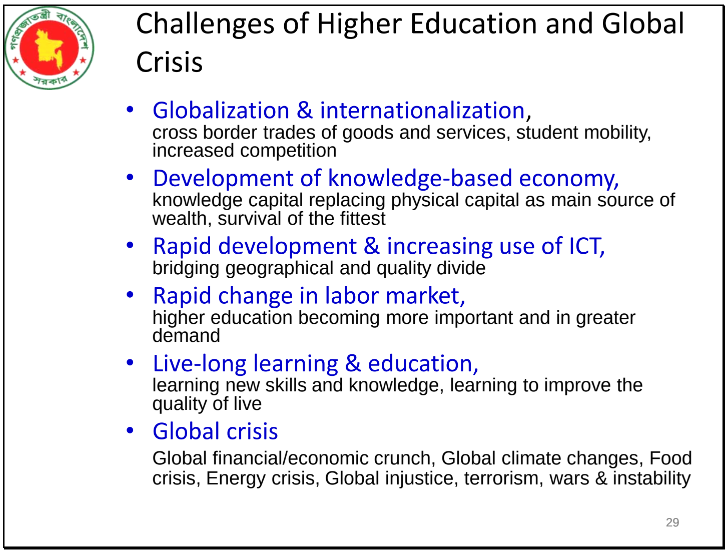

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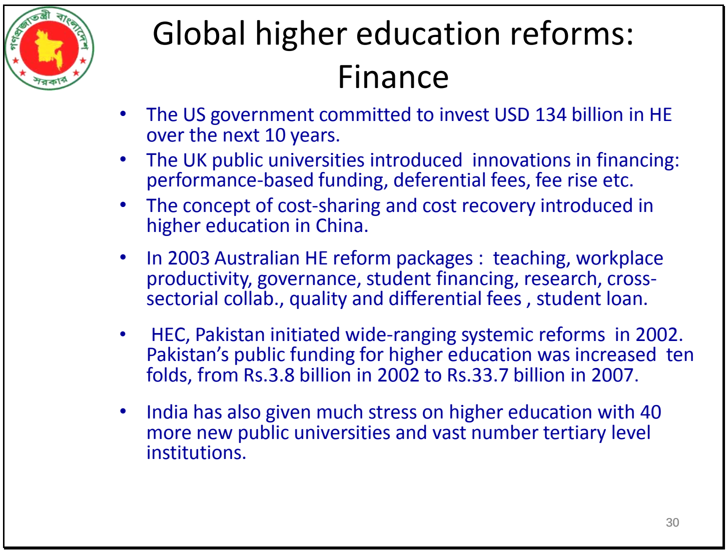

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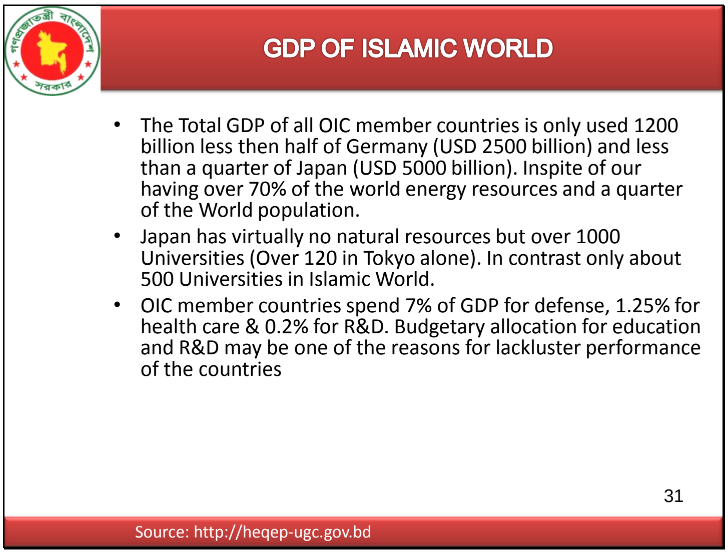
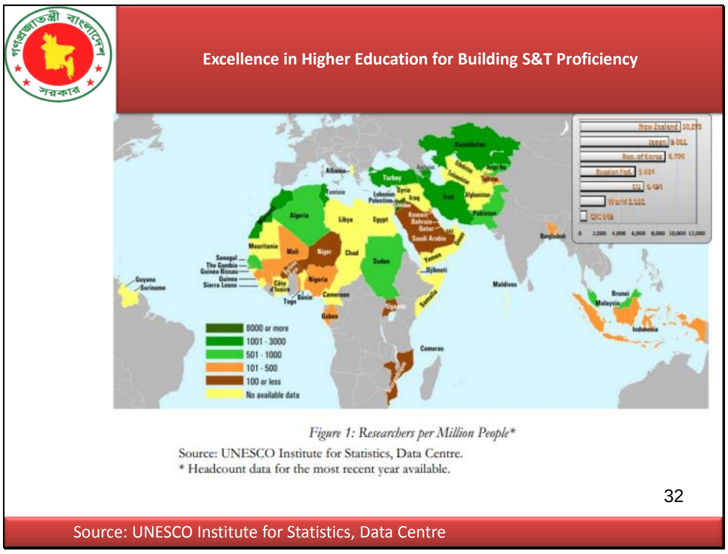


Figure 30. GDP of Islamic World.



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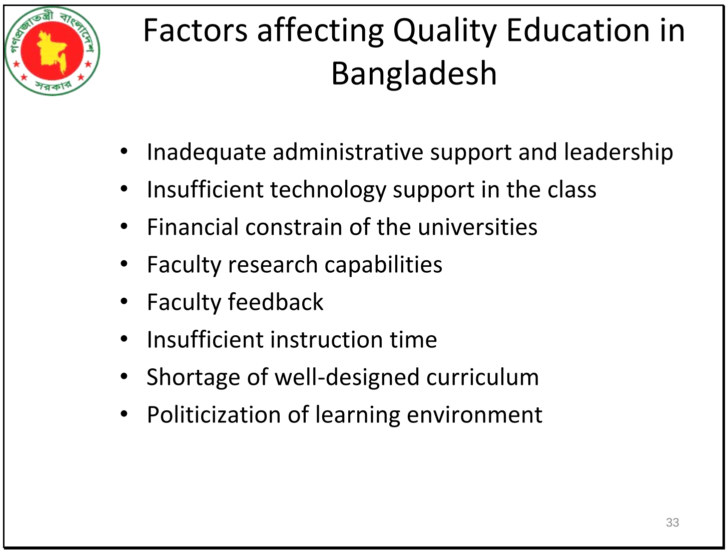

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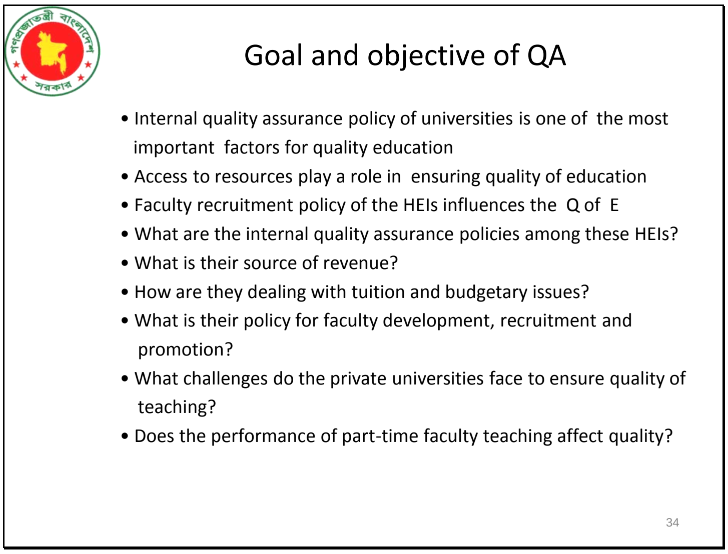

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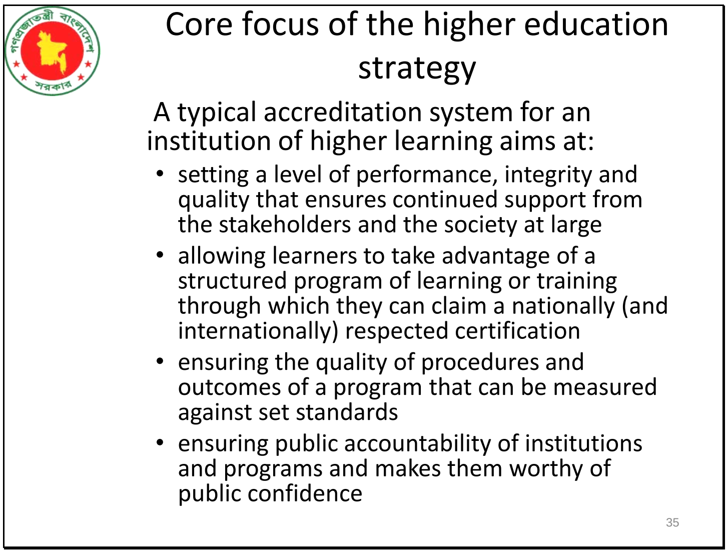

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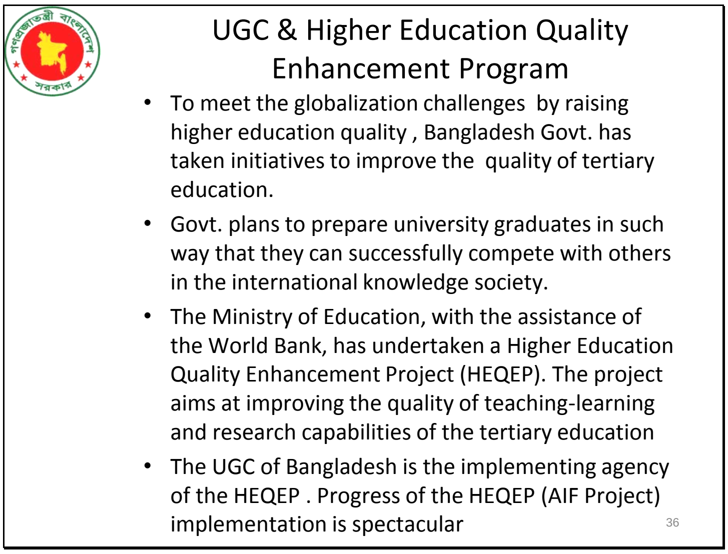


Figure 35. UGC & higher education quality enhancement program.

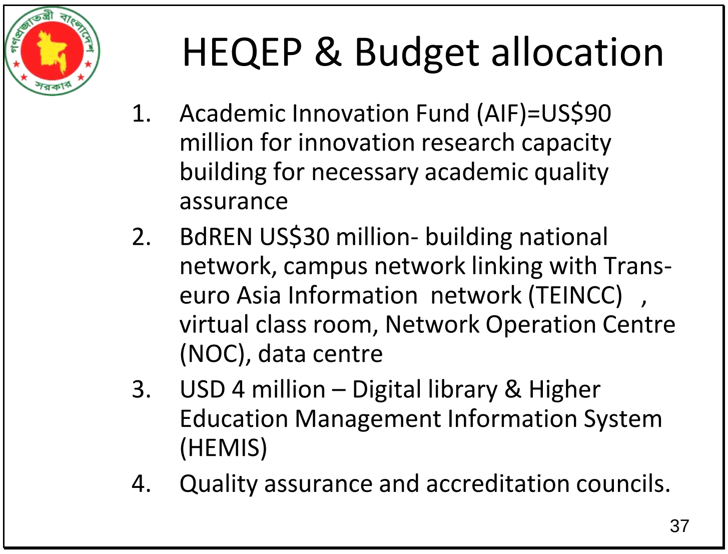


Figure 36. HEQEP & budget allocation.

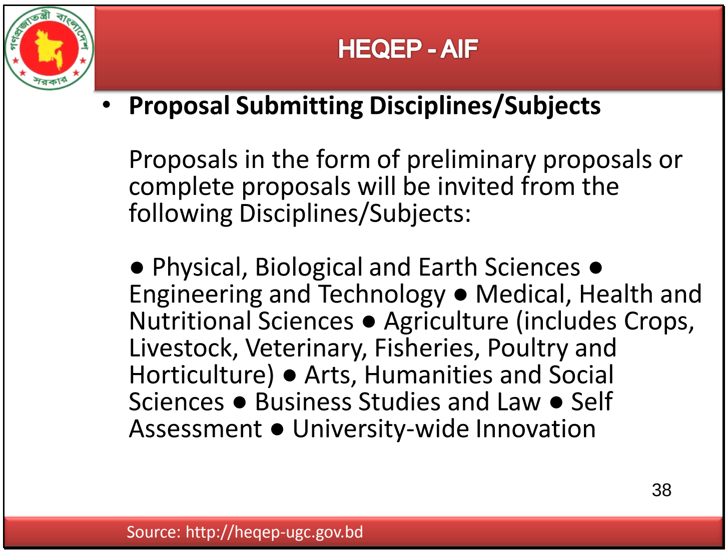


Figure 37. HEQEP –AIF.

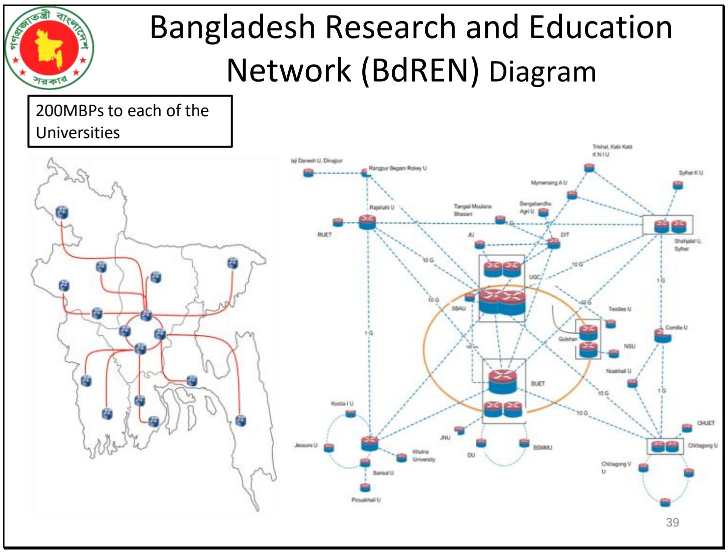


Figure 38. Bangladesh research and education network (BdREN) diagram.

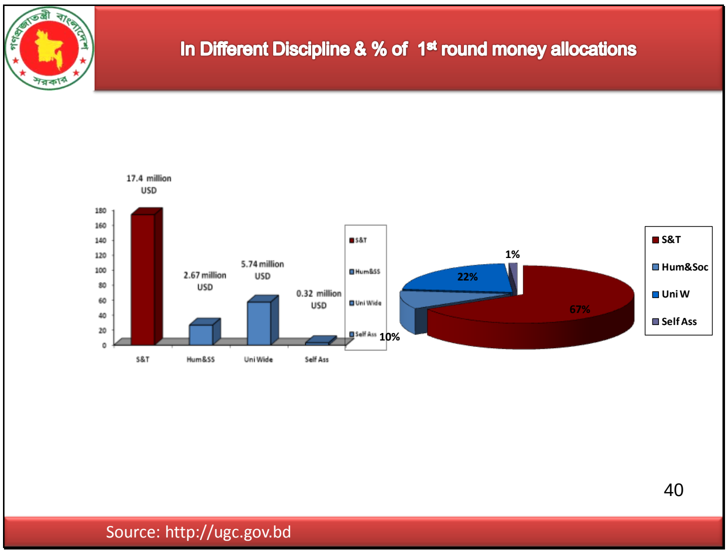
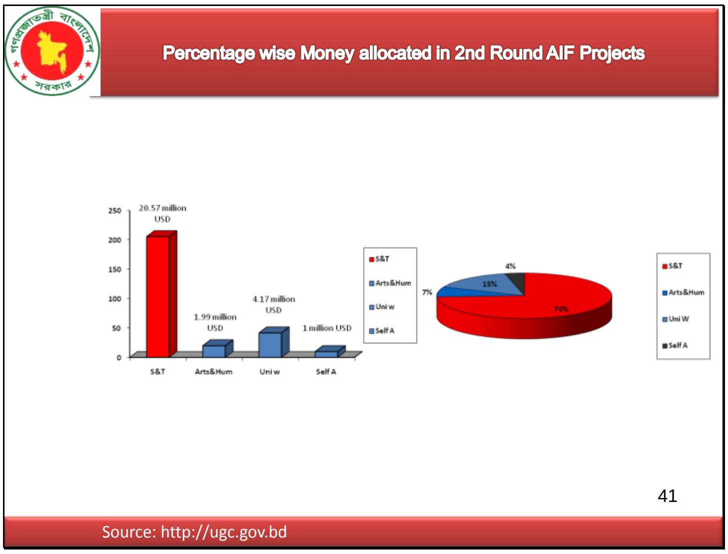


Figure 39. In different disciplines & % of 1st round money allocations.



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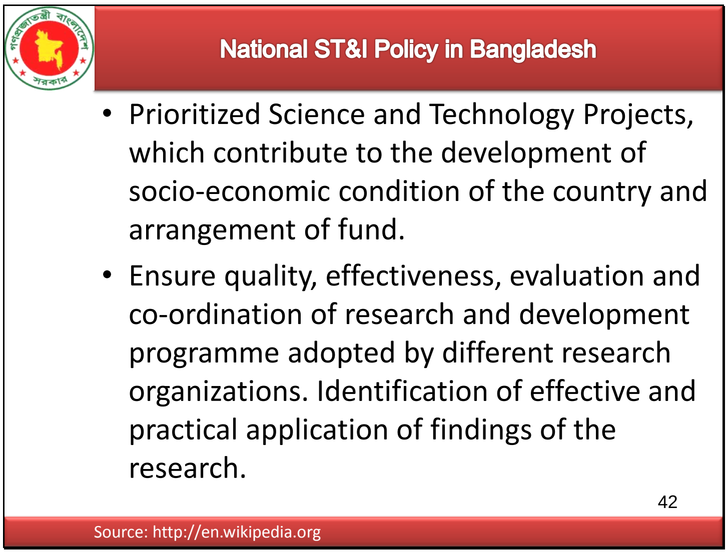

Figure 41. National ST&I policy in Bangladesh.

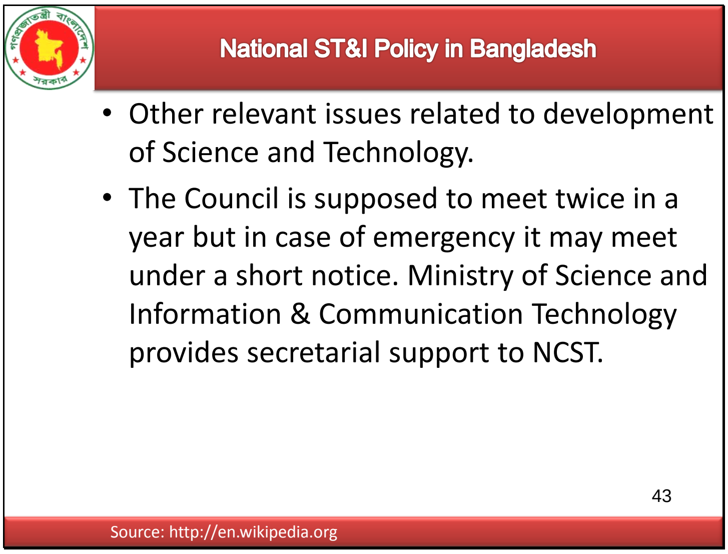

Figure 42. National ST&I policy in Bangladesh.

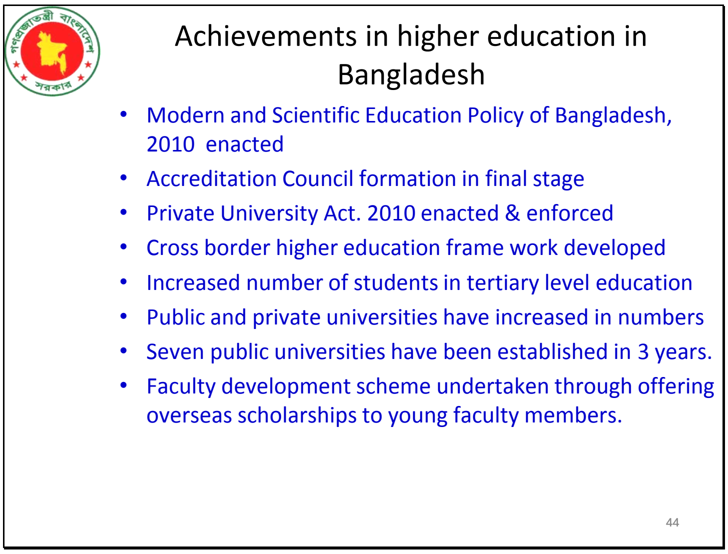

Figure 43. Achievements in higher education in Bangladesh.

Achieving S&T Proficiency in the OIC: The COMSTECH Perspective

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COMSTECH Secretariat, Islamabad
Pakistan

ABSTRACT

COMSTECH is a vast platform for joint scientific cooperation to an estimated 1.5 billion Muslims comprising 30% of world's youth and holding political control over 70% of global energy reserves and 49% of mineral resources. However, largely due to their unfledged educational system and lack of scientific skills human capital devoid of scientific skills, it contributed a mere 6.7% to the world's GDP in 2012 and generated only 4.3% in high technology exports.

In terms scientific development the present state of COMSTECH countries is such that none of its members is classified at par with scientifically developed countries. Only Turkey and Malaysia are identified as leaders with emergent innovation systems and potential to acquire technology capabilities. UAE, Indonesia, Iran, Qatar, Oman, Saudi Arabia, Lebanon, Egypt, Tunisia, Pakistan, Morocco, Jordan and Kazakhstan can be categorized as scientifically developing countries. The remaining OIC states are classified as scientifically marginalized.

In COMSTECH perspective, as OIC member states increase intra-OIC trade from the current level of 15% and focus on increasing technology trade with industrially advanced OIC partners, the potential for growth in scientific infrastructure will get a boost and register a smooth transition from traditional to a more modern socio economic set up. This is possible because trade creates demand for technology and makes people interact in many different ways. A commitment by member states to allocate a certain share of their technology trade for intra-OIC trade is also likely to act as a stimulant for technology and innovation activities in COMSTECH countries.

Providing opportunity for enhanced technology trade between COMSTECH member states will also create incentives to invest in the development of highly skilled human capital for scientific research to build required technology capability. This would greatly help in industrialization of OIC states, resulting in employment opportunities for the educated.

As developing countries, COMSTECH member states are not expected to innovate at the frontiers of technology. However, COMSTECH countries can initially source technology from within the OIC, specially from those 15 OIC states that are endowed with advanced industrial infrastructure, and who should be able to offer transfer of operational, management and marketing skills to put on track their less fortunate brethren seeking the required competence.

Figure 1. What is COMSTECH?

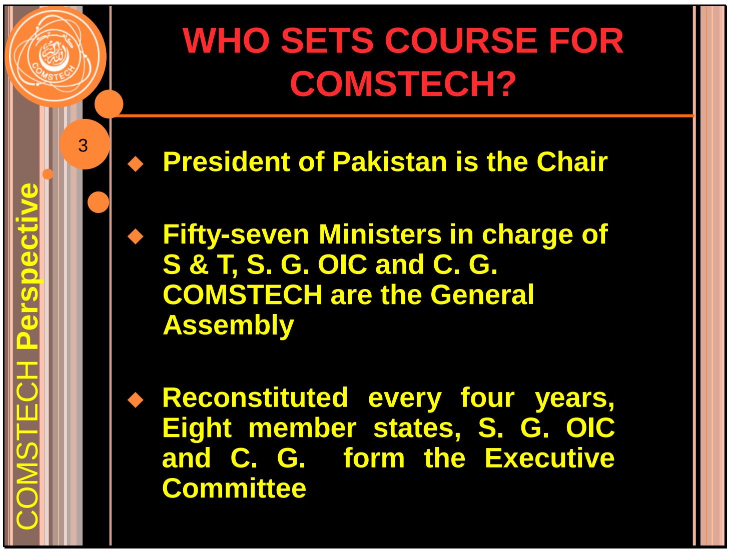


Figure 2. Who sets course for COMSTECH?

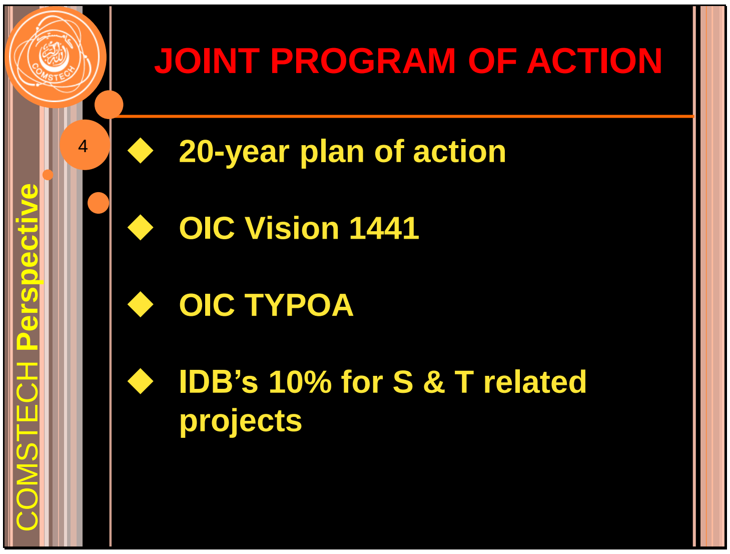


Figure 3. Joint program of action.

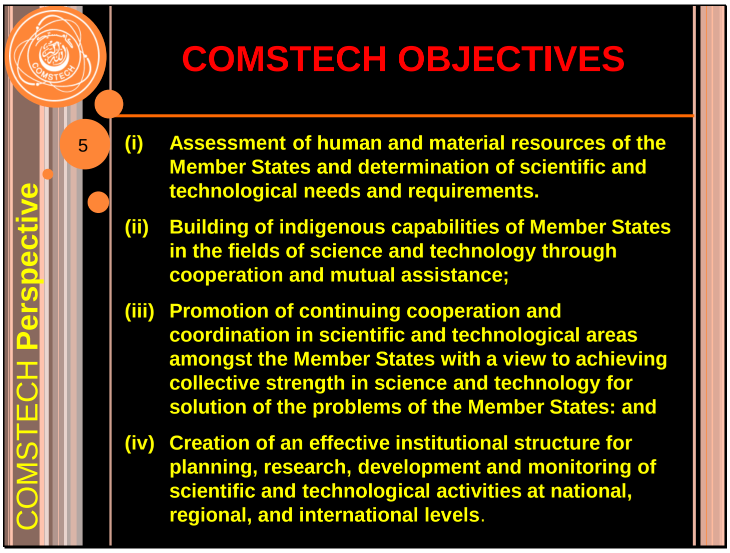


Figure 4. COMSTECH objectives.

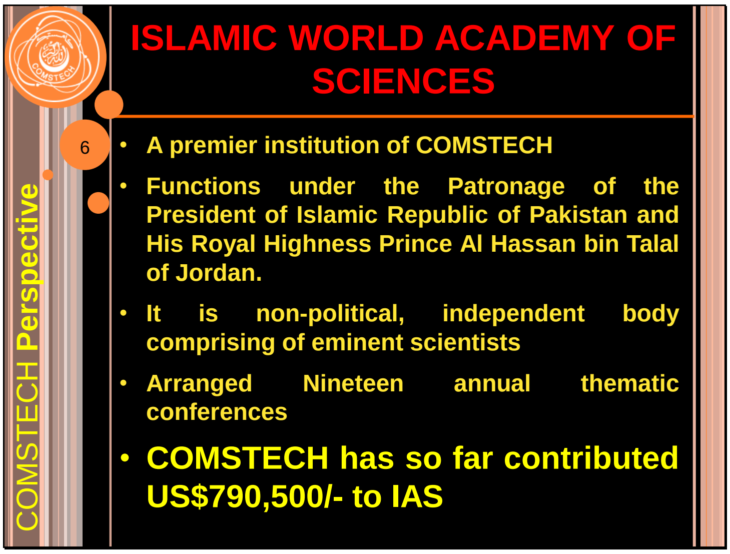


Figure 5. Islamic World Academy of Sciences.

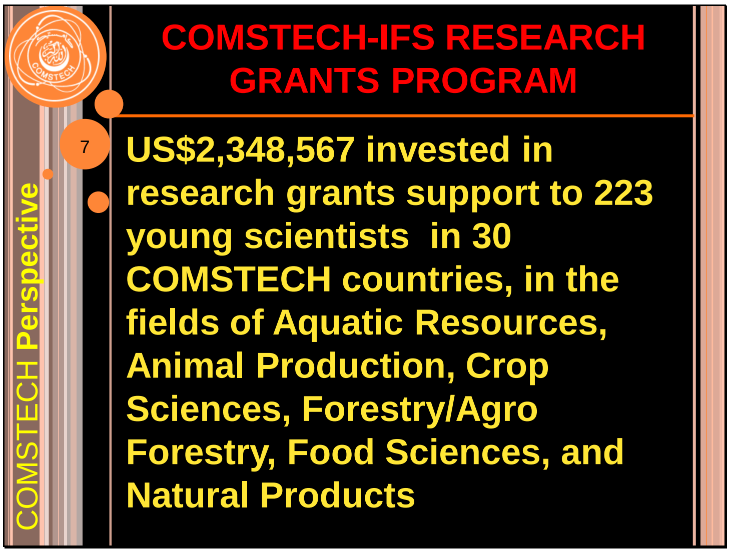
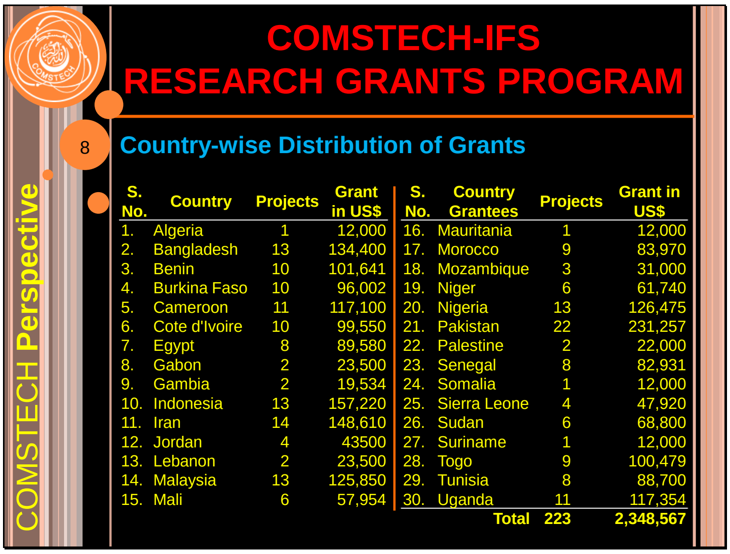


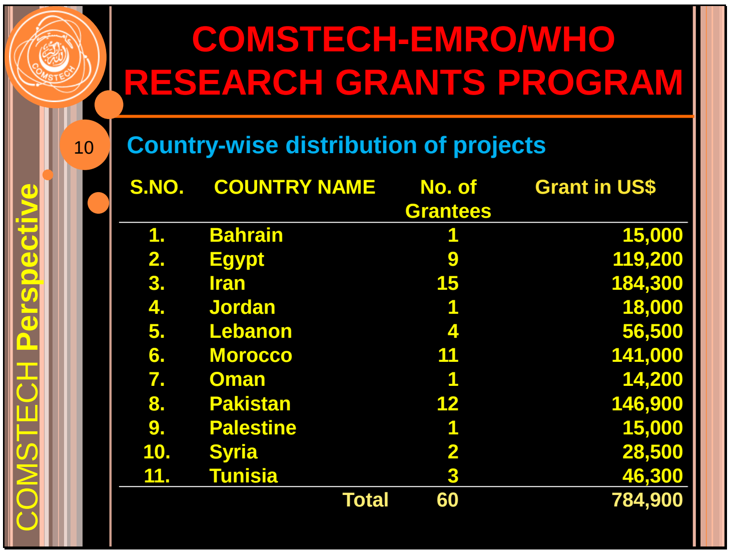
Figure 6. COMSTECH-IFS research grants program.



S. No.	Country	Projects	Grant in US$	S. No.	Country Grantees	Projects	Grant in US$
1.	Algeria	1	12,000	16.	Mauritania	1	12,000
2.	Bangladesh	13	134,400	17.	Morocco	9	83,970
3.	Benin	10	101,641	18.	Mozambique	3	31,000
4.	Burkina Faso	10	96,002	19.	Niger	6	61,740
5.	Cameroon	11	117,100	20.	Nigeria	13	126,475
6.	Cote d'Ivoire	10	99,550	21.	Pakistan	22	231,257
7.	Egypt	8	89,580	22.	Palestine	2	22,000
8.	Gabon	2	23,500	23.	Senegal	8	82,931
9.	Gambia	2	19,534	24.	Somalia	1	12,000
10.	Indonesia	13	157,220	25.	Sierra Leone	4	47,920
11.	Iran	14	148,610	26.	Sudan	6	68,800
12.	Jordan	4	43500	27.	Suriname	1	12,000
13.	Lebanon	2	23,500	28.	Togo	9	100,479
14.	Malaysia	13	125,850	29.	Tunisia	8	88,700
15.	Mali	6	57,954	30.	Uganda	11	117,354
					Total	223	2,348,567

Figure 7. COMSTECH-IFS research grants program.

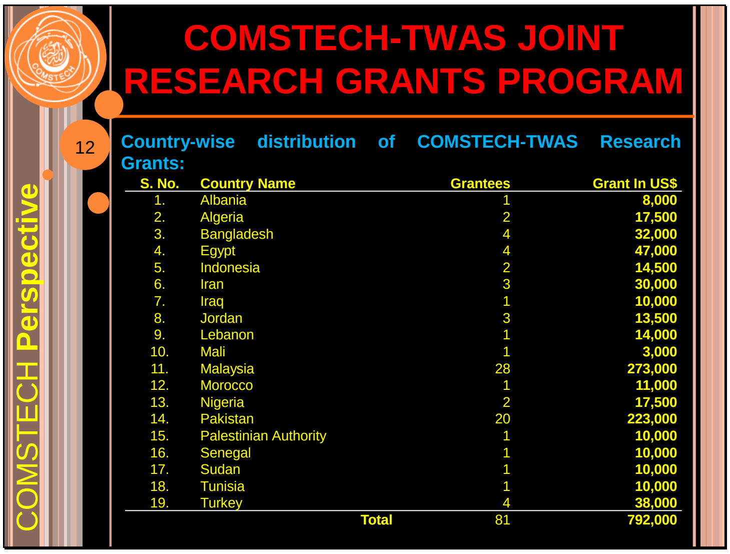
Figure 8. COMSTECH-EMRO/WHO research grants program.



S.NO.	COUNTRY NAME	No. of Grantees	Grant in US$
1.	Bahrain	1	15,000
2.	Egypt	9	119,200
3.	Iran	15	184,300
4.	Jordan	1	18,000
5.	Lebanon	4	56,500
6.	Morocco	11	141,000
7.	Oman	1	14,200
8.	Pakistan	12	146,900
9.	Palestine	1	15,000
10.	Syria	2	28,500
11.	Tunisia	3	46,300
	Total	60	784,900

Figure 9. COMSTECH-EMRO/WHO research grants program.

Figure 10. COMSTECH-EMRO/WHO research grants program.



S. No.	Country Name	Grantees	Grant In US$
1.	Albania	1	8,000
2.	Algeria	2	17,500
3.	Bangladesh	4	32,000
4.	Egypt	4	47,000
5.	Indonesia	2	14,500
6.	Iran	3	30,000
7.	Iraq	1	10,000
8.	Jordan	3	13,500
9.	Lebanon	1	14,000
10.	Mali	1	3,000
11.	Malaysia	28	273,000
12.	Morocco	1	11,000
13.	Nigeria	2	17,500
14.	Pakistan	20	223,000
15.	Palestinian Authority	1	10,000
16.	Senegal	1	10,000
17.	Sudan	1	10,000
18.	Tunisia	1	10,000
19.	Turkey	4	38,000
	Total	81	792,000

Figure 11. COMSTECH-EMRO/WHO research grants program.

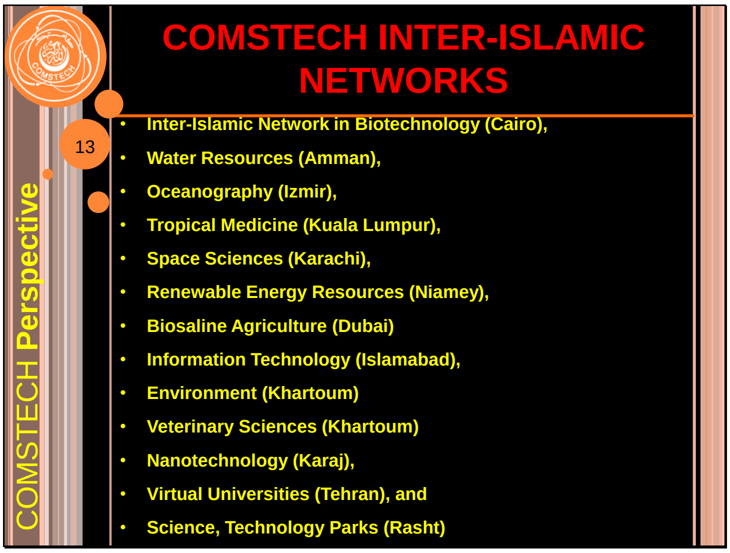


Figure 12. COMSTECH inter-Islamic networks.

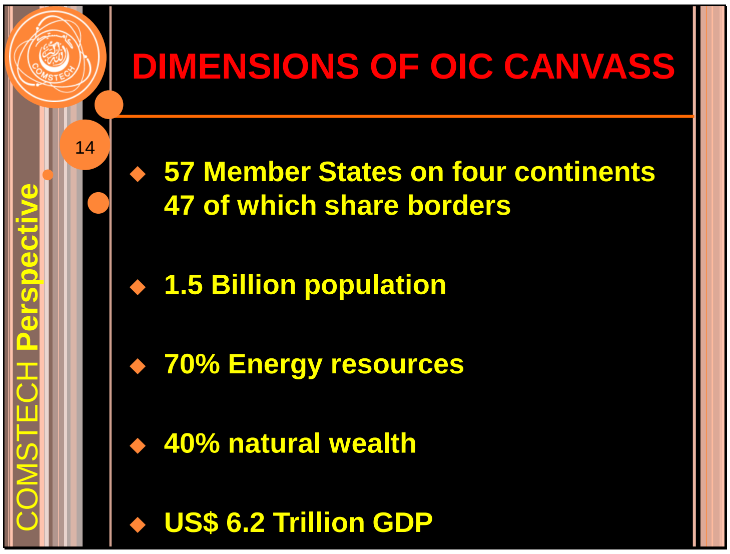


Figure 13. Dimensions of OIC canvass.

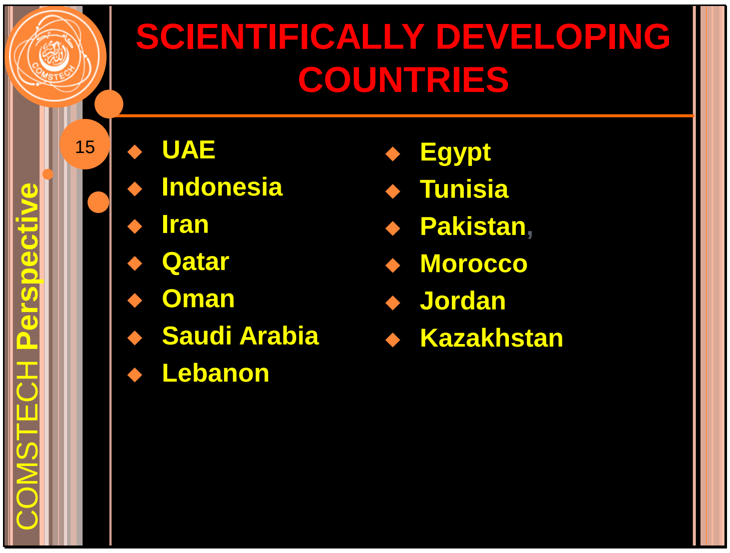


Figure 14. Scientifically developing countries.

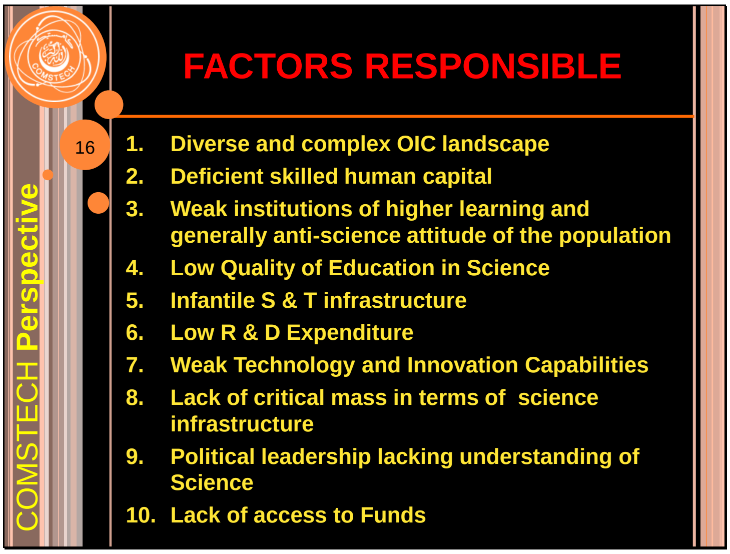


Figure 15. Factors responsible.

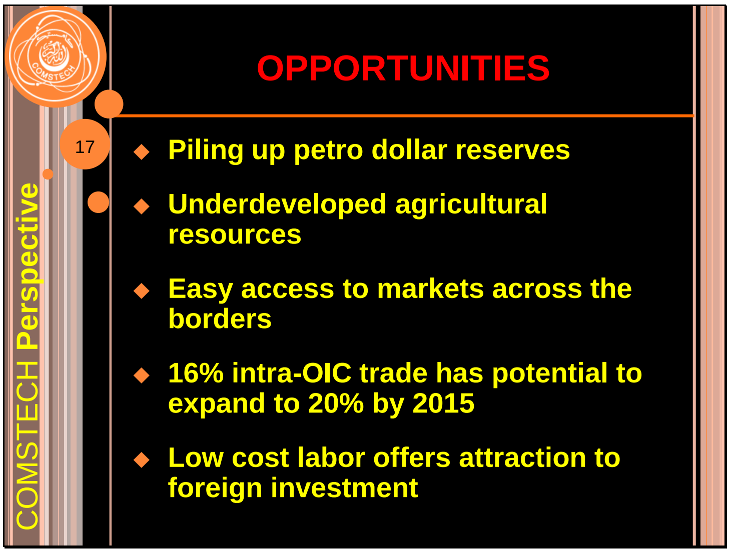


Figure 16. Opportunities.

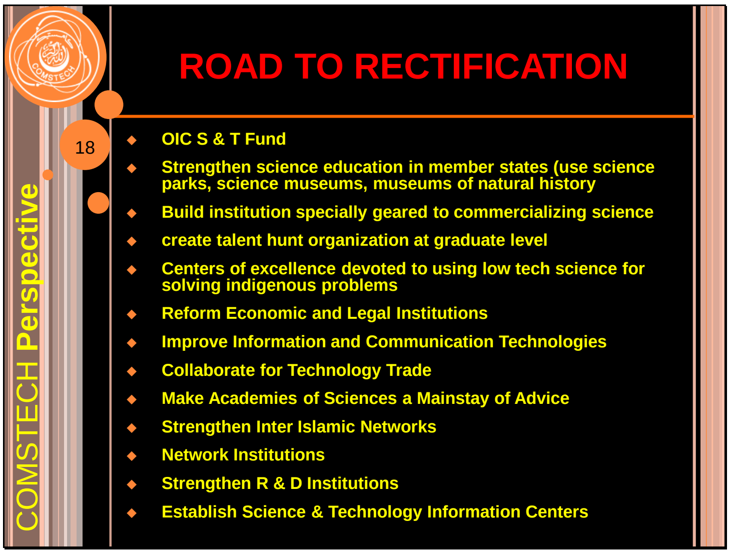


Figure 17. Road to rectification.

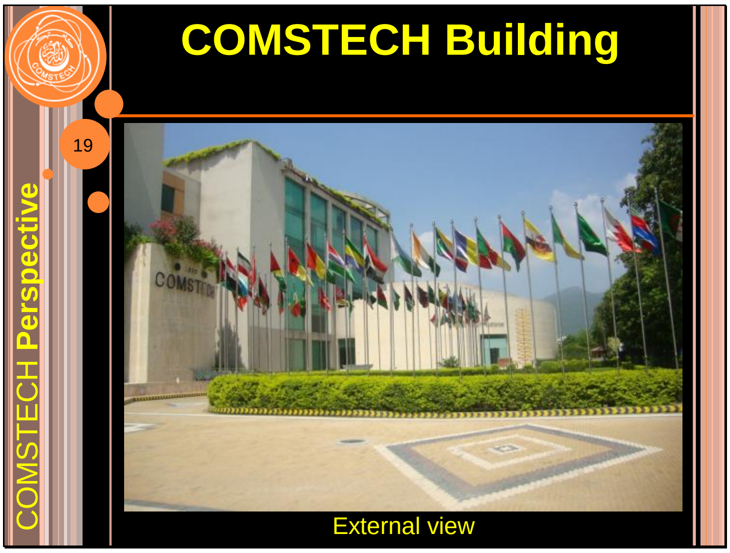


Figure 18. COMSTECH building.

Figure 19. COMSTECH building.

1

Figure 20. Snaps of facilities available at COMSTECH.

Higher Education and Scientific Proficiency for Knowledge-Based Economic Development in OIC Member Countries

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Bangladesh University of Health Sciences
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1 INTRODUCTION

In this age of high technology and globalisation it is expected that sustainable economic development needs to be based on intelligent and judicious use of existing resources and intellectual capital. This is especially true for developing countries that are highly populous but poor in natural resources or are heavily dependent on non-renewable and finite natural resources. Knowledge-based sustainable development requires excellence in higher education and proficiency in scientific, technological and social science disciplines that underpin economic development. Excellence in higher education and quality of research are very closely related; the highest ranking universities of the world also happen to be the best research universities. It is no wonder that the top-ranked higher education institutions in the world are almost exclusively situated in the economically and technologically advanced countries in the North, with only a handful in the rapidly advancing countries of the developing world.

2 ECONOMIC DEVELOPMENT AND SCIENTIFIC PROFICIENCY IN THE ISLAMIC WORLD

While higher education is an essential prerequisite for the development of knowledge-based economies in the OIC member countries, both academic excellence and sustainable development are critically dependent on scientific proficiency and a strong technology base. Unfortunately none of the 57 OIC member countries are classified as being economically or scientifically advanced; 21 of these are classified as least developed countries. Because of the lack of scientific proficiency it is not surprising that only a small handful of universities in the OIC member countries make an appearance, in a small number of international ranking systems, within the top 500 in the world.

Wealth by itself is not the only determinant of economic and scientific advancement. Some OIC member countries have huge cash reserves because of their natural resources and yet they are not considered to be economically advanced or even qualify as rapidly advancing countries. The main determinant of their current less than expected status in socio-economic development is their lack of scientific and technological proficiency. Some of these countries, especially the oil-rich states, have mostly opted to import required technology and expertise rather than using their transient wealth to build a sustainable economy based on intellectual capital through development of higher education and research capacity. Fortunately the situation is slowly changing in some of these countries.

3 CURRENT STATE OF HIGHER EDUCATION AND RESEARCH IN OIC MEMBER COUNTRIES

The attainment of knowledge-based sustainable development in the OIC member countries will require the establishment of at least a few "world-class" research universities with the capacity to carry out internationally competitive research in strategic and priority areas. To identify such universities the IDB, OIC and IAS commissioned an extensive study to measure research productivity of different universities based on various parameters (SESRTCIC Report, April 2007). While a set of rankings of universities within the OIC region has been obtained by using different data sets based on overall research productivity, the figures unfortunately suggest that the research productivity of even the highest ranked universities in the OIC region is almost negligible in comparison to universities in the developed world.

As it now stands there is hardly any university in the OIC member countries that can be termed world-class especially in terms of scientific research and training. Some of the factors that affect teaching and research in many of the universities and contribute to low scientific proficiency of most OIC member countries are listed below:

- Curricula in most universities are not appropriate for producing science and technology graduates for local market.
- Funds for R&D in universities, both from the public and private sectors, is meagre. Even in countries where governments have made deliberate positive intervention to correct the situation (such as Malaysia, Pakistan, Saudi Arabia and UAE) the overall contribution to research and innovation is far below that of what is required.
- Research productivity and innovation are not important determinants for personal advancement of teachers in most universities and many academics are reluctant to take on any additional responsibilities that would not increase their emoluments.
- Teaching and administrative loads for senior academics is too high leaving little time for research.
- Inadequate supervision of junior researchers and research students as suitably qualified teachers do not have enough motivation or time.
- Poor infrastructure and unsupportive research environment is ubiquitous in universities all over the Islamic world.
- Unavailability of major equipment and cutting edge technologies prevents research and innovation in most universities from being internationally competitive.
- Most university libraries are severely under- resourced and lack very important international scientific journals.
- Absence or dearth of PhD programmes and post-doctoral fellowships results in a serious lack of "critical mass" of scientifically trained personnel in academia, research institutions and technology-based industries.
- Scarcity or absence of competitive peer-reviewed research grants compels universities to concentrate on teaching only.
- There is very little interaction or sharing of resources between universities and non-campus research institutions.
- There is also negligible interaction with or funding from industry.
- Lack of focus in areas of strength or national/regional priorities results in scarce resources being spread too thin and lack of effectiveness.
- There is a serious lack of regional coordination and cooperation between OIC member countries for tackling common problems despite the existence of organisations such as COMSTECH, COMSATS and ISESCO.
- BRAIN DRAIN. The ultimate consequence of the myriad of problems that academics and researchers face is a very debilitating brain drain from the developing world, including the OIC countries, to the economically and technologically advanced countries in the West.

4 WHAT ARE THE REASONS, CONSEQUENCES AND REMEDIES FOR THE BRAIN DRAIN?

- Postgraduate training in the advanced countries of the West, the predominant option open to students in the Islamic world, has often very little relevance to the needs of home countries of the students, as training grants and scholarships offered are rarely in areas of national or regional priority.

- The research atmosphere and the availability of adequate resources available at home on their return are not conducive to continuation of sophisticated research that the students were involved in during their overseas training.
- There is economic and/or political instability in many OIC member countries that have direct bearing on the security and wellbeing of academics and researchers.
- The remuneration and living conditions are most often below reasonable expectations, and usually lag far behind what is on offer in the commercial sector.
- There is a serious lack of opportunities to get involved in "world class" research on national or regional problems for those who opt to return and work in their countries of origin.

The last point is the one most often cited by the brightest young expatriate scientists as the reason for their emigration to the West. It is ironic that the engine for research in the West, and especially modern biosciences research, is largely driven by an army of young scientists from the developing world while there is an acute shortage of trained manpower in their own countries of origin. It is unfortunate that the scientifically lagging and least developed countries are not only failing to keep pace but their expatriate scientists are contributing to wealth creation in the West instead of being provided the opportunity to help build research proficiency and capacity in their own countries.

If the debilitating brain drain is to be stemmed, then the IDB and OIC must strive to drastically improve the research environment and transform the research culture in the universities in their member countries. A very serious effort should be made to transform the brain drain from the developing world to the industrially advanced countries into brain retention and brain circulation within the OIC region through appropriate support for both basic and applied research. Additionally, the development of a vibrant and supportive research atmosphere and provision of decent living and working conditions could persuade expatriate researchers to return home, and failure to create such conditions will accentuate the debilitating brain drain. A further aim should be to develop a brain bank by tapping into the enormous talent and expertise available among the region's expatriate scientists and encouraging them to contribute to the development of science and technology in their countries of origin and in the OIC region in whatever way they can.

5 STRATEGIES FOR ACHIEVING REQUIRED REFORMS IN HIGHER EDUCATION AND RESEARCH, AND FOR BUILDING NATIONAL AND REGIONAL S&T PROFICIENCY

- Development of locally relevant and multidisciplinary science curricula that enables graduates to be appropriately trained for local employment.
- Higher education and training in technologically more advanced OIC- member countries, instead of in advanced countries in the West, will be both cheaper and more relevant to local development needs.
- Development of web-based science and technology libraries for universities and research institutions. Some very good advances have been made in some countries including Pakistan and Bangladesh.
- Transformation of research culture with increased emphasis on multidisciplinary and multi-institutional collaboration, development of intellectual property, technology transfer, and commercialization of research.
- Strategic and long term funding for basic and applied research, including competitive research grants, and PhD and post-doctoral fellowships to create critical mass of trained personnel and

to provide sustained support to collaborative research in areas of national and regional priorities.

- Active partnership with local industries to fund academic and industrial research and for the commercialization of research outcomes.
- Instead of wasting scarce research funds on teachers who are reluctant or do not have an aptitude for it, these funds should be diverted to inadequately funded active researchers in universities.
- Teachers not involved in research should take on more teaching and administrative duties, and should get adequately recognised for this, so that active and productive researchers have more time for research and supervision of research.
- The remuneration and incentives for productive research in academia must be greatly improved using the performance-based reward model that has been introduced by the Higher Education Commission in Pakistan.
- Development of independent and locally-driven R&D agenda for tackling the major problems affecting the OIC member countries. This is only possible if there is minimum reliance and dependence on importation of high-end technology and expertise from the West.
- Establishment and fostering of regional academic and R&D partnerships in focused areas of research of common interest.
- South-South academic and research collaborations between “Centres of Excellence” in OIC member countries that possess complementary expertise and facilities.

6 NEED FOR MULTIDISCIPLINARY COLLABORATION AND FOCUS IN AREAS OF PRIORITY

Because of lack of adequate resources and infrastructure it is not practical for the scientifically lagging OIC member countries to be internationally competitive and productive in all areas of research. In order to improve research productivity and proficiency there must be regional focus on only a small number of priority areas where there is greatest need and also existing strength and potential. Productive research in these areas will require multidisciplinary and multinational collaboration and cooperation between “Centres of Excellence” in different universities in the OIC member countries.

Most policy makers, including prominent ones in the Islamic world, believe that the scientifically lagging and least developed countries have much more pressing priorities to simply cope and survive, and internationally competitive biosciences research should be carried out by those best equipped to do this, namely the R&D laboratories in the West and in the relatively technologically proficient and rapidly advancing countries of the developing world such as China, India and Brazil. In effect this means that scientists living and working in most of the developing world should confine their activities to what is deemed appropriate by those who set the R&D agenda in far-away countries that do not face the same problems faced by much of the developing world. This way of thinking ignores the actual needs and underestimates the existing capabilities in the scientifically lagging countries of the developing world including the least developed ones. Such an attitude will ensure that the agenda for growth and sustainability will continue to remain externally driven and scientifically lagging OIC-member countries in the region, and much of the developing world, will be reduced to permanent dependency and perhaps to permanent destitution.

The solution is in developing bold initiatives for the modernization of the educational system and building internationally competitive research capacity through the pooling of resources and expertise within the entire OIC membership. However, for this strategy to succeed it is necessary to focus on a small number of initiatives where there is the greatest need and existing strength.

7 CAPACITY DEVELOPMENT FOR INTERNATIONALLY COMPETITIVE RESEARCH AND TRAINING

One of the biggest obstacles to sustainable knowledge-based economic development in the OIC region is the huge “R&D chasm” that exists between initial discovery and its final commercial or social outcome. This serious structural deficiency can’t be overcome by supporting only late stage commercial research and importation of technology for that purpose. There must be very strong support for fundamental and developmental research preceding commercialization, and necessary contemporary technologies and expertise must be established.

Excellence in university teaching and training, and productivity in research will not only depend on concentration of efforts in areas of priority but also on the ready availability of cutting edge technologies, major equipment and regional core facilities that can be established nationally or through cooperation and sharing of resources between OIC member countries. There is where the IAS through its Fellows in different Islamic countries and COMSTECH, with the support of the IDB, can show the necessary leadership and play a catalytic role.

The Future of Renewables: Their Feasibility and Applications in Resource-Poor Countries

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1 INTRODUCTION

This paper focuses on the feasibility and applications of renewable energy sources in countries that lack fossil-energy sources in any significant amount, hence termed "resource-poor". Historically, renewable energy sources have been small scale, distributed and close to where people live thus filling the need for on-site sources of electricity. While this market continues to grow in most developing and some industrialized countries, there is now a new market for large-scale non-hydro renewable energy sources in Asia, Europe and North America. In some countries like Denmark, over 30% of the country's total electricity supply now comes from wind energy. In the US, there are proposals to produce 10% of the country's total electricity needs from wind energy by 2020. In many parts of the United States electricity from wind is cost-competitive with that from coal without any carbon credit. At present, the worldwide generation of electricity from wind approaches 300,000 MW and countries like China and USA each has over 60,000 MW of installed wind generation capacity.

The next most deployed non-hydro renewable is solar – thermal and phototovoltaic (PV). Between these two, solar PV application has been more widespread, reaching a total of over 100,000 MW at the end of 2012. While there are several concentrated solar power (CSP) plants under construction worldwide, the cumulative operating capacity at the end of 2011 was under 2,000 MW. However, this deployment has picked up significantly in 2012 and 2013.

Due to concerns about greenhouse gas emissions, high cost, lack of availability of cooling water for thermal power plants, and nuclear spent fuel processing, there is now a serious interest among electric utility planners to consider large-scale (hundreds of megawatts) wind, solar, hydro and biomass power plants to meet the growing need for electricity. Due to the investments made and policy support provided in several industrialized countries to reduce carbon emissions from the production of electricity, there is now a robust market for wind and solar energy projects in several EU countries, US and Japan.

In the resource-poor countries, renewable energy sources can fill the need for stand-alone remote area electricity needs, and supplement grid power supply under the right conditions.

Small scale renewable sources of electricity including solar, wind, biogas and small-scale hydro offer opportunities to provide electricity to the disadvantaged thus allowing them to benefit from electric lights, televisions, computers, internet, mobile phones, refrigerators, etc. The commercial, educational, social and healthcare benefits that can be brought in by these technologies to the disadvantaged population in the developing countries will be a hallmark of the 21st century.

This article focuses on three issues dealing with solar, wind, hydro and biomass technologies. The first is – what developments are occurring with respect to these technologies globally. Following that we examine the reasons for success behind their deployment. Finally we ask - what technology and policy support will be necessary to replicate these successes in resource poor countries that are not endowed with significant fossil-fuel resources? Some of the answers are attempted in the context of renewable energy deployment in Bangladesh.

2 SOURCES OF ELECTRICITY IN THE WORLD

If we look at the generation mix for electricity production worldwide, we find that in 1973, the breakdown was 38.3% coal, 24.7% oil, 21.0% hydro, 12.1% natural gas, 3.3% nuclear and only 0.6% geothermal, solar, wind, combustible renewables and municipal waste combined. 37 years later in 2010, that mix had changed to 40.6% coal/peat, 22.2% natural gas, 16.0% hydro, 12.9% nuclear, 4.6% oil and 3.7% geothermal, solar, wind, combustible renewables and municipal waste. In percentage terms, the share of nuclear grew to about four times, and non-hydro renewables grew to about four and a half times. In some countries, the growth of renewables was very significant. For example, in 2009 there was more wind power generation installed in the United States than any other type including coal, nuclear or natural gas.

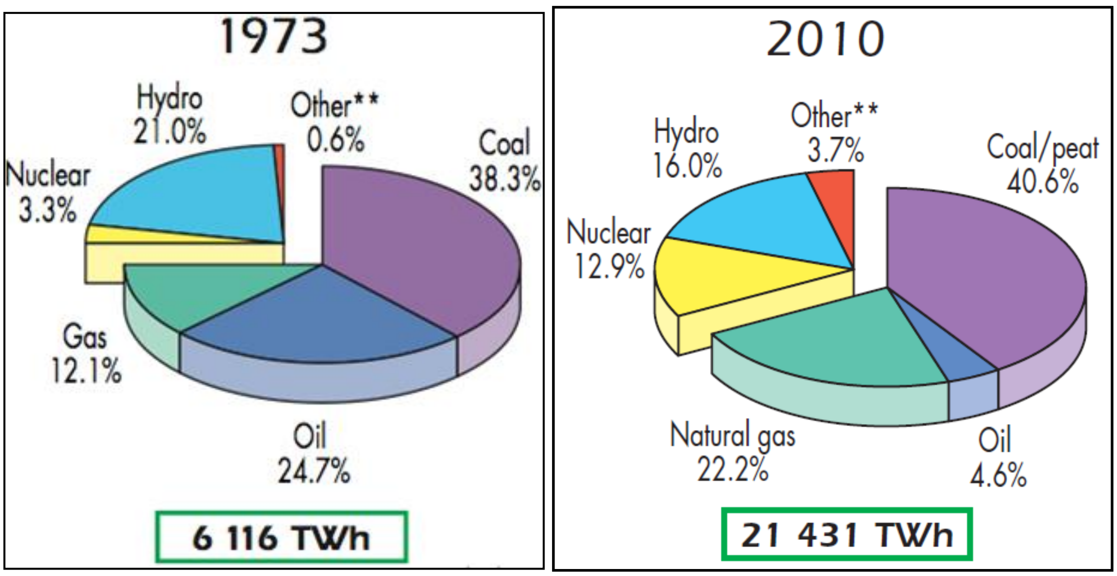

Figure 1. Electricity Generation Mix in the World.

3 SOLAR PHOTOVOLTAIC (PV) ELECTRICITY

Photovoltaic (PV) systems directly convert sunlight to electricity. In today's energy and environment-conscious society the clean and seemingly inexhaustible source of energy from PV provides an attractive option. Once a very high priced technology, used exclusively for space applications, photovoltaics is now well-known around the world and is finding rapidly expanding energy markets. Millions of PV systems have been installed around the globe including a large number in resource-poor countries. For remote lighting and communications, PV systems with battery storage have provided the most cost-effective source of electricity for many years. Now electric utilities are using PV systems to provide power to sectionalizing switches, area and warning lights, and for cathodic protection. For remote applications, utilities find PV based systems more reliable and less expensive than their conventional options.

3.1 The Photovoltaic Cell and Module

The PV effect is exhibited most prominently in various semiconductors. Most commercial solar cells are made of crystalline and amorphous silicon materials, though many other promising materials are currently being investigated. The diversity of PV materials and their different characteristics demonstrate the richness of this growing technology. When sunlight strikes the solar cell, part of the light spectrum imparts enough energy to create electron-hole pairs in the semiconductor material. A potential barrier in the cell is set up by forming a junction between dissimilarly-doped semiconductor layers. This separates the light-generated carriers (i.e., electrons and holes) resulting in an induced voltage of about 1/2 volt. The available current is a function of cell area and light intensity. The electricity is collected and transported by metallic contacts placed on both surfaces of the cell.

PV cells are formed into modules by connecting them in series and parallel in order to get more current and voltage. For even greater power, modules can be interconnected in larger groups to form arrays. The direct current (dc) electricity generated by the PV array is usually passed through a power conditioner for voltage and power regulation, and conversion to alternating current (ac) electricity.

Commercially available PV modules can convert sunlight into electricity with efficiencies ranging from 6% to 18% at present depending on the type of cell used – thin film or crystalline silicon. Currently available PV cells are highly reliable with a 25-year or longer life. The cost of PV modules was in the range of $1000 per peak watt in the 1950's. Currently PV modules cost under $1.00 per peak watt, and produce electricity for as little as 15 cents per kilowatt-hour.

3.2 Growth of Solar PV

Now let us look at the growth of solar photovoltaic (PV) electricity globally. At the end of 2012 there was over 100 GW solar photovoltaic electrical capacity installed around the world. The global cumulative installed PV capacity by 2011 was about 70 GW with 75% in the EU bloc. A total of about 29.7 GW of solar PV systems was connected to the grid in 2011 while in 2010, 16.8 GW was installed as shown in the Figure 2 below. The EU continues to be the dominant player having introduced over 21 GW of PV capacity into the grid in 2011, followed far behind by Asia Pacific countries (2.7 GW), the Americas (2.2 GW), and rest of the world including Africa and the Middle East (0.6 GW). The data for selected countries in 2011 is as follows: Japan 1296 MW, USA 1855 MW, South Korea 92 MW, China 2200 MW, Canada 364 MW, Australia 774 MW, and India 300 MW. More details are in Table 1. When we compare these numbers with those found in Muslim Majority Countries (MMC) we see that their installed capacities are orders of magnitude less than what are found in the industrialized countries plus China and India. At the end of 2012 Bangladesh had about 75 MW of PV installed capacity primarily in the form of small-scale roof-top solar home lighting systems.

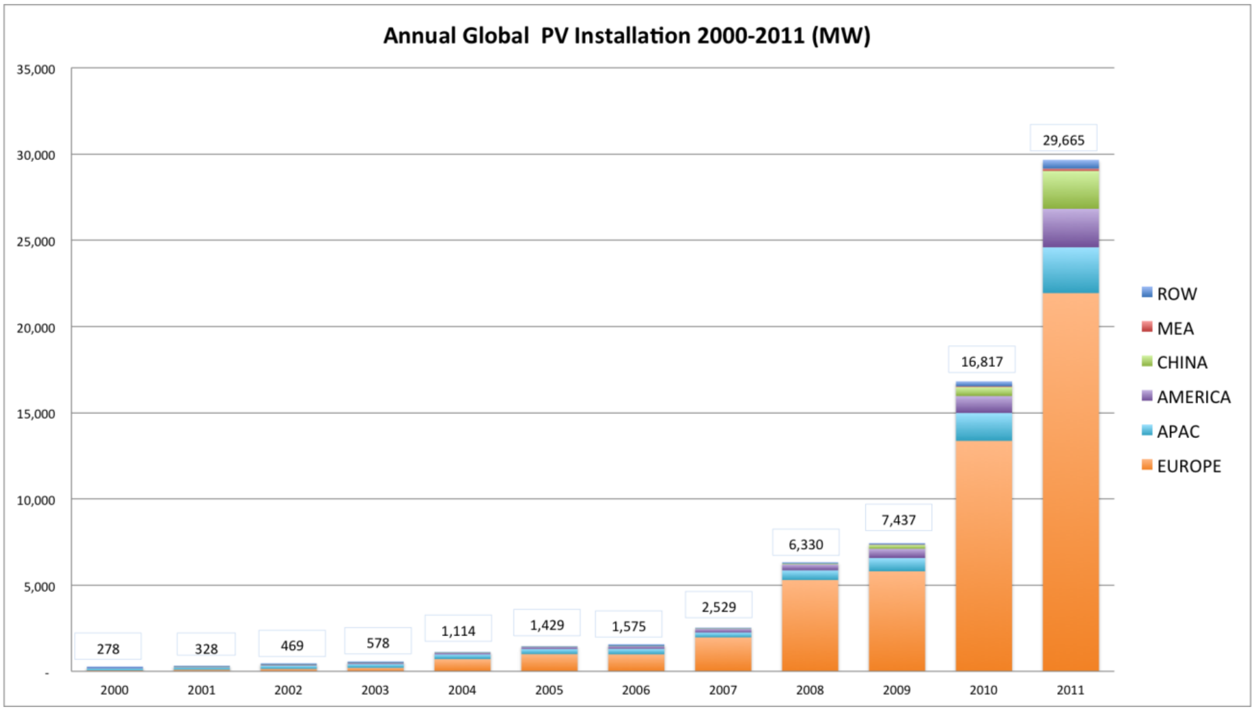

Figure 2. Global Market Outlook for Photovoltaics (http://www.epia.org).

Table 1. Electricity from Solar PV in Selected Countries in MW

(Source: http://en.wikipedia.org/wiki/Solar_power_by_country)

Rank	Country or Region	2010	2011	2012
	World	39,778	69,684	102,024
	European Union	29,328	51,360	51,360
1	Germany	17,320	24,875	32,509
2	Italy	3,502	12,764	16,987
3	China	893	3,093	8,043
4	United States	2,519	4,383	7,665
5	Japan	3,617	4,914	6,704
Muslim Majority Countries				
1	UAE			10[1]
2	Saudi Arabia			15.5[2]
3	Malaysia	15	15	15
4	Turkey	6	6	6
5	Egypt	5.2	5.2	5.2

1 http://www.masdar.ae/en/energy/detail/masdar-city-solar-pv-plant
2 http://www.saudiaramco.com/en/home.html#news%257C%252Fen%252Fhome%252Fnews%252Flatest-news%252F2013%252Fkapsarc-solar-energy-field-inaugurated.baseajax.html

4 CONCENTRATED SOLAR POWER (CSP)

Concentrating solar power involves capturing solar radiation for use in either a Rankine steam cycle, as in tower, trough, and Fresnel technology, or with the Stirling cycle, as in dish technology. After years of stagnation, concentrating solar power has seen a renaissance with almost as many megawatts under construction at the start of 2013, as have been built over the past 25 years.

There are two types of concentrated solar power (CSP) technologies – solar tower and solar trough collector.

4.1 Concentrating solar power tower

Concentrating solar power tower projects that rely on a tower system to focus sunlight to a central location at the top of a tall tower are called solar power towers, solar central tower plants, heliostat power plants, or power towers. All tower designs rely on focusing the sun’s rays to a central point and then using the heat difference to run a steam turbine using the Rankine cycle.

4.1.1 How tower technology works

The tower systems that have been installed have used either water or molten salt as the heat transfer medium. When utilizing molten salt, the plant produces power in the following manner:

Heliostats: Reflective plates that reflect solar light towards a predetermined target, the receiver, which is located at the top of the tower.
Cold Salt Tank: Molten salt storage tank that pumps 290 ^{O}C molten salt from the tank to the receiver in the tower.
Tower: The tower contains the receiver, which heats up the molten salt to 565 ^{O}C before being pumped down to be stored in the hot molten salt tank.
Hot Salt Tank: Molten salt storage tank that keeps the energy accumulated in the form very high temperature molten salt from receiver in the tower.
Steam Generator: Hot molten salt is delivered to the steam generation system, where the salt transfers its heat to the water, reducing the molten salts temperature.
Turbine: The heat transferred changes the water into high pressure steam to move the turbine.
Electric Generator: The turbine powers the electric generator producing electrical energy.
Electrical Transformer: The electricity is delivered to a transformer to be injected into the distribution grid.

The heliostats are oriented towards the sun using two-axis solar tracking. For the tower configuration, the azimuth length controls the number of heliostats that can be put into a row of a given radius.

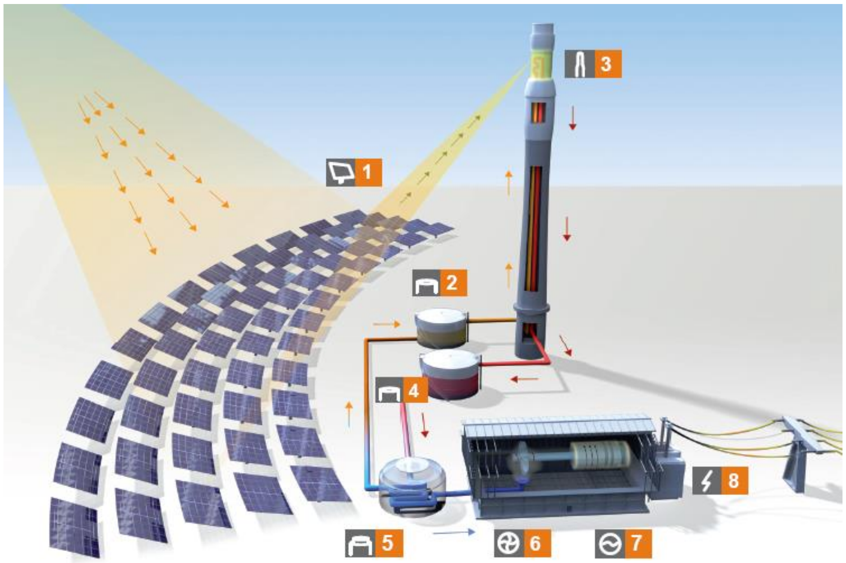

Figure 3. Gemasolar Thermosolar, 19.9 MW Plant in Fuentes de Andalucía, Spain.[1]

4.1.2 Tower technology materials

Heliostat materials still primarily use a second surface mirror under a protective layer. The basic configuration is a structural support with an adhesive layer that has a reflective material sandwiched between two protective layers. In this conventional configuration, the structural support is where different material choices have attempted for cost and weight reductions. In high temperature situations, low chromium steel is primarily used; in low temperature situations carbon steel is primarily used. Where high temperature molten salt degradation will be an issue, stainless steel is primarily used.

4.2 Concentrating solar power troughs

Concentrating solar power troughs projects rely on Solar Collector Assemblies (SCA) consisting of a parabolic trough to concentrate sunlight on an evacuated collector tube that contains a heat transfer medium. All trough designs rely on focusing the sun's rays along the length of the collector tube and then using the heat difference to run a steam turbine using the Rankine cycle. As of 2012, trough projects made up over 95% of all utility scale concentrating solar power projects, with over 65% of all trough projects being found in Spain.

4.2.2 How trough technology works

Concentrating solar power trough projects rely on parabolic mirrored systems. The trough systems consist of a single axis tracking parabolic mirror (reflector) and receiver (absorber tube). The heat transfer media has remained relatively the same over the years with older plants, built between 1984-2008, using Diphenyl/Biphenyl oxide (Therminol, DOWTHERM A), water, or air, while newer plants, built between 2009-2012, use thermal oil, water, Diphenyl/Biphenyl oxide (Therminol, DOWTHERM A), and molten salt. Therminol is a brand name that consists of a family of synthetic high temperature heat transfer fluids that are blends of Diphenyl oxide and biphenyl that have been used for decades by chemical, textile and plastics manufacturers.

[1] "Gemasolar: how it works." Torresol Energy reinventing solar power. Torresol Energy., 02 Mar. 2012. (http://www.torresolenergy.com/EPORTAL_DOCS/GENERAL/SENERV2/DOC-cw4cb709fe34477/GEMASOLARPLANT.pdf) 14 Jan. 2013.

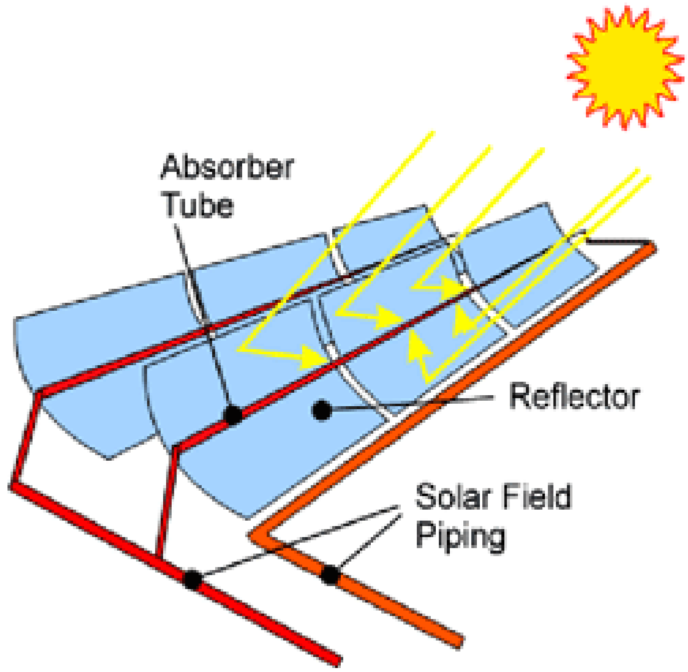

Figure 4. Solar Collector Assembly (SCA).[2]

In cases where water is used as the heat transfer medium, thermally inefficient thick walled tubes must be used to contain the high-pressure steam. Thermal oil, while having years of use in multiple projects, suffers significant degradation with time; this has pushed for more interest in molten salt.

Different types of heat transfer media lead to different configurations based on the combination of heat transfer media if storage is used. While different heat transfer media are used in the parabolic troughs section of the plant, the most common heat transfer medium used in storage is molten salt. Trough plants use synthetic oil as their heat transfer medium and produce power using parabolic mirrors to focus sunlight onto tubes containing the heat transfer media.

[2] "Parabolic Trough Solar Field Technology." *NREL National Renewable Energy Laboratory*. US Department of Energy, Office of Energy Efficiency and Renewable Energy, 28 Jan. 2010. (http://www.nrel.gov/csp/troughnet/solar_field.html). 16 Jan. 2013.

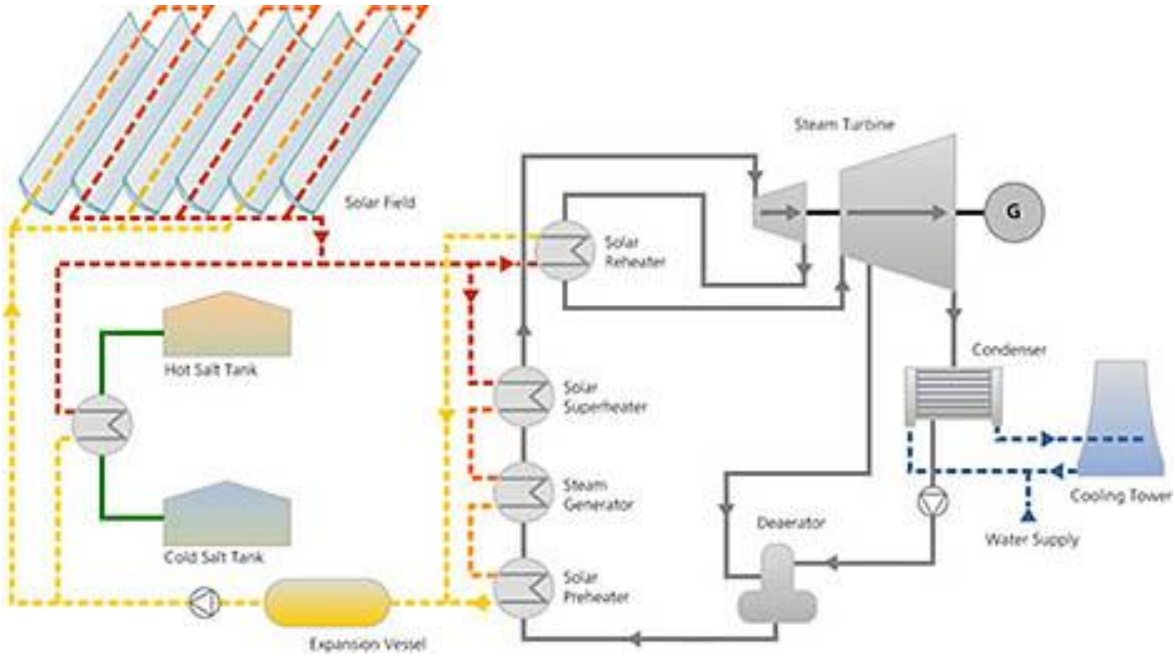

Figure 5. Abengoa solar trough-based concentrating solar system diagram.[3]

Solar Field: The location that contains the reflective mirrors and receiver tubes. The parabolic mirrors reflect the solar energy up to the receiver tube where either 201 ^{O}C water is vaporized to an outlet temperature of 340 ^{O}C, 293 ^{O}C Diphenyl/Biphenyl oxide is raised to an outlet temperature of between 349-393 ^{O}C, other thermal oils start at 293 ^{O}C and raise to an outlet temperature of 393 ^{O}C, or 290 ^{O}C molten salt is raised to an outlet temperature of 550 ^{O}C. At this point the heat transfer medium either moves towards the storage tank, the steam turbine, or a heat exchanger prior to either of those.
Optional Hot (Salt) Tank: Storage tank that keeps the energy accumulated in the form near outlet temperature heat transfer medium, usually molten salt.
Optional Cold (Salt) Tank: Storage tank that keeps the energy accumulated in the form inlet temperature heat transfer medium, usually molten salt.
Optional Heat Exchanger for Storage Tank: When the heat transfer medium that goes through the troughs is not the same as the heat transfer medium that is in the tank a heat exchanger is required. In the case of the 4.72 MW Archimede plant in Italy the heat exchanger is not needed as molten salt is used in the troughs and the storage tanks. Molten salt requires special considerations including corrosion, abrasion, salt aging when in contact with oxygen, salt creeps, and freezing.
Steam Turbine: The water from the heat exchangers (preheater, reheater, superheater) are delivered to the steam generation system, where they use the steam to move the turbine and connected electrical generator to produce electrical energy.
Solar Reheater: Here exhaust steam from the high pressure turbine is passed through a heat exchanger to collect more energy before driving the low pressure turbine.
Solar Superheater: Here the steam picks up more energy from heat transfer medium and its temperature is now superheated above the saturation temperature.
Steam Generator: A device used to create steam by applying heat energy to water.

[3] McDermott, Mat. "Feds Back Big Solar Power With Nearly $2 Billion in Loan Guarantees." *TreeHugger*. MNN Holdings, LLC, 06 July 2010. (http://www.treehugger.com/corporate-responsibility/feds-back-big-solar-power-with-nearly-2-billion-in-loan-guarantees.html). 17 Jan. 2013.

Solar Preheater: A solar heat exchanger designed to preheat the water from the deaerator
Deaerator: The tank that removes dissolved gases from return water.
Condenser: A device that condenses the steam back to water.
Cooling Tower: A device used to transfer waste heat from the condenser to the atmosphere.
Water Supply: Due to the incorporation of a cooling tower an addition of makeup water in necessary.

4.2.3 Trough technology materials

Figure 6. Archimede Solar Energy Project 5 MW Plant in Sicily, Italy.[4]

The materials used in trough technology are very similar to those used in tower technology. Due to the difficulty of manufacturing parabolic shapes, heliostat materials, using metalized plastic films, are far more commonly used, but still is not the primary choice being used in parabolic trough mirrors. It is still the industry standard to use silver deposited under a protective layer of glass. The basic configuration of materials is a sandwich-type structure consisting of a structural support with an adhesive layer that has a reflective material sandwiched between two protective layers; this configuration changes from tower to trough technology only the shape. In this conventional configuration, the structural support is where different material choices have been attempted for cost and weight reductions. Because of the ability to scale trough designs, their popularity for commercial applications has meant different heat transfer media have been tested and brought into commercial use. This means there is significantly more variability in the trough technology materials than in the tower technology materials. Cobra Energia, having a strong background in energy and water distribution networks, as well as industrial systems and has been both a developer and owner on several Spanish CSP trough plants, provided the basis for a Chalmers University breakdown of what materials are used in a concentrating solar plant that uses synthetic oil in the collectors and molten salt storage technology with a rating of 50 MW and has 7.5 hours of storage; that breakdown is below.

Solar thermal has also been incorporated into conventional technologies, using integrated design. Early on, natural gas was integrated through the use of small gas-fired components, such as Solar Electric Generating Station (SEGS) in California to provide backup power and meet capacity obligations during summer peak from 12 PM to 6 PM. The SEGS was designed not to utilize the natural gas superheater for more than 25% of the time. Figure 7 shows a solar trough system for solar electric generating station (SEGS), 80 MW parabolic trough co-located with natural gas plant in California, United States.

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[4] "Parabolic Trough." *Archimede Solar Energy*. Archimede Solar Energy, n.d. (http://www.archimedesolarenergy.com/parabolic_trough_archimede.htm). 16 Jan. 2013.

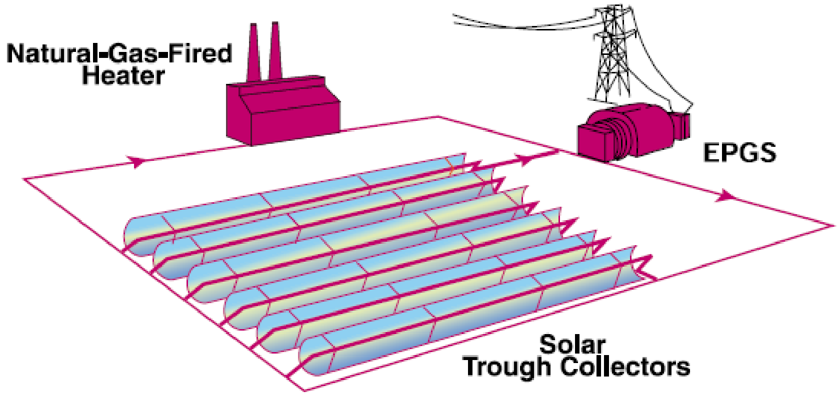


Figure 7. Solar Trough System for Solar Electric Generating Station (SEGS).

Solar thermal power plants have also been used to supplement the heat in coal-fired power plants. The Cameo hybrid coal plant in Colorado (US) integrated solar combined-cycle with a coal generation plant. It was designed to lower coal usage and emission by preheating boiler feed water. Figure 8 shows a 49 MW hybrid coal parabolic trough plant with 2 MW equivalent coming from the parabolic trough in Colorado, United States. Table 2 shows electricity from solar thermal (CSP) in selected countries. Table 3 shows capacity announced or under construction in a few countries which reflect significant new activities in 2012 and 2013.

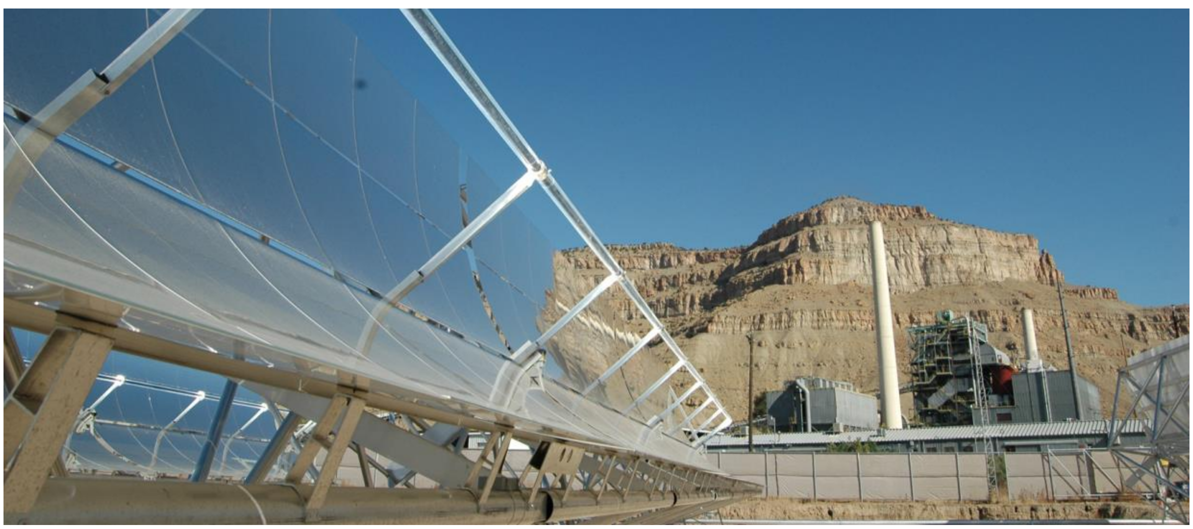


Figure 8. 49 MW hybrid coal parabolic trough plant in Colorado, United States.

Table 2. Electricity from Solar Thermal (CSP) in Selected Countries in MW
(Source: http://en.wikipedia.org/wiki/Solar_power_by_country)

Rank	Country or Region	2005	2006	2007	2008	2009	2010	2011
	World	354	355	438	494	820	1,193	1,707
	European Union	0	0	11	62	384	638	1,108
1	Spain	0	0	11	61	382	632	1,102
2	United States	354	355	427	432	512	517	517
3	Italy	0	0	0	0	0	4.7	4.7
4	Germany	0	0	0	0	0	1.5	1.5
Muslim Majority Countries								
1	Algeria	0	0	0	0	0	0	25
2	Morocco	0	0	0	0	0	20	20
3	Egypt	0	0	0	0	0	0	20

Table 3. Capacity Announced/Under Construction in Selected Countries in MW

Rank	Country	2012 (Announced)[1]	2013 (Under Construction)[3]
1	Spain	1080[2]	350
2	United States	2360[3]	1267
3	Italy	30[2]	-
4	Germany	-	-
Muslim Majority Countries			
1	UAE	100 (2013)	100 (operational)
2	Algeria	150	-
3	Morocco	130	160 (2015) 3 (2013)
4	Egypt	100 (2015)	

1 http://www.irena.org/menu/index.aspx?mnu=cat&PriMenuID=47&CatID=99
2 http://en.wikipedia.org/wiki/List_of_solar_thermal_power_stations
3 http://www.nrel.gov/csp/solarpaces/by_country.cfm

5 POWER FROM THE WIND

Wind energy systems have been used for centuries as a source of energy for mankind. Windmills were deployed for pumping water in China several centuries B.C. Until the 1970's the primary use of windmills in the United States was for water pumping and distributed stand-alone generation of electricity in cattle ranches. The significant exception was the utility-interactive 1250 kW Smith-Putnam wind turbine generator (WTG) that operated in Vermont from 1941 to 1945. So, there was a tremendous boost in capacity when multi-megawatt machines were built in the United States starting in the late 1970's. During this time frame, large-scale WTG developments in the United States happened which produced prototype machines whose capacities ranged from 100 kW to 4000 kW. Apparently these development projects raised more questions than they answered, and the attempts to commercialize the multi-megawatt WTG's were not successful. During the late 80's and early 90's, the focus in the United States and elsewhere had been to limit the size of WTG's to a few hundred kilowatts. U.S. and Danish wind turbine generators (WTG's) of several hundred kilowatt capacity are were widely deployed for commercial scale utility grid-connected applications. Beginning in the late 90's and they early 2000's there was again new focus on multi-megawatt WTG's, which formed the backbone of the European activity, and resulted in thousands and thousands of machines deployed in northwestern Europe and on the Mediterranean coast. Beginning in the mid to late 2000's there have been widespread applications of WTG's in the United States, Germany, UK, Spain, Denmark, India and China.

5.1 Components of the wind energy conversion system

The wind turbine assembly consists of the rotor assembly, the drive train - bedplate assembly, the yaw assembly, and the tower. The turbine rotor initially operated at 35 rpm and generated 2000 kW of electric power in a 11.42 m/s wind (at 10 m). The hub and blades are connected to a low-speed shaft that drives a gearbox. In the gearbox the low-speed shaft speed was first increased from 35 rpm to 1800 rpm, and later from 23 rpm to 1200 rpm. A high-speed shaft connects the gearbox to the alternator. The major components are described in the following subsections:

Rotor Assembly: the rotor assembly consists of three major sub-assemblies: the blades, the hub assembly, and the pitch-change mechanism. Each blade is attached to the hub through a three-row, cylindrical roller bearing that permits the full pitch of the blade from the power position (0°) to the feather position (90°). Blade pitch is controlled by hydraulic actuators operating through a mechanical linkage with sufficient capacity to feather the blades.

The Hub Assembly: consists of a hub barrel and a hub tailshaft. The hub barrel houses the pitch-change bearing and supports the blades. The tailshaft joins the barrel with a 120° saddle flange and a transition to the circular main-bearing seat and flange. The main rotor bearing is shrink fitted to the hub tailshaft and bolted to the bedplate adapter to form the rotor-bedplate interface. The pitch-change mechanism positions the blades in response to commands from the control system. It consists of hydraulic actuators, swing links, a thurst ring and bearing, and two blade pitch rods. The stationary hydraulic actuators translate fore and aft motion to the rotating pitch assembly through a thrust ring. This assembly is supported by both stationary and rotating swing link arms to maintain clearance from the low-speed shaft and thus allow the fore and aft motion to change the pitch of the blade through the pitch rods.

Drive Train Bedplate Assembly: The drive train assembly consists of a low-speed shaft and couplings, a three-stage gearbox, and a high-speed shaft that drives the alternator. The high-speed shaft incorporates a dry-disk slip clutch for protection against torque overloads and a disk brake that will stop the rotor in the event of an over speed condition and also is used to hold the rotor in a parked position. The entire assembly is supported on a bedplate and enclosed in an aluminum nacelle fairing for protection.

Yaw drive assembly: Yaw rotation of the machine to align it with the wind is provided by the yaw drive, which consists of upper and lower structures, a cross roller bearing, dual hydraulic drive motors, and six hydraulic brakes. Each yaw motor drives a pinion meshing with a ring gear on the inner face of the yaw bearing. The yaw brakes dampen dynamic excitations in yaw motions while the nacelle is being driven.

Tower: The steel tubular truss tower is made of multiple vertical bays with bracing designed for bolted field assembly. Tubular members were used to reduce "tower shadow" loads on the blades as they pass the tower.

Control system: The control system provides unattended safe and reliable operation of the wind turbine plus the features of a data logging system. It will automatically start, operate, and stop the machine, align it with the wind, and provide dispatcher control through a telephone link. In addition, if the control system detects any operation or machine anomaly, it is programmed to safely shut the wind turbine down.
Wind power, albeit site specific, has a much higher market penetration than solar PV electricity.

The global cumulative wind capacity exceeded 282 GW by the end of 2012. Over 86 GW of wind capacity was brought online in 2012. Deployment by region was Asia 34.6%, EU 37.4%, North America 23.9% and ROW 4%. China leads the world with the USA, Germany, Spain and India in the top five nations. The annual and cumulative capacity installed by selected countries is shown in Table 4. Figure 9 shows the top 10 countries for new installed capacity only in 2011. Figure 10 on the other hand, shows the forecasted capacity (GW) of wind energy up to the year 2020.

Table 4. Electricity from Wind in Selected Countries in MW
Source: World Wind Energy Association

Rank	Nation	2002	2004	2006	2008	2010	2012
	World	**31,180**	**47,693**	**74,123**	**120,903**	**196,630**	**282,482**
	EU		34,383	48,122	65,255	84,074	105,696
	N. America						67,576
	Asia						97,810
1	China	468	764	2,599	12,210	44,733	75,564
2	United States	4,685	6,725	11,603	25,170	40,180	60,007
3	Germany	12,001	16,629	20,622	23,903	27,215	31,332
4	Spain	4,830	8,263	11,630	16,740	20,676	22,796
5	India	1,702	3,000	6,270	9,587	13,065	18,421
	MMC*						
1	Turkey	19.4	20.6	64.6	333.4	1,274	2,312
2	Egypt	69	145	230	390	550	550

3	Morocco	53.9	53.9	64	125.2	286	291
4	Tunisia	19	20	20	20	54	104
5	Iran	11	25	47.4	82	100	91
6	Pakistan	0	0	0	6	6	56
7	Kazakhstan	0	0	0.5	0.5	1.5	2.2
8	Azerbaijan	0	0	0	0	0	2.2
9	Jordan	0	1.45	1.5	1.5	1.5	1.5
10	Indonesia	0	0.5	0.8	1.2	1.4	1.4

* Muslim Majority Countries

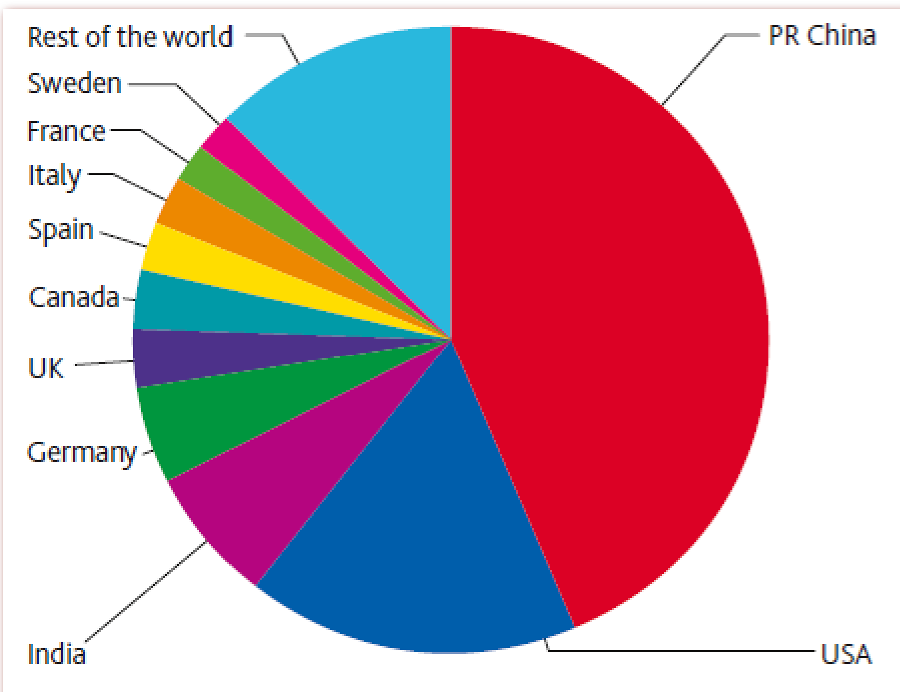


Figure 9. Top 10 new installed capacity Jan-Dec 2011.
Source: Global Wind Report, GWEC (2011).

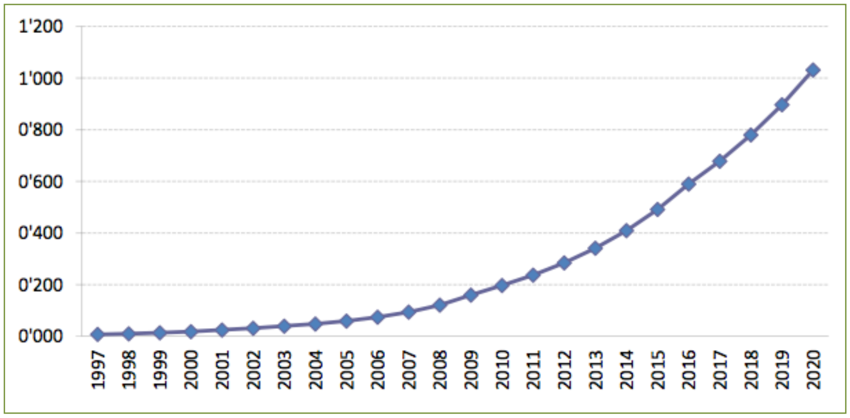


Figure 10. The forecasted growth in capacity (GW).
Source: World Wind Energy Association 2011 Report http://www.wwindea.org/

6 HYDROPOWER

Table 5 shows hydroelectric capacity (GW) in a few countries, which have some of the largest power plants in the world, followed by several Muslim Majority Countries with large hydropower plants. Table 6 shows hydroelectric energy (TWh) produced between 2000 and 2011 in these and a few other countries.

Table 5. Hydropower capacity in GW for 2012

Rank	Country	2012
1	China	248.9*
2	United States	99.9*
3	Brazil	84.2
4	Canada	77*
5	Russia	47.6*
Muslim Majority Countries		
1	Turkey	19.6
2	Iran	9.5*
3	Pakistan	6.6
4	Egypt	3

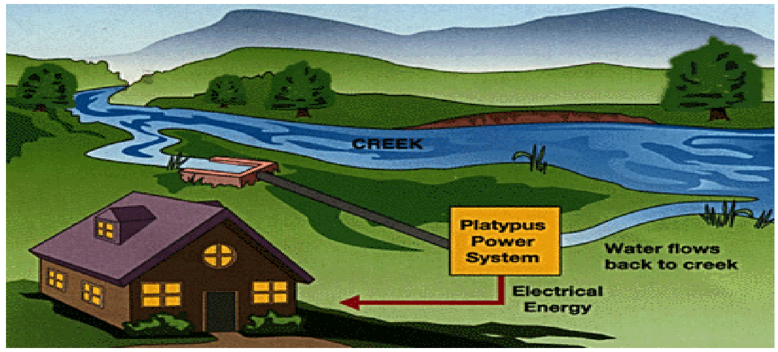
* pumped storage included.
IHA, http://www.hydropower.org/about-iha/documents/index.html

Table 6. Hydropower Generation in Selected Countries in TWh

Rank	Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	China	222.5	277.5	288	283.7	353.5	397	435.8	485.3	585.2	615.6	722.2	694
2	Brazil	304.5	267.9	286.1	305.6	320.8	337.5	348.8	374	369.6	391	403.3	429.6
3	Canada	356.9	331.6	349.4	336.3	338.5	362.8	354.6	369.5	376.4	366.5	350.9	376.5
4	US	278.4	219.2	267	278.6	271.1	273.1	292.2	250	257.4	276.2	262.8	328.4
5	Russia	165.3	175.9	164.1	157.6	177.6	174.5	175.2	179	166.7	176.1	168.4	164.9
1	Turkey	30.9	24	33.7	35.3	46.1	39.6	44.2	35.9	33.3	36	51.8	52.4
2	Pakistan	17.6	18.3	20.4	25.6	24.2	30.7	30.2	31.6	27	28.2	29.5	30.6
3	Egypt	14.2	14.4	14	13	12.6	12.6	12.9	15.5	14.7	12.9	12.9	13.7
4	Iran	3.8	4.1	8	9.6	11.9	13.1	18.5	18	7.5	6.5	9.5	11.9
5	Uzbekistan	5.9	5.4	7.3	7.6	6.9	6.1	6.3	6.4	11.4	9.3	10	10.2
6	Kazakhstan	7.5	8.1	8.9	8.6	8.1	7.9	7.8	8.2	7.5	6.9	8	7.9
7	Malaysia	7.4	6.4	5.3	5.7	5.8	5.2	7.1	6.7	8.7	7.2	7	7.4
8	Azerbaijan	1.5	1.3	2	2.5	2.8	3	2.5	2.4	2.2	2.3	3.4	2.7
9	Bangladesh	0.9	1	1.1	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.5	1.5

The only commercial hydroelectric project in Bangladesh, the 230 MW Kaptai Hydroelectric Power Plant, is almost 50 years old. There seems to be no other potential for similar hydropower plant in the country. While Bangladesh herself has limited hydropower resources, the surrounding countries like Myanmar, Bhutan and Nepal have some of the highest untapped hydro potentials in the world. Exploitation of such resources and cross-border power transfer through India are some of the opportunities worth exploring.

7 SMALL SCALE HYDROELECTRICITY



Small hydro is the development of hydroelectric power on a scale serving a small community or an industrial plant. The definition of a small hydro project varies but a generating capacity of up to 10 megawatts (MW) is generally accepted as the upper limit of what can be termed small hydro. This may be stretched up to 30 MW in the United States, and 50 MW in Canada.

Small hydro can be further subdivided into mini hydro, usually defined as less than 1,000 kW, and micro hydro which is less than 100 kW. Micro hydro is usually the application of hydroelectric power sized for smaller communities, single families or small enterprise.

Small hydro plants may be connected to conventional electrical distribution networks as a source of low-cost renewable energy. Alternatively, small hydro projects may be built in isolated areas that would be uneconomic to serve from a network, or in areas where there is no national electrical distribution network. Since small hydro projects usually have minimal reservoirs and civil construction work, they are seen as having a relatively low environmental impact compared to large hydro. This decreased environmental impact depends strongly on the balance between stream flow and power production. Plants with a reservoir, i.e. small storage and small pumped-storage hydropower plants, can contribute to distributed energy storage and decentralized peak and balancing electricity. Such plants can be built to integrate at the regional level intermittent renewable energy sources.

8 SITUATION IN BANGLADESH

8.1 Solar Photovoltaics in Bangladesh

Bangladesh is one of the success stories in solar home lighting systems. More than 1.7 million such units have been installed under government sponsorship since 2002 ranging in sizes from 10 to 130 watts of peak solar panel capacity. See Figure 11. These are now generating more than 75 MW of electric power across the country. The lives and livelihoods of millions of villagers, shopkeepers and school children have been transformed by the availability of electric lights. At the same time the health of millions has been improved by decreased reliance on polluting kerosene lanterns that add to Bangladesh's greenhouse gas emissions.

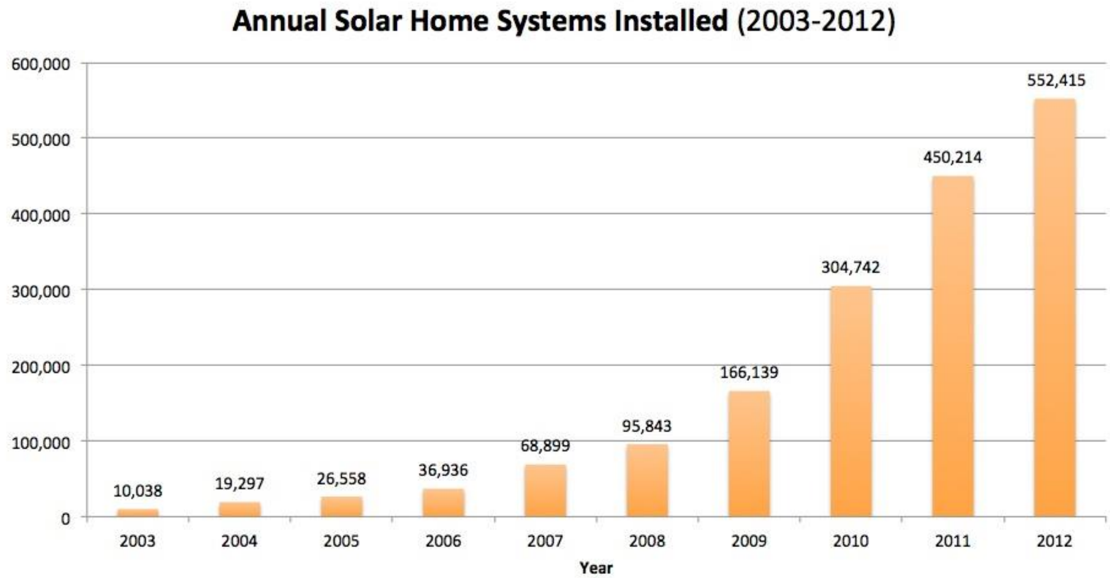


Figure 11. Annual Solar Home Systems installed in Bangladesh.

Due to recent renewable portfolio standards (RPS) initiated by the Government of Bangladesh and several power sector agencies, the commercial scale solar photovoltaic electricity is beginning to take root in the country. For example, in order for any multi-story residential apartment building to get electrical connection in Dhaka, the capital city, 3% of the sanctioned electrical load must come from solar energy. This has required building owners to install roof-top solar AC electric systems to serve a part of their lighting and fan loads. The picture in Figure 12 - from an apartment building in Dhaka - shows solar panels for electricity serving the building common area lighting load.

Figure 12. AC solar electric supply at an apartment building in Dhaka.

Figure 13 shows solar panels from a rural water supply cooperative in Dhamrai, Savar in Bangladesh managed by the Local Government Engineering Department (LGED). The solar AC electric system in this building is used for lights, fans, a color television, mobile phone and laptop chargers in the meeting room of this cooperative.

Figure 13. AC solar electric supply at a water supply community center (LGED Project).

8.2 Electricity from Biomass

Biomass energy comes in various forms including bagasse, rice husk, wood chips, landfill methane, municipal organic waste, cow dung, poultry farm waste, etc. But the amount electricity generated from these sources vary widely with bagasse-based electricity generation probably taking the lead. Multi-megawatt bagasse-fired power plants can be found in India, Indonesia and Brazil, among others. There are also multi-megawatt organic waste-based power plants in the US, Europe and Japan. Figure 14 shows the 250 kW rice husk-fed electric power plant that was established in Gazipur (near Dhaka) in 2008 with financial assistance from the Infrastructure Development Company (IDCOL) of Bangladesh. But the project faced difficulties operating during the daytime as the local demand for electricity was only at night to serve the lighting load.

Figure 14. Biomass Electricity Plant in Bangladesh.

8.3 Biogas for Energy

Bangladesh has made significant progress in producing biogas for energy using farm waste. Figure 15 shows a biogas supply network fed by chicken waste. This locally produced biogas provides cooking fuel which otherwise comes from tree branches and wood sticks causing severe environmental problems in many developing countries. Table 7 shows the growth of different sizes of biogas plants in Bangladesh between 2006 and 2012. At the end of 2012 there were over 26 thousands biogas plants in Bangladesh.

Figure 15. Cooking Gas from Chicken Drops in Bangladesh.

Table 7. Growth of Biogas plants in Bangladesh (source: IDCOL, Bangladesh)

Size	2006	2007	2008	2009	2010	2011	2012	Total
1.2 m3	59	30	17	3	6	1	3	**119**
1.6 m3	86	329	206	203	131	80	61	**1096**
2.0 m3	28	572	636	1089	940	942	752	**4959**
2.4 m3	13	544	904	1891	2182	2076	1928	**9538**
3.2 m3	5	414	682	1225	1379	1327	1251	**6283**
4.8 m3	6	278	376	742	1104	1108	1206	**4820**
Total	**197**	**2167**	**2821**	**5153**	**5742**	**5534**	**5201**	**26815**

9 POLICY SUPPORT FOR TECHNOLOGY PENETRATION

As we have discussed the technologies and their deployments in the industrialized and developing countries, the question may be asked - why some countries are more successful than others in integrating renewables into the electricity generation mix? Most countries with significant renewable energy penetration into their respective markets have one or more of the following three regulatory regimes in place:

A. Renewable Portfolio Standards (RPS);
B. Feed-in Tariff (FIT); and
C. Power Purchase Agreements (PPA).

While **RPS** policy attempts to promote the use of renewables by mandating their use, the **Feed-in Tariff (FIT)** program tries to achieve the same goal through providing economic incentives to the renewable energy project developers. FIT is a renewable energy policy that offers guaranteed payments to renewable energy developers for the electricity they generate. FITs are responsible for approximately 75% of global PV and 45% of global wind deployment.

In simple terms, FIT allows the renewable energy project developer to be paid at a higher rate for their electricity than the price of the grid-power for a pre-determined number of years. It should be mentioned here that in several countries, these incentives are very attractive and as a result they are over-subscribed very quickly. Consequently, only a part of the offerings end up being accepted and built in these countries. Countries with active FIT programs include Canada, India, Thailand and some other European countries like Germany and Spain.

In the case of **power purchase agreements (PPA),** developers of large scale solar and wind energy projects sell power to electric power distribution companies through a competitive bidding process. The additional cost borne by the distributor is either blended with their overall cost of electricity purchase, or covered by subsidies by the central government (like the case in India), or both.

In response to the severe power shortages in Bangladesh, there are plans afoot to develop many distributed and central station power plants to feed the grid. While the need for new power plants is well justified, this only addresses a part of the problem, as the grid here reaches about half the population. Moreover grid extension is not cost effective if the existing demand does not sustain the need for power supply throughout the 24-hour period, which is the case in rural Bangladesh. The Gazipur rice-husk power plant is a case in point. Because of almost no daytime load, the power plant operated only at night. This did not give them enough revenue and the project was ultimately abandoned. It is therefore important that countries like Bangladesh explore a parallel path for the development of small-scale renewable power supplies to serve the niche market as well as to supplement the grid power, which is in short supply. In this regard the government policy to require supplemental solar power to support grid electricity is a program that needs to be sustained and strengthened. In addition to this renewable portfolio standard, the option for feed-in tariff need to be tested for its impact on encouraging private sector investments for renewable electric energy generation in Bangladesh like what is happening in India, Thailand, China, Japan, European Union, United States, etc. Competitively-bid power purchase agreements can also play a significant role in this process.

With larger (several kilowatts or higher) AC solar electric systems, it will be possible to serve small commercial enterprises, schools, health clinics, irrigation pumps, etc. that create and sustain educational, health and employment opportunities at the local level.

10 HOW CAN WE MOVE FORWARD?

While some resource-poor countries have had some success in deploying small home lighting and biogas systems, in order to respond to electricity needs for the broader population and sustain the supply in a commercial scale, these countries need to move to the next level of renewable energy technology deployment. This can provide the foundation to provide reliable and affordable power beyond just the electric light at night. In the solar context, policymakers need to explore the applicability of more distributed microgrids, which are collections of many solar panels that produce thousands of watts at a time rather than the 40 – 50 watts produced by the conventional solar home system (SHS) in use today in Bangladesh. A large number of such panels combined with batteries and other small generators - if available - and simple computer software that optimizes electricity consumption, would power not only homes in a village, but irrigation pumps, schools, clinics, small industries and shops as well. By diversifying the users of this solar energy - some of whom would be using the energy during the day - the overall utilization of the electricity produced by the system increases significantly and the per-kWhr cost of electricity will fall by a factor of three or more. There is a 100-kW solar PV microgrid operating in Bangladesh run by Purobi Green Energy Ltd on the island of Swandip.

Figure 16. 100-kW Photovoltaic Microgrid in Swandip, Bangladesh.

Another way to popularize renewable energy-based microgrids in Bangladesh or other resource-poor countries will be to develop local cooperatives who can help run such microgrids. The Small Scale Water Resources Development Sector Projects run by the Local Government Engineering Department (LGED) as membership cooperatives (discussed with reference to Figure 13) could be employed to operate the electricity cooperatives. Villages could create solar co-ops in which all villagers who want electricity would be member-owners of the cooperative that would own the microgrid. These co-ops could be run as non-profit institutions, with members making decisions about pricing, technology used, etc.

Just as micro-finance revolutionized Bangladesh, and indeed finance around the world, so too can community-owned microgrids expand access to electricity for millions at more affordable rates than conventional SHS. Doing so would build upon the success of SHS in a way that increases utilization of the electricity produced while lowering costs overall.

11 INFRASTRUCTURE FOR INFORMATION SHARING

It thus appears that there is a great need among resource-poor countries to learn from each other, share best practices and try to understand the policy support necessary to scale from successful pilot projects to widespread deployments. Thus information sharing is very important. One platform for such information sharing can come from ICEIS - International Center for Energy & Information Systems (www.iceis.net), a network of researchers and practitioners developed at Virginia Tech which links research and technology centers in academic institutions in Muslim Majority Countries.

International Center for Energy and Information Systems is a center of excellence, which helps to foster collaboration between academic researchers in developing and emerging countries focusing on energy and information systems. The goal ICEIS is to formulate regional and global solutions for energy development and environmental sustainability, and associated information systems topics including secure data communication for the reliability, security and resilience of the energy supply systems. ICEIS offers its clients seminars, workshops, joint studies and training activities. The Center collaborates with its member institutions in countries in Africa, Asia and the Middle East through the regional hubs in Egypt, Turkey, Jordan, Qatar/UAE, Bangladesh and Indonesia to ensure broader participation among Muslim Majority Countries. These interactions foster technical discussions and help bring about energy development and use in conjunction with environmental protection. The Center's goal is to foster collaborative research, and provide a platform for workshops, training programs and sharing project development experience. In particular, the Center will work with the community of researchers, professionals and policy makers to develop strategies and mechanisms to: (i) facilitate and foster interaction and exchange among energy and information systems (EIS) researchers across a broad range of institutions, programs and technologies, (ii) enable sharing of knowledge generated by EIS research with the broader engineering and scientific communities, sharing and integrating experimental tools and platforms, (iii) facilitate and foster collaboration and information exchange between ICEIS researchers and industry, (iv) facilitate international collaboration on EIS research and (v) provide policy makers in these countries access to analytical tools, technical experts and field experiences from member countries.
Researchers in ICEIS strive to find environmentally compatible methods of energy supply and usage that are cost-effective and have the lowest possible carbon footprint throughout the world. Topics of primary interest include:

- Solar and renewable energy technologies;
- Advanced power generation and storage technologies;
- Energy efficiency and demand response;
- Smart electricity grid;
- Critical infrastructure protection;
- Global warming and greenhouse gas emissions; and
- Biofuel production and fossil fuel substitution;

12 CONCLUSIONS

This article has examined the challenges and opportunities of deploying renewable energy sources to meet a significant amount of commercial energy sources in resource poor countries that lack domestic fossil fuel. It has presented the growth of solar, wind, hydro and biomass technologies globally, and addressed three issues dealing with the deployment of these technologies. The first was – what developments are occurring with respect to these technologies globally. This was followed by an examination of reasons for success behind their deployment. Along the same lines the building blocks for the renewable energy technologies were discussed – components of the wind energy conversion system, elements that make up solar photovoltaic or concentrated solar power system, different parts of hydro turbine generators and what constitutes a biogas generator or a biomass power plant. Then the paper presented some suggestions about what technology and policy support will be necessary to replicate these successes and begin to develop a local industry, which can start producing components if not the full line of end products in resource-poor countries. Finally, an information sharing platform was proposed which can assist the resource-poor countries to learn from successful examples globally and attempt to apply those in their own countries to improve the quality of life.

The Need for Multidisciplinary Research to Address Energy, Water and Climate Change Challenges

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ABSTRACT

Climate change, energy and water security are undoubtedly among the most significant challenges the world faces today. These challenges require a dedicated response from the scientific and academic communities, working in collaboration with industry and government to study, research and develop innovative sustainable solutions. This presentation will highlight the need for following a comprehensive multidisciplinary approach to education and research that focuses on the integration of technology, policy and systems for tackling the complex energy challenges we are facing. In addition, key research areas will be identified and reference will be made to the ongoing activities undertaken at Masdar Institute to provide sustainable solutions for the defining challenge of our age.

Figure 1. Outline.

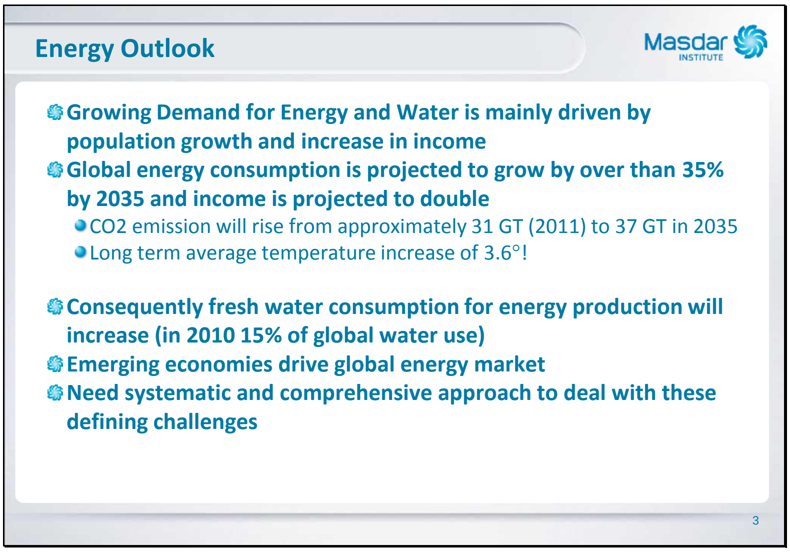

Figure 2. Energy Outlook.

Figure 3. Innovation is Key.

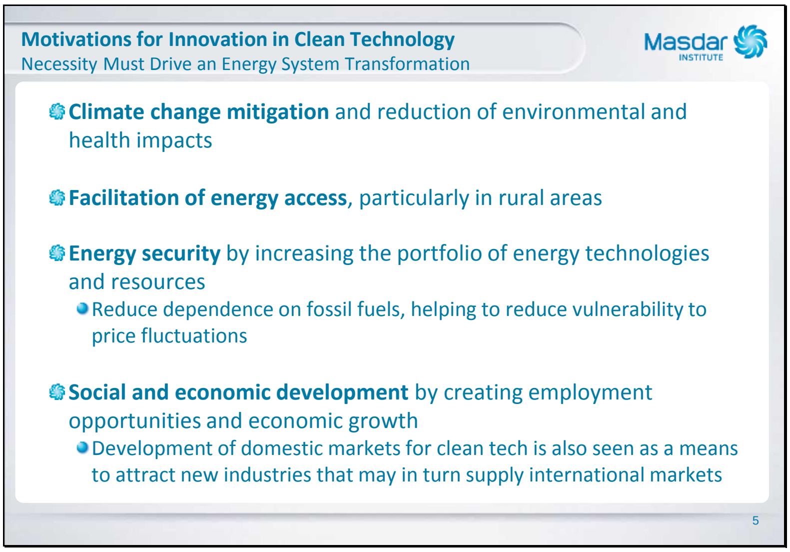

Figure 4. Motivation for Innovation in Clean Technology.

The driving forces now for clean technology innovation are (1) climate change mitigation, (2) universal energy access, (3) energy security, and (4) social and economic development.

- IPCC, 450 ppm, 2 C.
- 1.5 B no access.
- Fossil dependence for imports and exports.
- Creation of new industries.

Figure 5. Motivations for Clean Technology Innovation and Deployment.

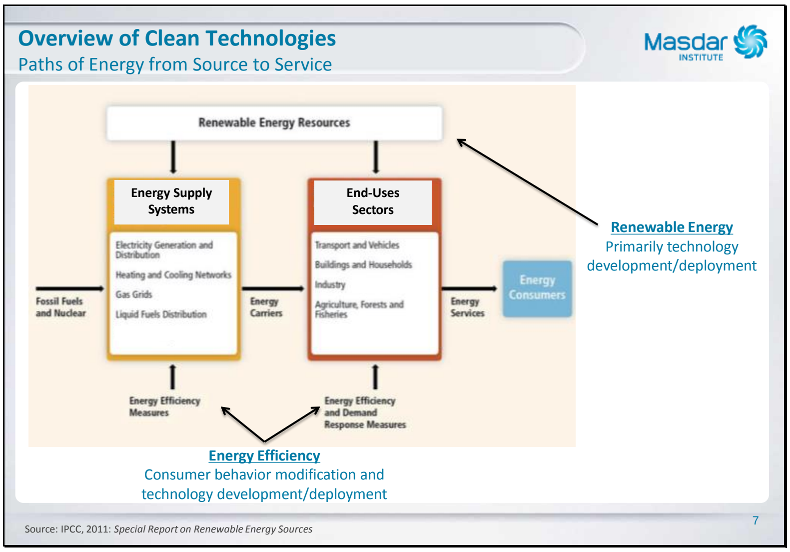

Figure 6. Overview of Clean Technologies.

The energy system is driven by energy consumers that demand services from various end use sectors. The fuels used in the sectors are either supplied directly from renewable sources our delivered by carriers that we'll discuss in a minute. The supply systems that provide the carriers are based on renewables or fossil.
Energy Consumers utilize Energy Services from end use sectors. End use sectors get energy from renewable directly or energy carriers (gas, liquids, solids) that can be transformed to useful forms of energy. Carriers derive from supply systems that are linked to primary energy sources that are renewable or fossil.
For both supply and end use we have efficiency targets to lower overall demand and this can be via behavior modification or tech. Renewables are tech.

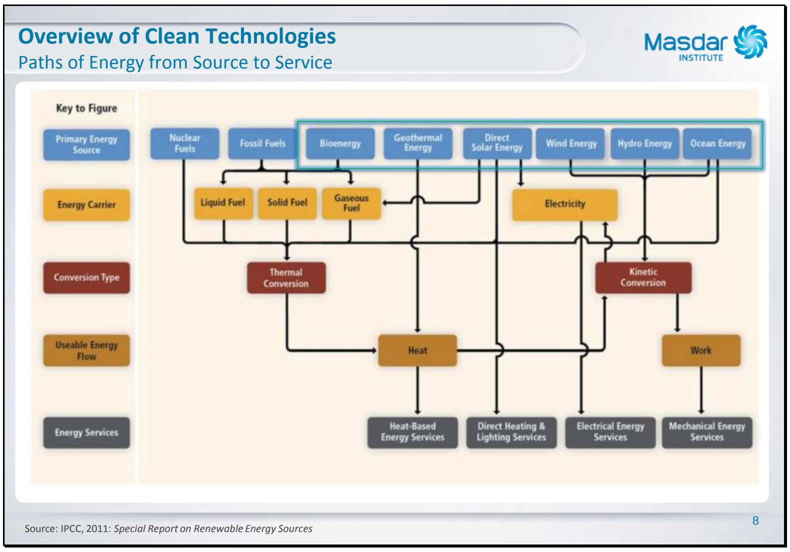

Figure 7. Overview of Clean Technologies.

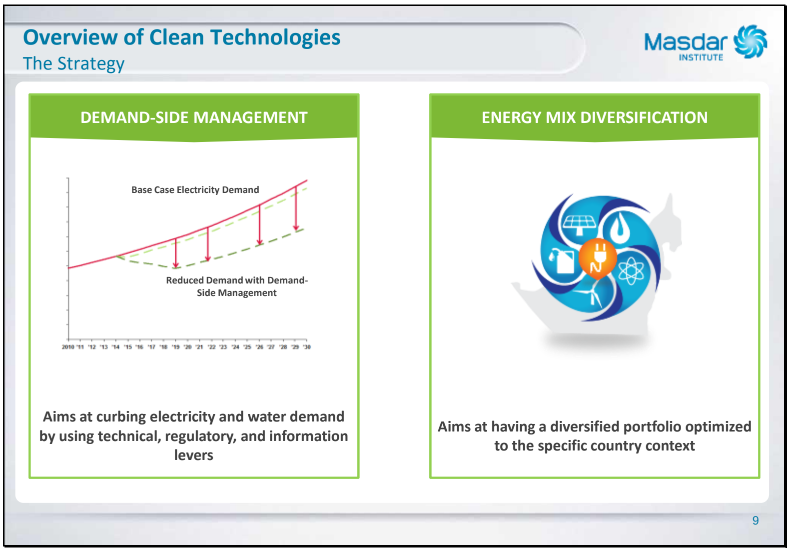

Figure 8. Overview of Clean Technologies.

Before discussing the percentage of electricity demand that will be met by either fossil or clean energy sources, we first need to have targets for what can and should be our demand. The electricity demand growth I spoke of previously is clearly not sustainable and so our first objective is lower demand via technical, regulatory and information levers that are part of regional DSM programs. Then we begin the discussion of specific generation targets.

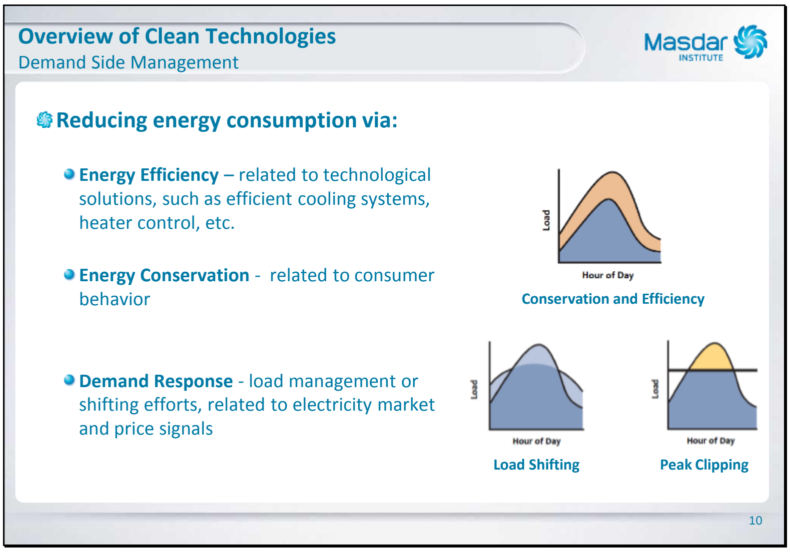

Figure 9. Overview of Clean Technologies.

Figure 10. Overview of Clean Technologies.

Key point is to improve energy conversions, reduce number of conversions, and maintain thermal efficiencies.

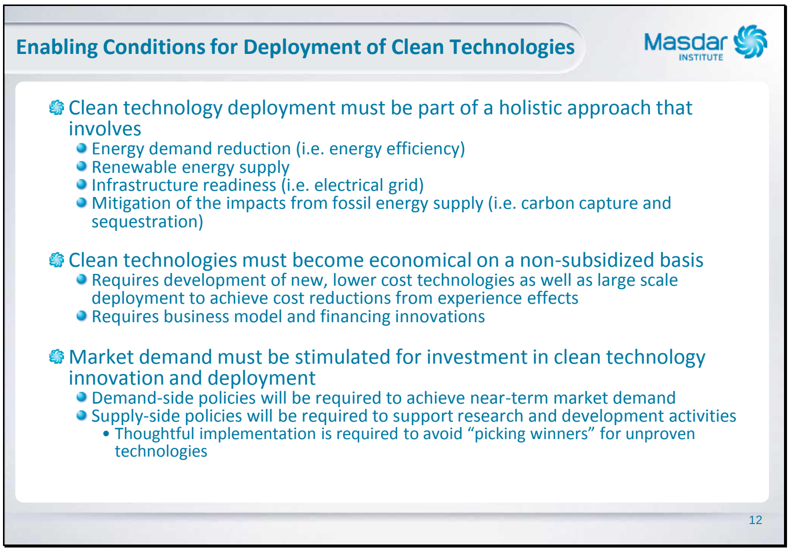

Figure 11 Enabling Conditions for Deployment of Clean Technologies.

Conditions required are energy efficiency to reduce demand, de-carbonized energy supply, infrastructure in place for the electrical grid to handle distributed and intermittent demand and ability to mitigate the impact of fossil energy that stays part of the future energy mix.

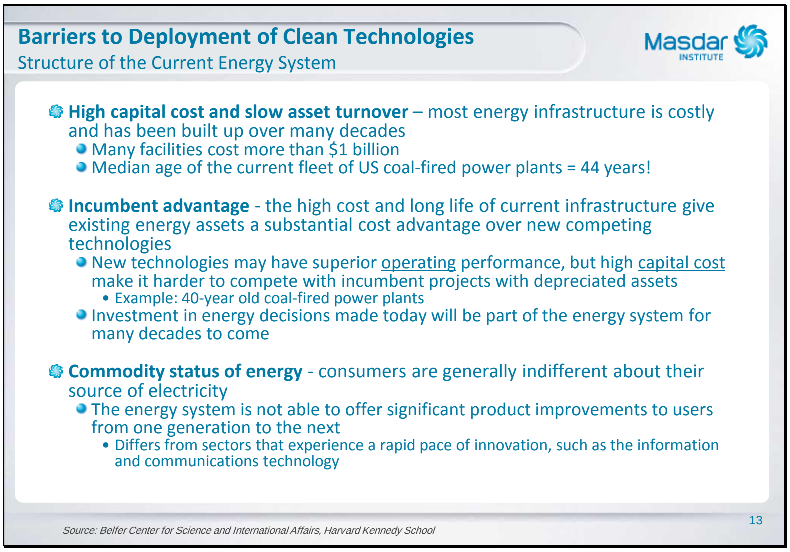

Figure 12. Barriers to Deployment of Clean Technologies.

Source: Narayanamurti, V., Anadon, L.D., Breetz, H., Bunn, M., Lee, H., and Mielke, E., 2011: *Transforming the Energy Economy: Options for Accelerating the Commercialization of Advanced Energy Technologies*, Belfer Center for Science and International Affairs, Harvard Kennedy School

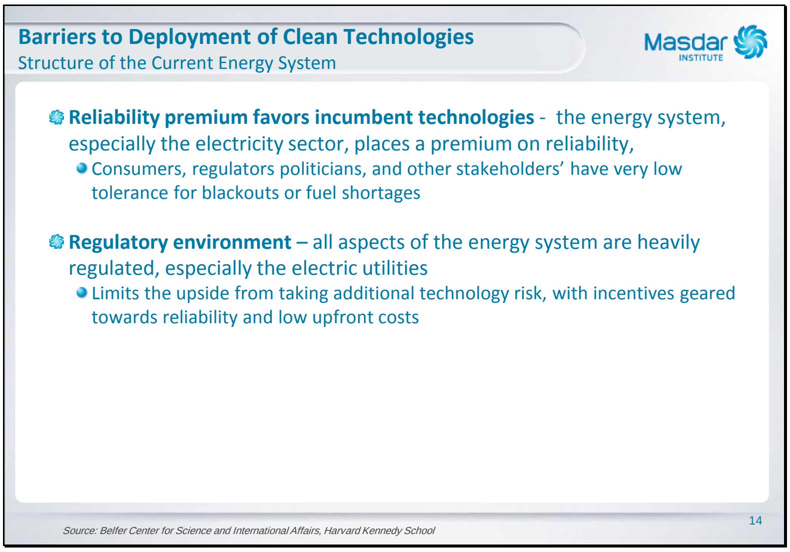

Figure 13. Barriers to Deployment of Clean Technologies.

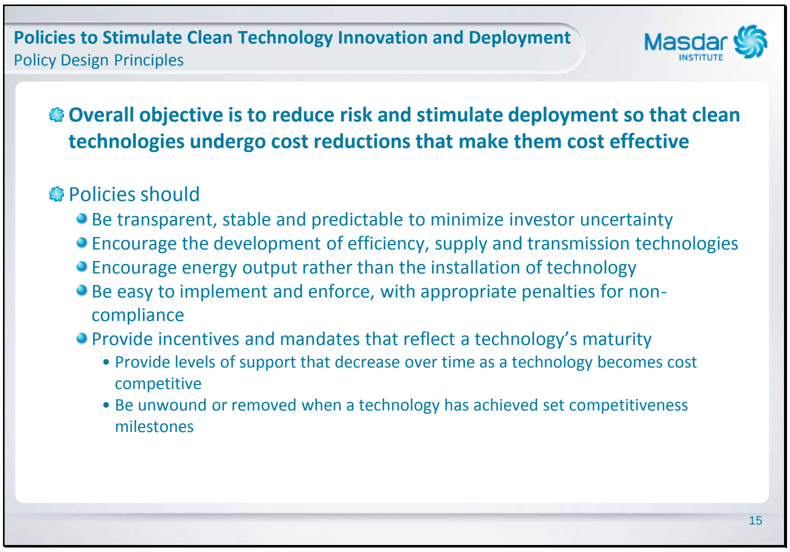

Figure 14. Policies to Stimulate Clean Technology Innovation and Deployment.

With demonstration and deployment we will be able to achieve the experience effects required to bring down overall costs.

Figure 15. Abu Dhabi Vision – MASDAR.

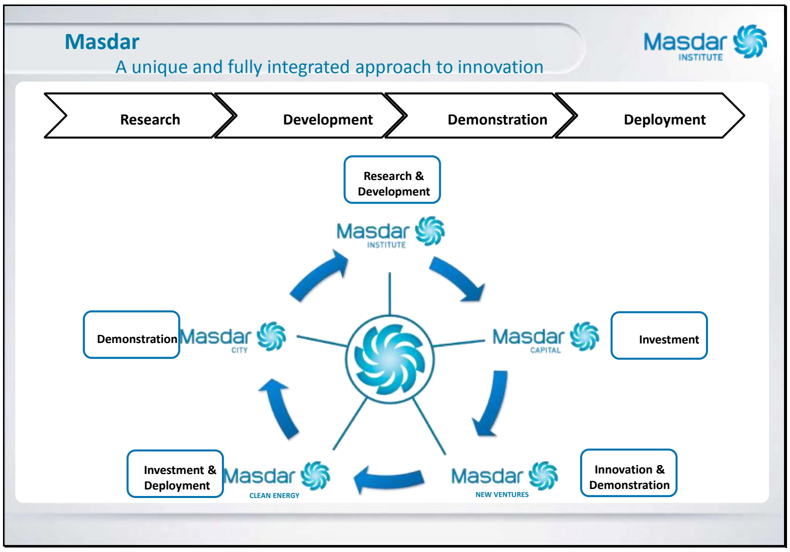

Figure 16. Masdar – A Unique and fully integrated approach to innovation.

Figure 17. Home of Irena.

Figure 18. World Future Energy Summit.

Figure 19. Zayed Future Energy Prize.

Figure 20. Masdar Institute (MI) – A Research Driven University.

Figure 21. Rapid Growth-Commitment to Excellence.

Figure 22. Relationship with MIT.

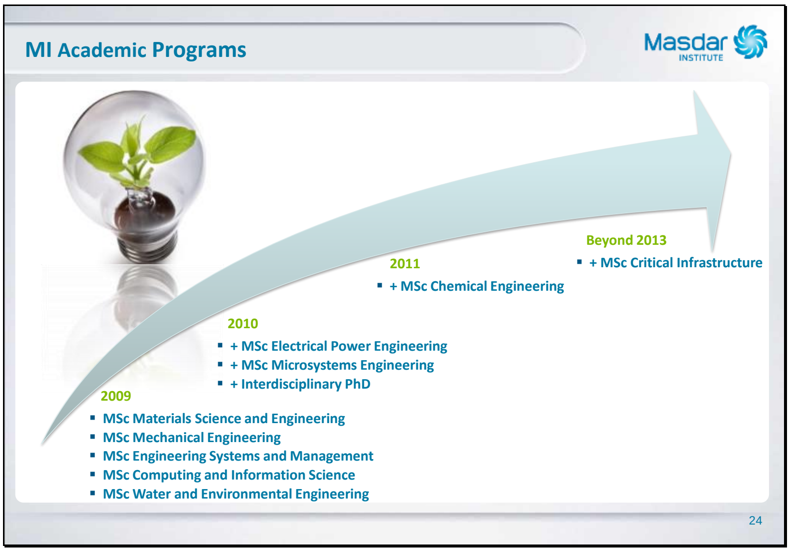

Figure 23. MI Academic Programs.

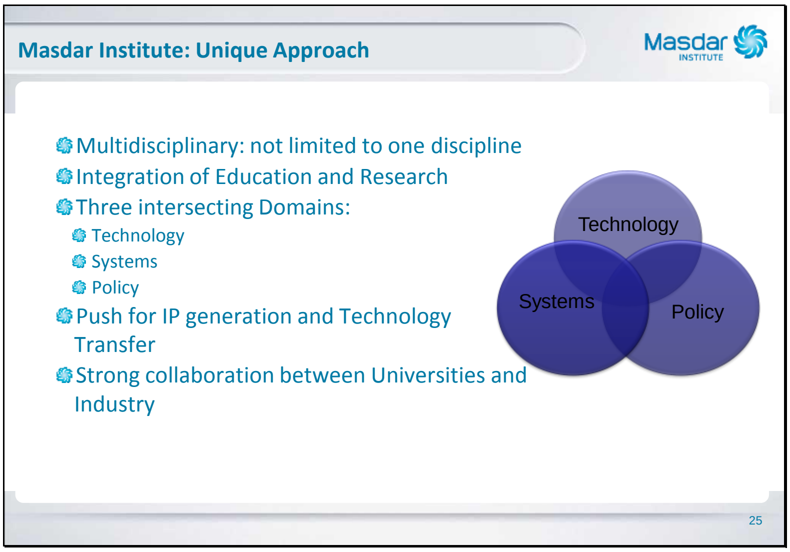

Figure 24. Masdar Institute: Unique Approach.

Figure 25. Academic Degree Programs.

Figure 26. Student Recruitment Strategy.

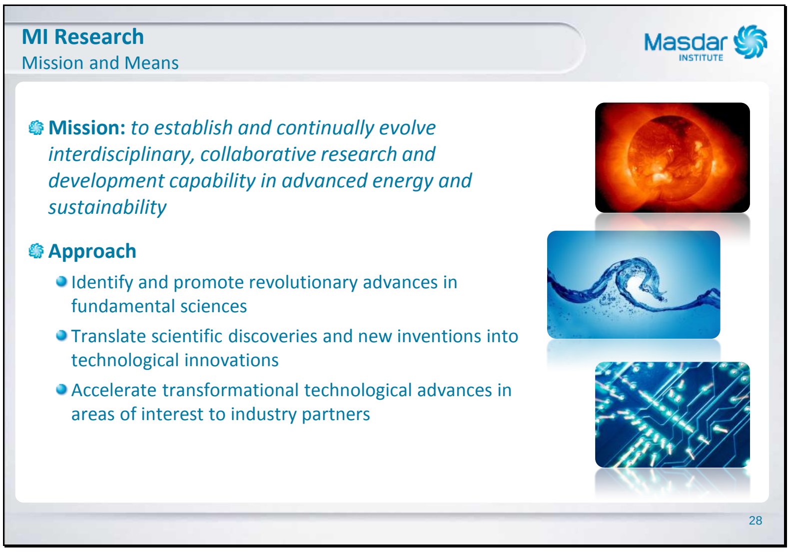

Figure 27. MI Research - Mission and Means.

Approach involves fundament research, translation of discoveries and inventions into technological innovations and acceleration of advances of importance to industry.

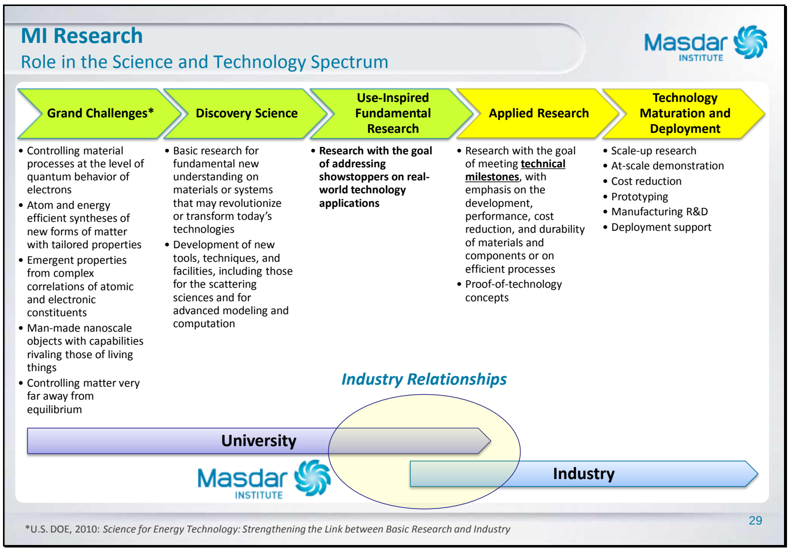

Figure 28. MI Research – Role in the Science and Technology Spectrum.

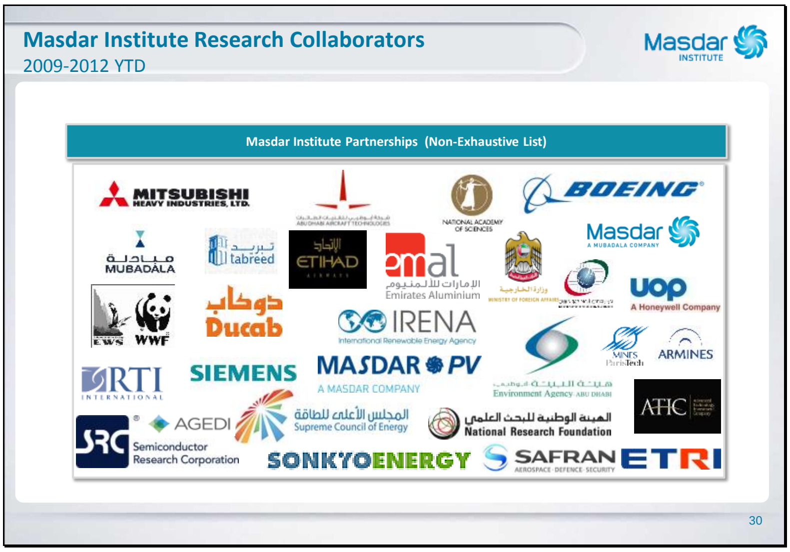

Figure 29. Masdar Institute Research Collaborators 2009-2012.

Figure 30. MI Research - Global Issues of Local Importance.

In Abu Dhabi R&D is guided by the Economic Vision 2030, which lays out the industries that will be at the heart of Abu Dhabi's economic diversification. Of particular interest with regard to R&D are the knowledge intensive industries such as aerospace, healthcare, semiconductors and of course energy. In combination with the economic vision with emphasize water, energy and climate to engage in use-inspired research that yields innovations in areas such as solar energy, semiconductor devices, advanced materials, and so on.

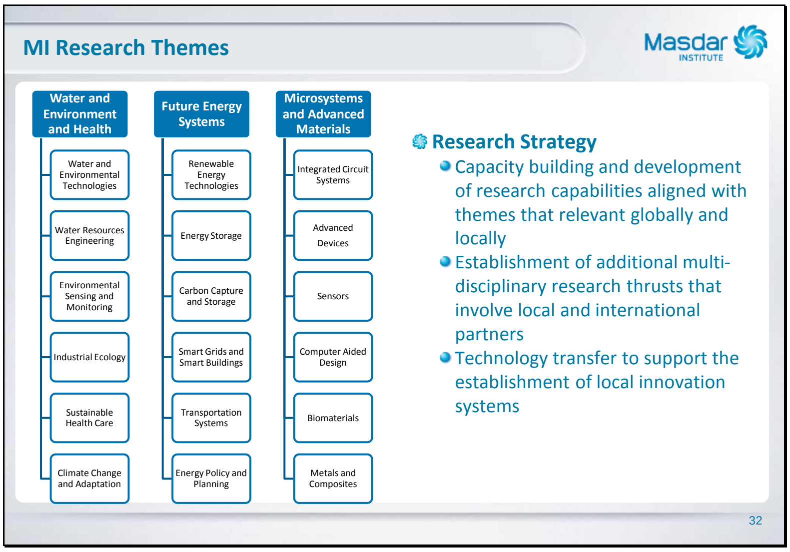

Figure 31. MI Research Themes.

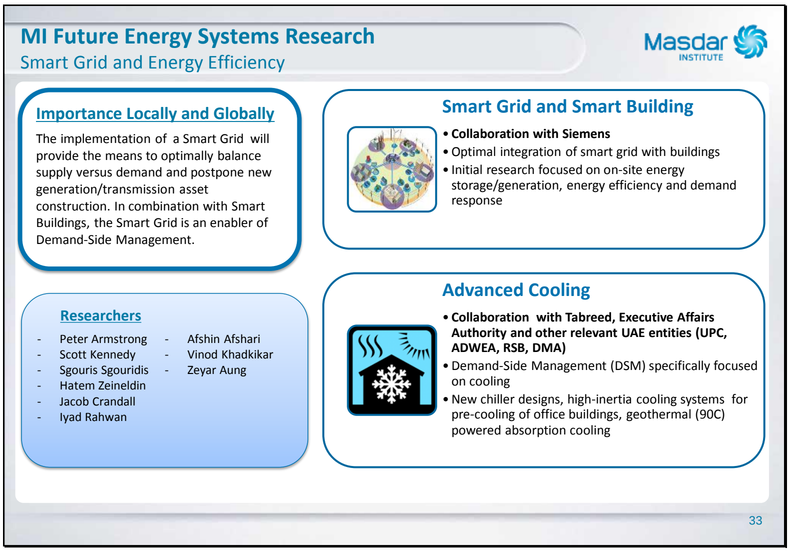

Figure 32. MI Future Energy Systems Research - Smart Grid and Energy Efficiency.

Here we have a snapshot of the research at Masdar Institute with emphasis on smart grids and energy efficiency. These are both areas directly aligned with the advanced energy and sustainability themes that are at the core of the Institute’s research. In fact, developed SGSB CoE with Siemens.

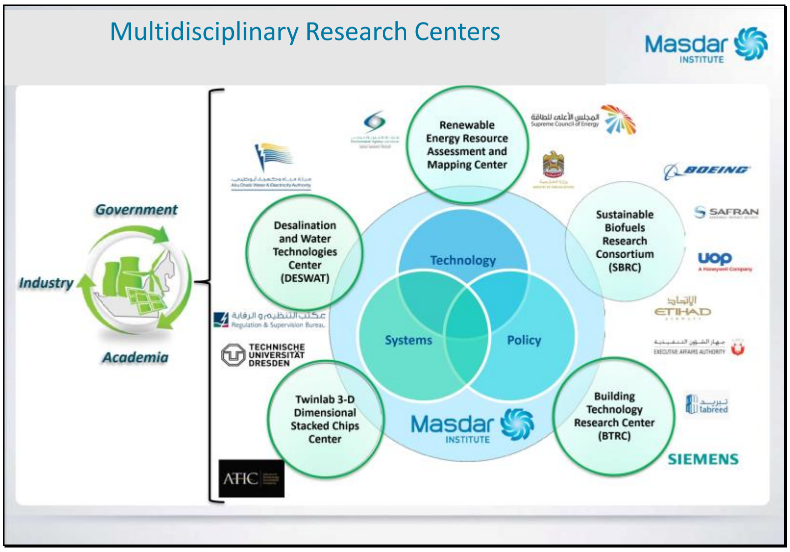

Figure 33. Multidisciplinary Research Centers.

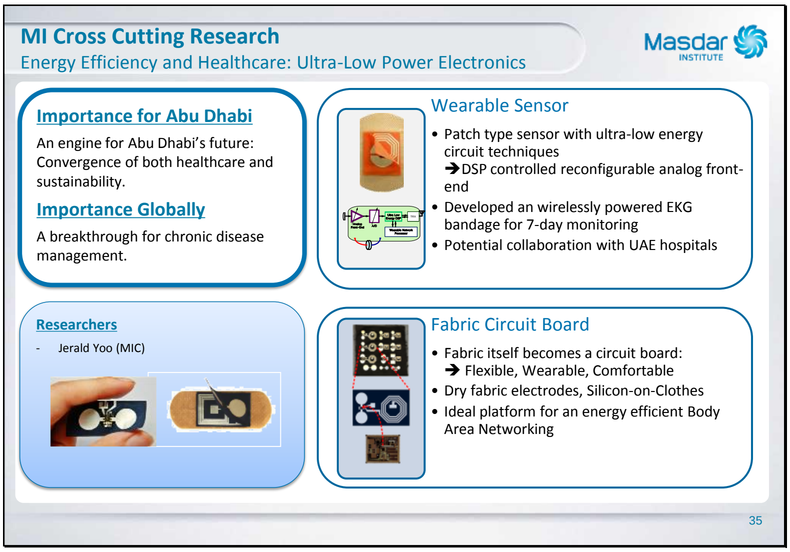

Figure 34. MI Cross Cutting Research - Energy Efficiency and Healthcare: Ultra-Low Power Electronics.

Specific example is the development of ultra-low power electronics for healthcare applications. Powering a small sensor that can be worn on a bandage is just one example of the cross cutting research being done at MI.

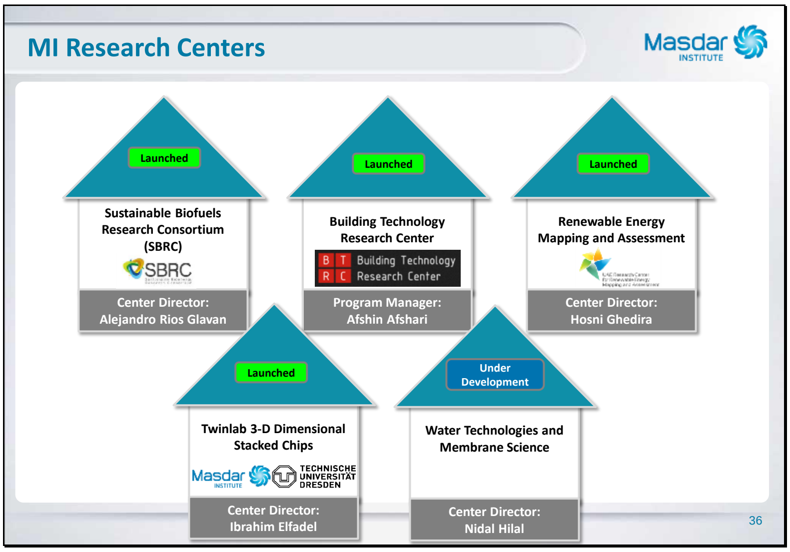

Figure 35. MI Research Centers.

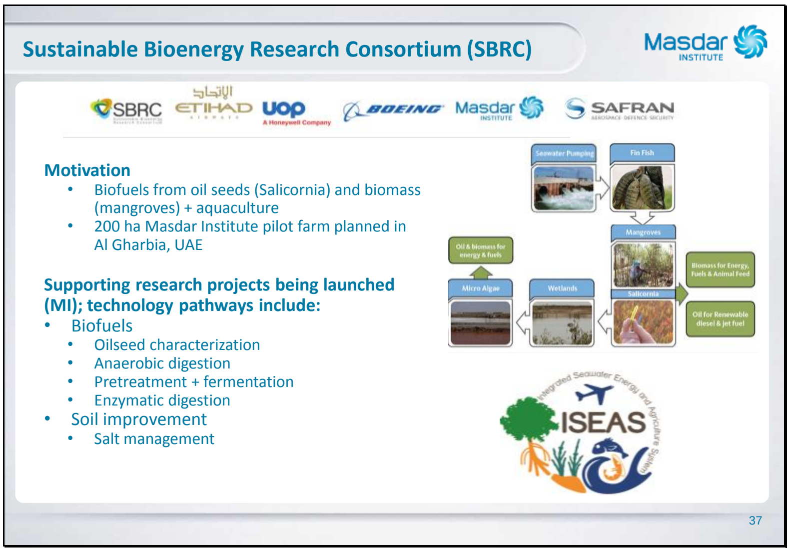

Figure 36. Sustainable Bioenergy Research Consortium (SBRC).

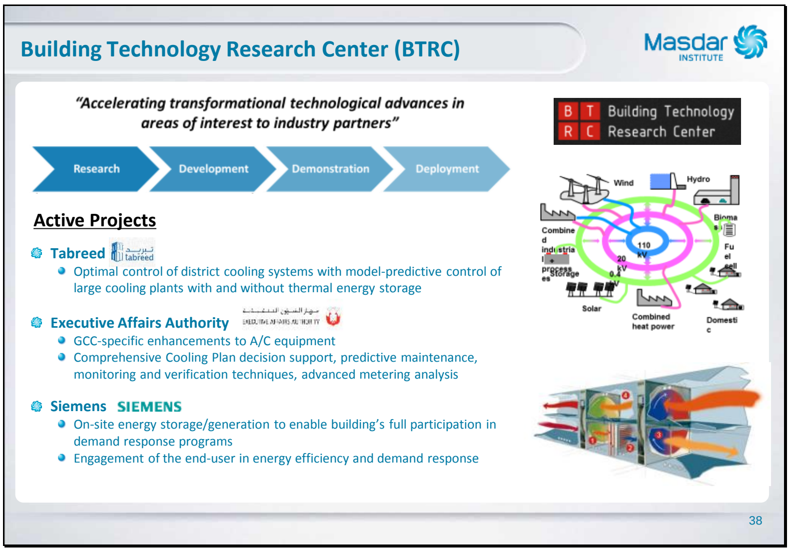

Figure 37. Building Technology Research Center (BTRC).

We have 2 research themes as part of the current research portfolio. The first deals with on-site energy generation and storage with demand response and includes projects that link demand response to thermal storage, load forecasting, and demand response coupled to adaptive generation. The second involves engagement of the end-user in energy efficiency and demand response and includes methods to modulate energy consumption.

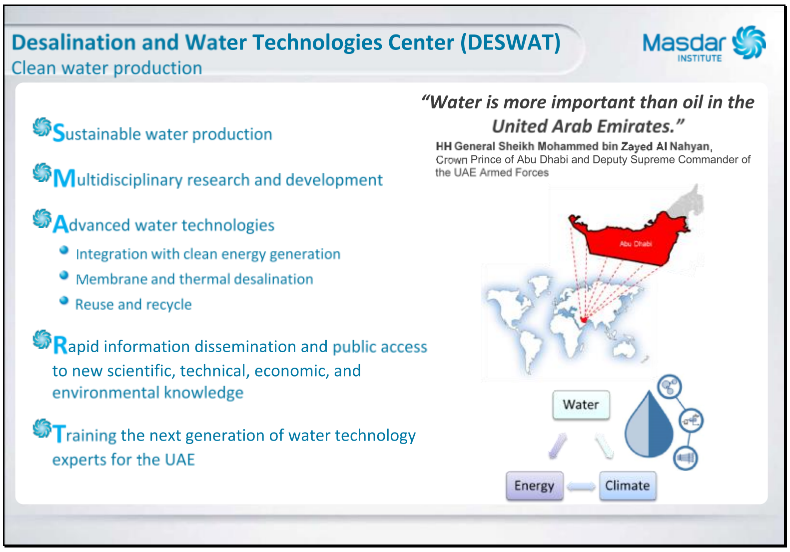

Figure 38. Desalination and water

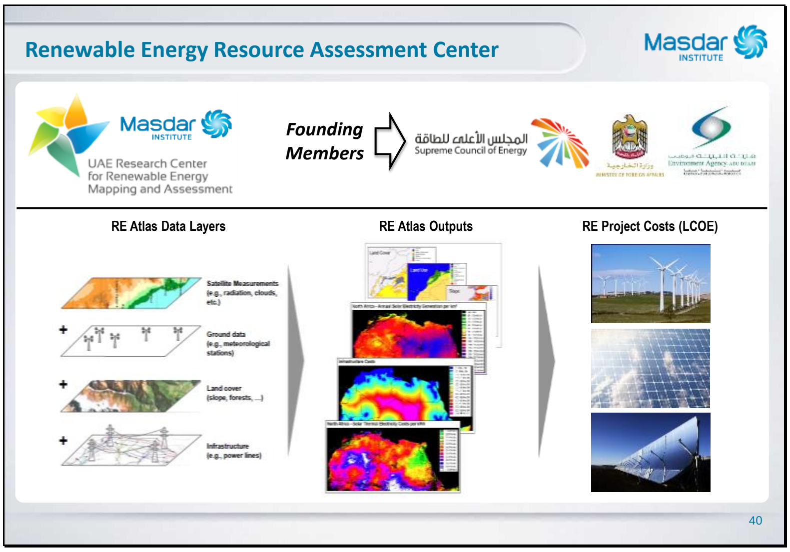

Figure 39. Renewable Energy Resource Assessment Center.

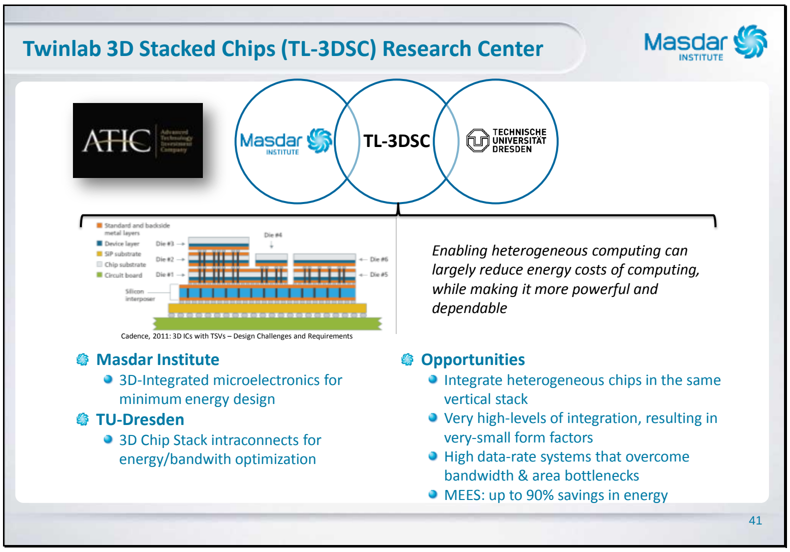

Figure 40. Twinlab 3D Stacked Chips (TL-3DSC) Research Center.

Public Health Research, Policies and Funding Opportunities

ABDALLAH DAAR FIAS
Professor of Public Health Sciences and of Surgery
University of Toronto, Toronto
Canada

ABSTRACT

Over the past few years it has become obvious that dealing with global health issues requires a novel approach in terms of identifying priorities for research, on the one hand, and innovative mechanisms and approaches in research funding. In my talk I will highlight the major milestones in the development of the Grand Challenges approach and the institutions and funding mechanisms that have evolved. I will focus on the creation and funding programmes of both the Global Alliance for Chronic Diseases and the various grand challenges initiatives such as the Bill and Melinda Gates Foundation's Grand Challenges in Global Health initiative and later the Grand Challenges Canada programme, focusing on the various ways in which researchers from the developing world can obtain funding. I will focus particularly on the Global Stars programme of Grand Challenges Canada, highlighting the innovative projects that have been funded across the developing world. Finally I will discuss the development of a whole new Grand Challenges community of countries that are coming together to work on solving complex global health problems through collaboration and innovation.

Figure 1. Communicable (infectious) diseases.

Our Definition of a Grand Challenge

*“A specific **critical barrier** that, if removed, would help solve an important health problem in the developing world with a high likelihood of global impact through widespread implementation”*

Figure 2. Our Definition of a Grand Challenge.

Grand Challenges in Global Health

H. Varmus, R. Klausner, E. Zerhouni, T. Acharya, A. S. Daar, P. A. Singer

17 OCTOBER 2003 VOL 302 SCIENCE www.sciencemag.org

GOALS AND GRAND CHALLENGES

To improve childhood vaccines:
- GC 1: Create effective single-dose vaccines that can be used soon after birth;
- GC 2: Prepare vaccines that do not require refrigeration;
- GC 3: Develop needle-free delivery systems for vaccines.

To create new vaccines:
- GC 4: Devise reliable tests in model systems to evaluate live attenuated vaccines;
- GC 5: Solve how to design antigens for effective, protective immunity;
- GC 6: Learn which immunological responses provide protective immunity.

To control insects that transmit agents of disease:
- GC 7: Develop a genetic strategy to deplete or incapacitate a disease-transmitting insect population;
- GC 8: Develop a chemical strategy to deplete or incapacitate a disease-transmitting insect population.

To improve nutrition to promote health:
- GC 9: Create a full range of optimal bioavailable nutrients in a single staple plant species.

To improve drug treatment of infectious diseases:
- GC 10: Discover drugs and delivery systems that minimize the likelihood of drug-resistant microorganisms.

To cure latent and chronic infections:
- GC 11: Create therapies that can cure latent infections;
- GC 12: Create immunological methods that can cure chronic infections.

To measure disease and health status accurately and economically in poor countries:
- GC 13: Develop technologies that permit quantitative assessment of population health status;
- GC 14: Develop technologies that allow assessment of individuals for multiple conditions or pathogens at point-of-care.

Figure 3. Grand Challenges in Global Health.

Figure 4.

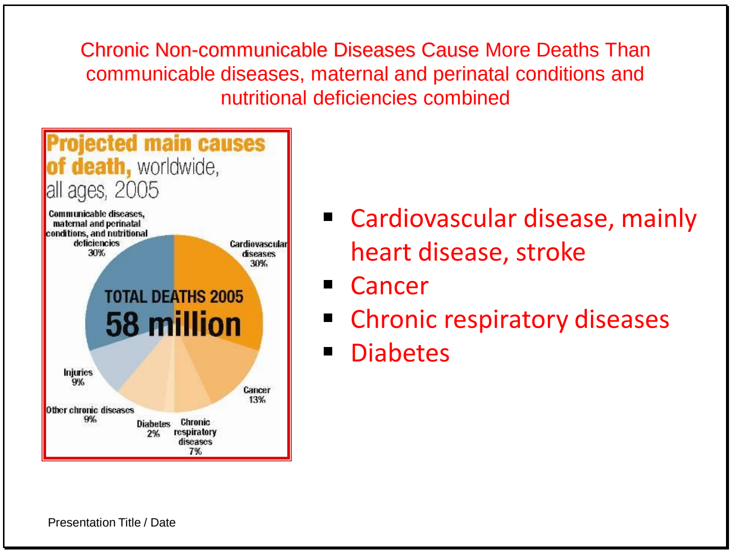

Figure 5. Chronic non-communicable diseases cause more deaths than communicable diseases, maternal and perinatal conditions and nutrition combined.

nature Vol 450|22 November 2007

FEATURE

Grand challenges in chronic non-communicable diseases

The top 20 policy and research priorities for conditions such as diabetes, stroke and heart disease.

Abdallah S. Daar[1], Peter A. Singer[1], Deepa Leah Persad[1], Stig K. Pramming[2], David R. Matthews[3], Robert Beaglehole[4], Alan Bernstein[5], Leszek K. Borysiewicz[6], Stephen Colagiuri[7], Nirmal Ganguly[8], Roger I. Glass[9], Diane T. Finegood[10], Jeffrey Koplan[11], Elizabeth G. Nabel[12], George Sarna[6], Nizal Sarrafzadegan[13], Richard Smith[14], Derek Yach[15] and John Bell[16]

Chronic non-communicable diseases (CNCDs) are reaching epidemic proportions worldwide[1–3]. These diseases — which include cardiovascular conditions (mainly heart disease and stroke), some cancers, chronic respiratory conditions and type 2 diabetes — affect people of all ages, nationalities and classes.

The conditions cause the greatest global share of death and disability, accounting for around 60% of all deaths worldwide. Some 80% of chronic-disease deaths occur in low- and middle-income countries. They account for 44% of premature deaths worldwide. The number of deaths from these diseases

Poor diet and smoking are two factors that contribute to the millions of preventable deaths that occur each year.

Figure 6. Feature.

The Global Alliance for Chronic Diseases

APPROXIMATELY 35 MILLION PEOPLE WILL DIE THIS YEAR FROM CHRONIC, NONCOMMUNICABLE diseases (CNCDs) worldwide (*1*, *2*). CNCDs include cardiovascular disease and stroke, cancer, diabetes, and chronic respiratory diseases. CNCDs account for 60% of all deaths worldwide, of which 80% occur in low- and middle-income countries (LMICs) (*3*). Yet, until now there has been no coordinated effort by major global health research councils to address these specific needs.

To this end, we announce a new global health initiative, the Global Alliance for Chronic Diseases (GACD). The first alliance of its kind among government health research councils, the GACD was launched on 15 June 2009 in Seattle, Washington, coincident with the meeting of Heads of International Biomedical Research Organizations. The GACD has a global reach, bringing together an initial formative group of six major national health research councils. These agencies together represent about 80% of all public research funding in the world. Member agencies are Australia's National Health and Medical Research Council; the Canadian Institutes of Health Research; the Chinese Academy of Medical Sciences; the U.K. Medical Research Council; and the U.S. National Institutes of Health, specifically its National Heart, Lung, and Blood Institute and Fogarty International Center. In addition, the Indian Council of Medical Research has been invited to be a Member agency of the Alliance.

The GACD intends to coordinate research activities that address the prevention and treatment of chronic diseases on a global scale (*2*). It will collectively seek to identify com-

The following priorities have been proposed by some GACD founding members, but exact research priorities await further discussion and will develop as the Alliance evolves: prevention of cardiovascular diseases; public health measures for the control of diabetes and obesity; characterization, quantification of risk factors (tobacco and environmental pollution), and development of control measures for chronic obstructive airways disease, cancer, cardiovascular disease and other disorders; and implementation research of interventions to address these and other priorities. A future Alliance research priority is likely to be in the area of mental health.

The creation of the GACD brings to fruition a global commitment to urgently increase the resources and attention to CNCDs. With concerted action, many millions of premature deaths can be averted in the decades ahead.

ABDALLAH S. DAAR,[1,2]* ELIZABETH G. NABEL,[1,3] STIG K. PRAMMING,[1] WARWICK ANDERSON,[4] ALAIN BEAUDET,[5] DEPEI LIU,[6] V. M. KATOCH,[7] LESZEK K. BORYSIEWICZ,[8] ROGER I. GLASS,[9] JOHN BELL[1]

[1]Preparatory Committee, Oxford Health Alliance, London, UK. [2]McLaughlin-Rotman Centre for Global Health, UHN/University of Toronto, Toronto, ON, Canada. [3]National Heart, Lung, and Blood Institute, Bethesda, MD, USA. [4]National Health and Medical Research Council, Canberra, ACT, Australia. [5]Canadian Institutes of Health Research, Ottawa,

Figure 7. The Global Alliance for Chronic Disease.

GACD

GLOBAL ALLIANCE FOR CHRONIC DISEASES

AN ALLIANCE OF HEALTH RESEARCH FUNDERS

- First of its kind
- Focuses on chronic diseases in low and middle income countries and low income populations of high income countries
- Supports collaborative, coordinated research at global scale on low-cost interventions and on capacity building for research and health care delivery
- Identifies common approaches to develop evidence base to guide policy

Figure 8. GACD.

Figure 9. GACD Membership.

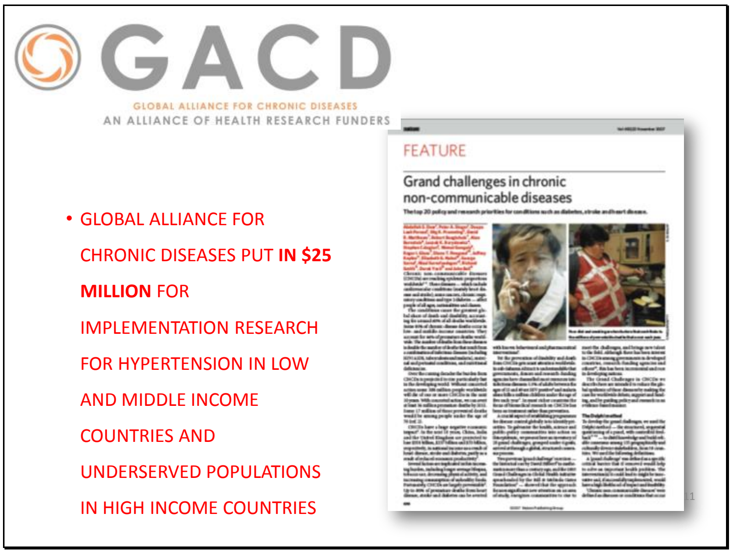

Figure 10. GACD.

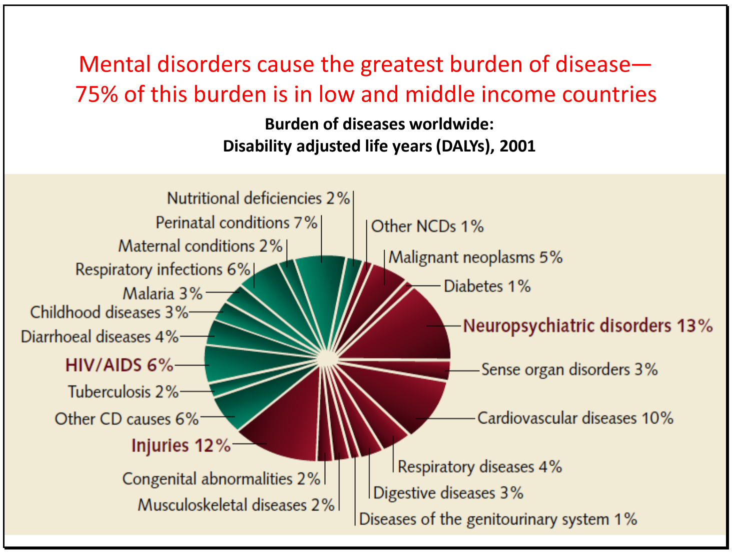

Figure 11. Mental disorders cause the greatest burden of disease 75% of this burden is in low and middle income countries.

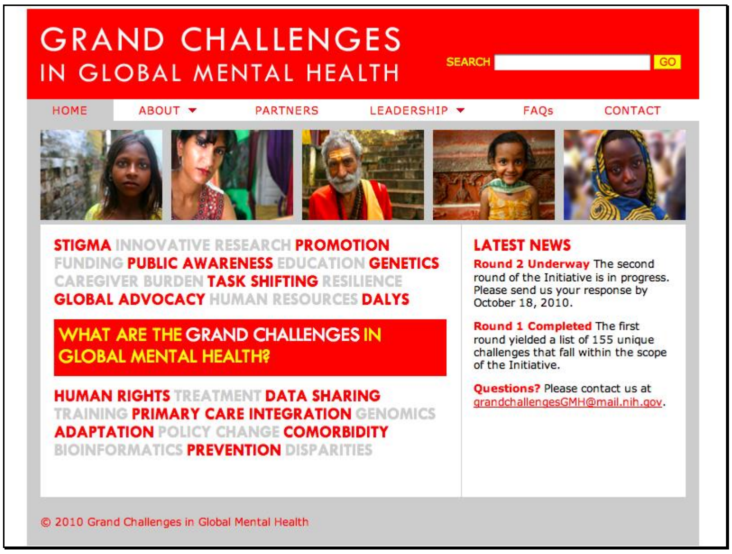

Figure 12. Grand Challenges in Global Mental Health.

Improving treatment for children with mental illness, like this girl in Somalia, is an urgent priority.

Grand challenges in global mental health

A consortium of researchers, advocates and clinicians announces here research priorities for improving the lives of people with mental illness around the world, and calls for urgent action and investment.

Schizophrenia, depression, epilepsy, dementia, alcohol dependence and other mental, neurological and substance-use (MNS) disorders constitute 13% of the global burden of disease (Table 1), surpassing both cardiovascular disease and cancer[1]. Depression is the third leading contributor to the global disease burden, and alcohol and illicit drug use account for more than 5% (ref. 2). Every seven seconds, someone develops dementia[3], costing the world up to US$609 billion in 2009 (ref. 4). By 2020, an estimated 1.5 million people will die each year by suicide, and between 15 and 30 million will make the attempt[5].

The absence of cures, and the dearth of preventive interventions for MNS disorders, in part reflects a limited understanding of the brain and its molecular and cellular mechanisms. Where there are effective treatments, they are frequently not available to those in greatest need. In 83% of low-income countries, there are no anti-Parkinsonian treatments in primary care; in 25% there are no anti-epileptic drugs[6]. Unequal distribution of human resources — between and within countries — further weakens access: the World Health Organization's European region has 200 times as many psychiatrists as in Africa[7]. Across all countries, investment in fundamental research into preventing and treating MNS disorders is disproportionately low relative to the disease burden[8].

To address this state of affairs, the Grand Challenges in Global Mental Health initiative has identified priorities for research in the next 10 years that will make an impact on the lives of people living with MNS disorders. The study was funded by the US National Institute of Mental Health (NIMH) in Bethesda, Maryland, supported by the Global Alliance for Chronic Diseases (GACD), headquartered in London. Answers to the questions posed will require a surge in discovery and delivery science. We use the term 'mental health' as a convenient label for MNS disorders. We exclude conditions with a vascular or infectious aetiology (such as stroke or cerebral malaria), because these fell within the scope of the two previous grand challenges initiatives — in global health and in chronic non-communicable diseases[9].

This initiative differs from previous priority-setting exercises for mental

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Nature, July 7, 2011

Figure 13. Grand Challenges in Global Mental Health.

The Creation of Grand Challenges Canada

2008 Canadian Federal Budget Created The

Development Innovation Fund → Grand Challenges Canada

…support the best minds in the world as they search for breakthroughs in global health …

Figure 14. The Creation of Grand Challenges Canada.

Figure 15. Mission of Grand Challenges Canada.

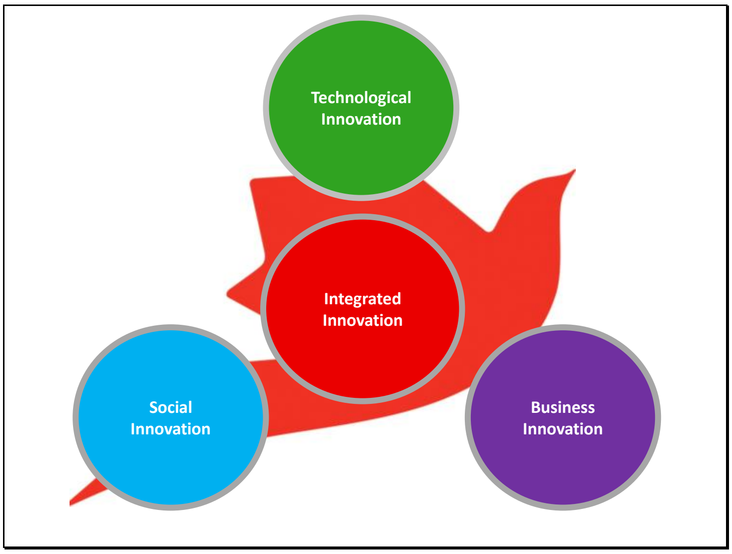


Figure 16.

Figure 17. Grand Challenges Canada Programs.

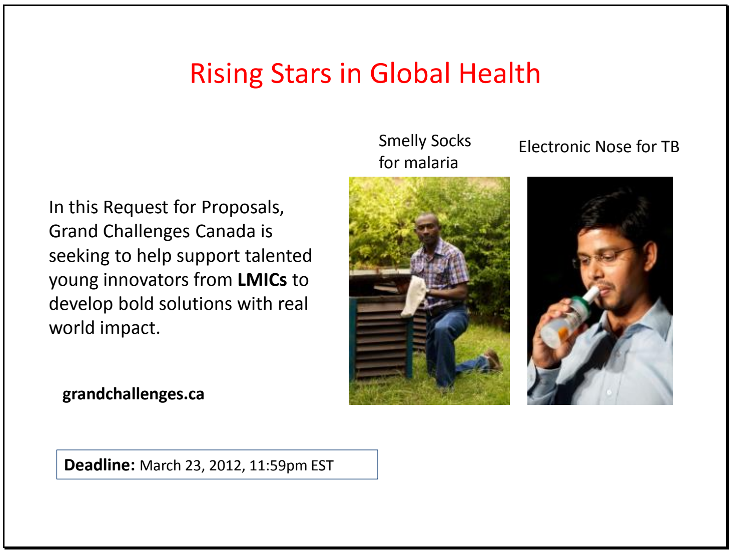


Figure 18. Rising Stars in Global Health.

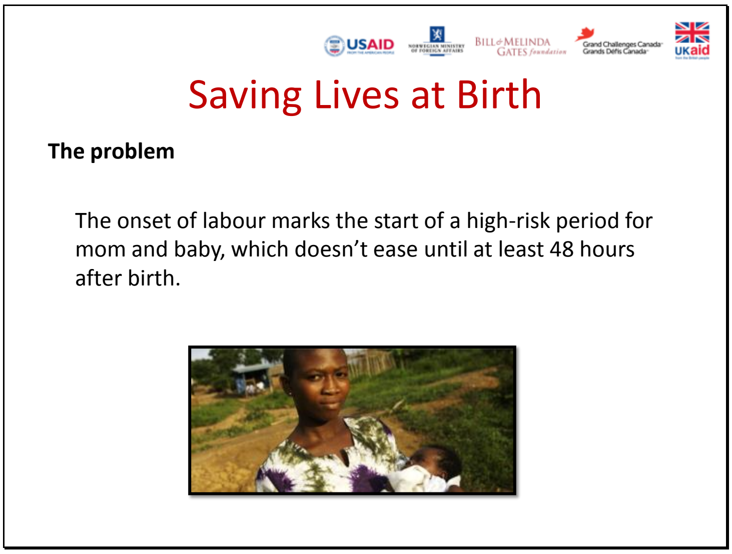


Figure 19. Saving Lives at Birth.

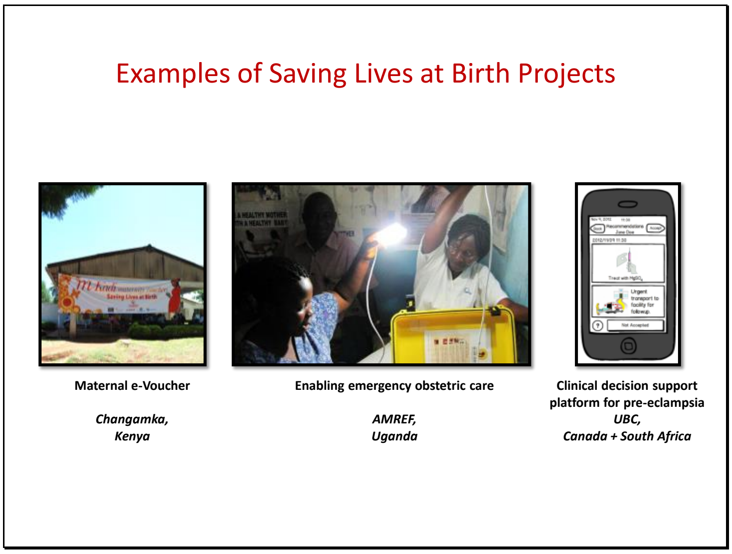


Figure 20. Examples of Saving Lives at Birth Projects.

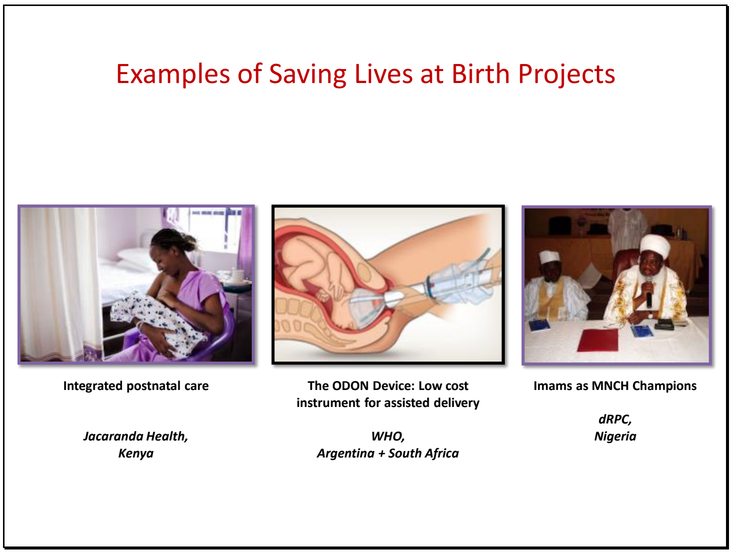


Figure 21. Examples of Saving Lives at Birth Projects.

Figure 22. Global Mental Health.

Grand Challenges Canada Grants to Bangladesh/Address Issues in Bangladesh

- A primary care toolkit to tackle child labour and promote health equity
- Mobile Health Solutions for Breast Cancer Case-Finding, Referral, and Navigation in Rural Bangladesh
- Use of Mobile Phone for Improving Low Immunization Coverage among Children Living in Rural Hard-to-reach Areas and Urban Streets of Bangladesh
- Simple inexpensive safety kitchen and low birth weight in resource-poor setting: A randomized controlled trial
- Self-financed health scheme of labor cooperative for accessing quality healthcare of informal sector workers
- Interventions of street food vendors in Bangladesh for strengthening street food safety

Figure 23 Grand Challenges Canada Grants to Bangladesh/ Address Issues in Bangladesh.

Grand Challenges Canada Grants to Bangladesh/Address Issues in Bangladesh

- Prenatal calcium to prevent preeclampsia and preterm birth in resource poor rural settings: can a novel differential time-release microencapsulated powder overcome barriers to adherence and scaleup?
- Early treatment with rectal artesunate to halt disease progression and reduce disability in survivors: the neurocognitive assessment of children in Study 13
- Effect of maternal and newborn vitamin A supplementation on cognitive development of school aged children in rural Bangladesh

Figure 24. Grand Challenges Canada Grants to Bangladesh/ Address Issues in Bangladesh.

Grand Challenges Movement

- Grand Challenges in Global Health (2003)
- Grand Challenges Explorations (2007)
- Grand Challenges Canada (2010)
- Grand Challenges Canada’s Stars in Global Health (2010)
- Grand Challenges for Development (2011):
- Grand Challenges Brazil (2012)
- Grand Challenges India 2013)

Figure 25. Grand Challenges Movement.

Grand Challenges Programs

- Define challenges whose solution would unleash progress in key areas
- Engage the world's most innovative researchers
- Focus research on making an impact for those most in need
- Build collaboration among researchers and funders to accelerate impact
- Build an expanding global network of programs and partners

Figure 26. Grand Challenges Programs.

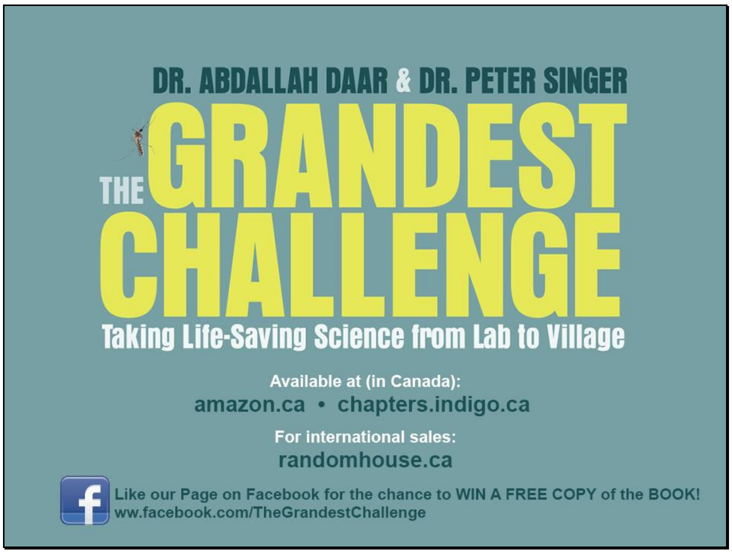


Figure 27. Grandest Challenge.

Public Health Research Funding and Policies in Turkey

UGUR DILMEN FIAS
General Director of Health Research
Turkish Ministry of Health, Ankara
Turkey

ABSTRACT

In Turkey, research on public health, especially in the last 10 years, has become increasingly important.

The Ministry of Health, universities and big companies that want to do research are conducting studies and projects related with the public health by using variety of funds.

In this research, the General Directorate of Health Researches which was established with the new organizational structuring after the Health Transformation Project, plays a major role. The field research oriented to vast majority of public and these researches are supported by various funds.

These funds are; the resources allocated from the General Budget of the Ministry of Health, research shares allocated from the Ministry revolving funds, the World Bank research support funds, Ministry of Health projects supported by the European Union and within the scope of European Union framework programs, the Scientific and Technological Research Council of Turkey TUBITAK European Union Framework 7 common call program sources.

Figure 1.

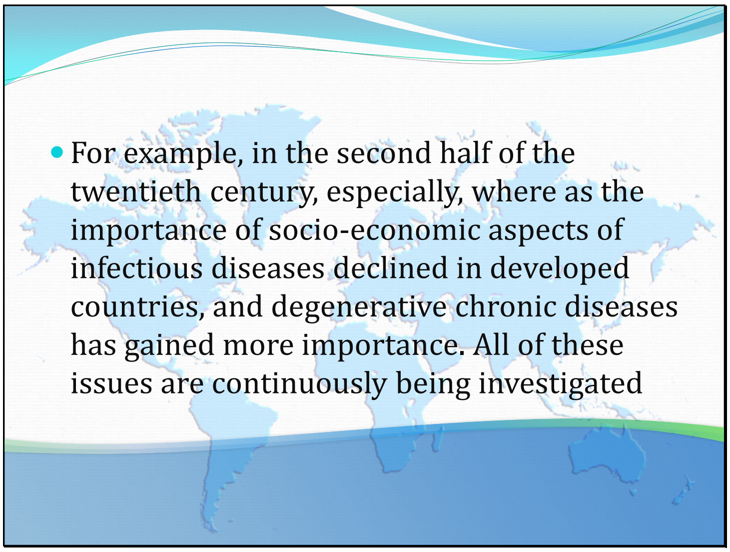


Figure 2.

Figure 3.

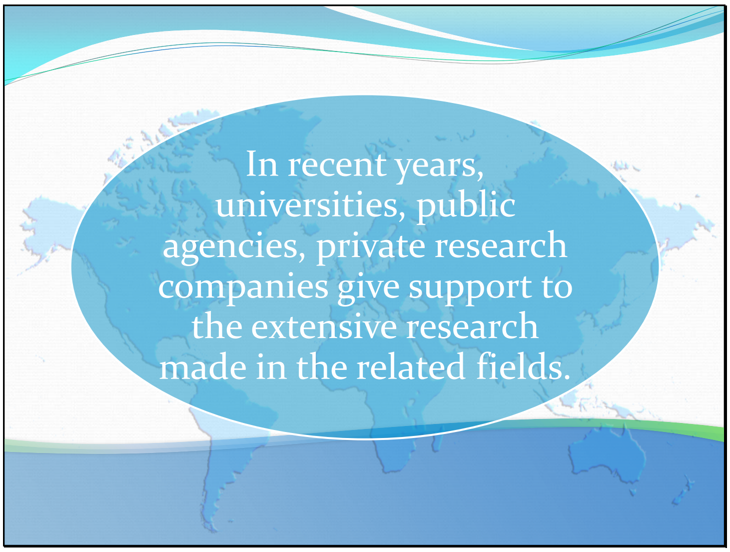


Figure 4.

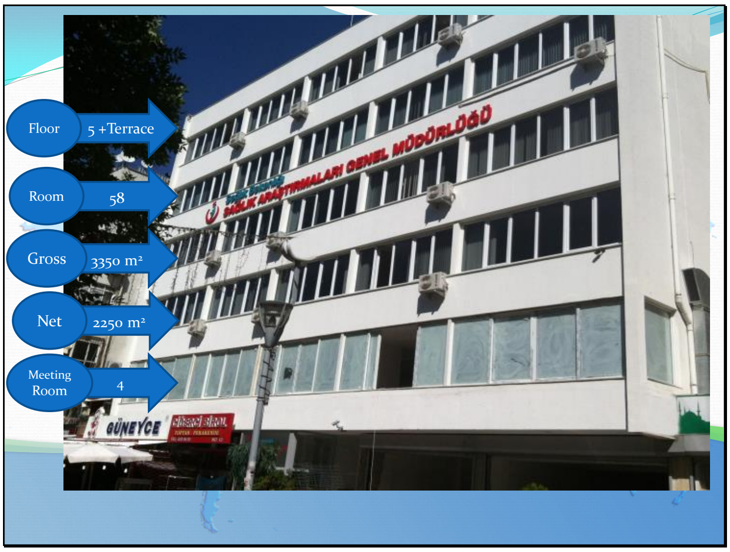


Figure 5.

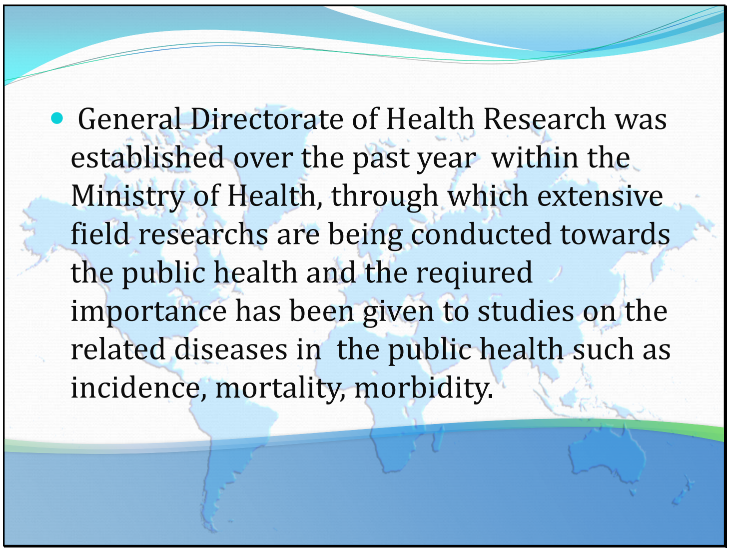
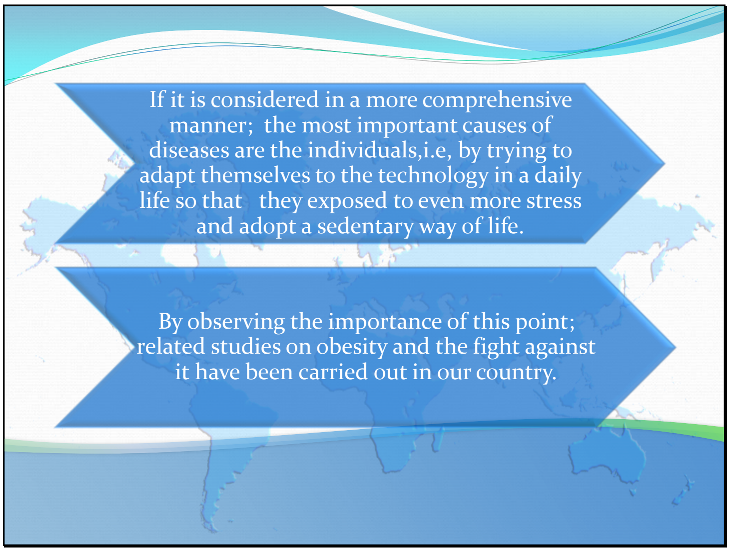


Figure 6.



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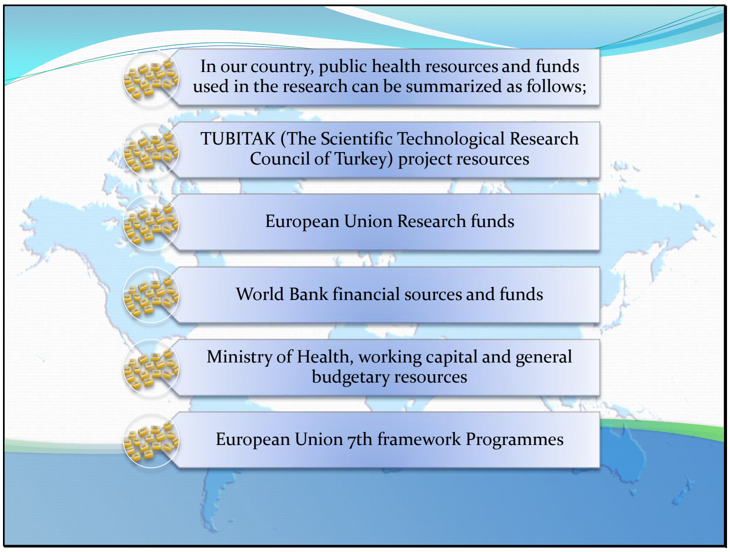

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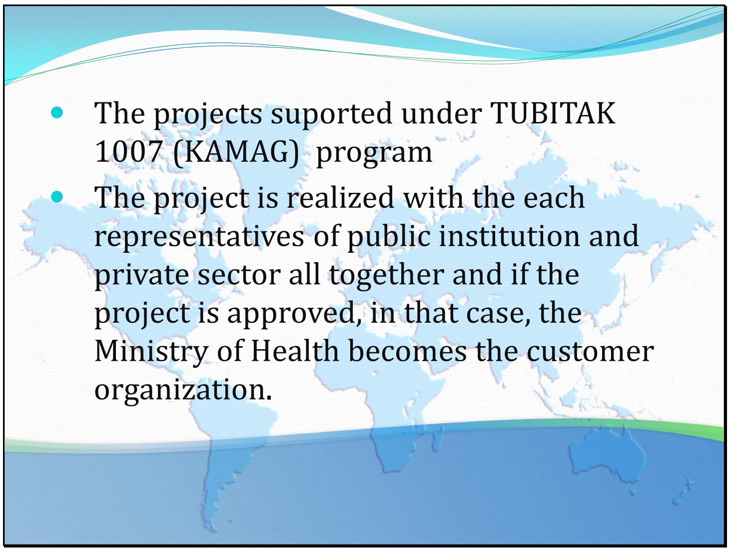
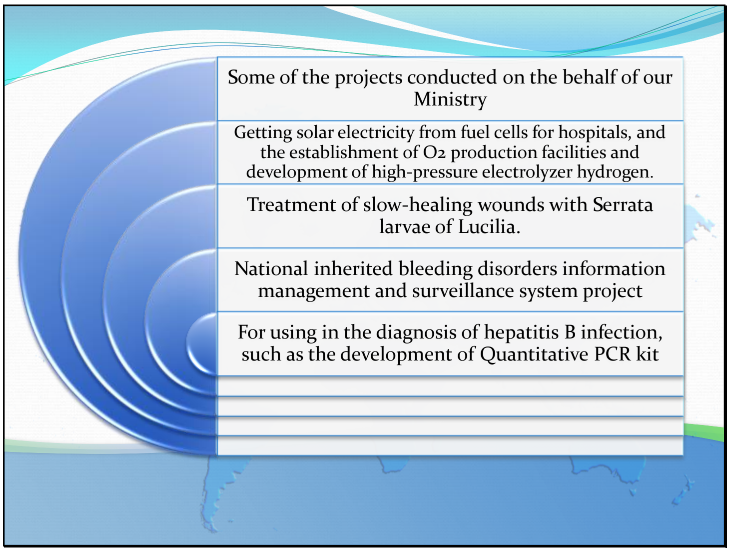


Figure 9.



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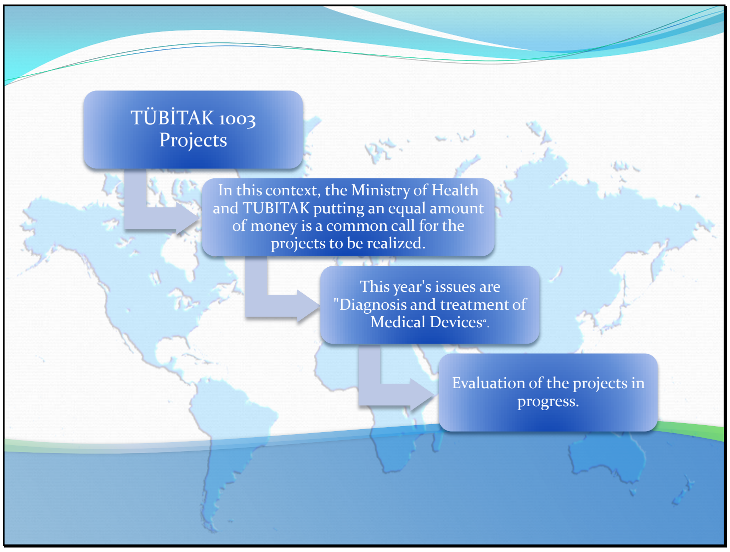


Figure 11.

Figure 12. European Union Research Funds.

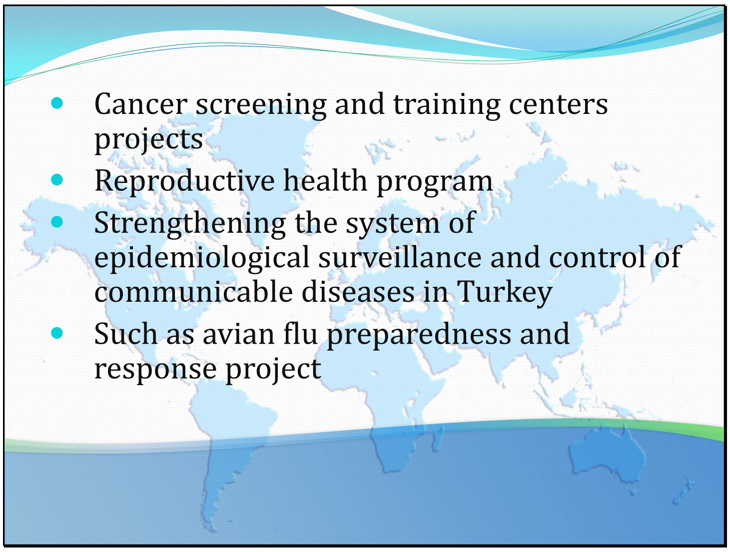


Figure 13.

Figure 14.

Figure 15.

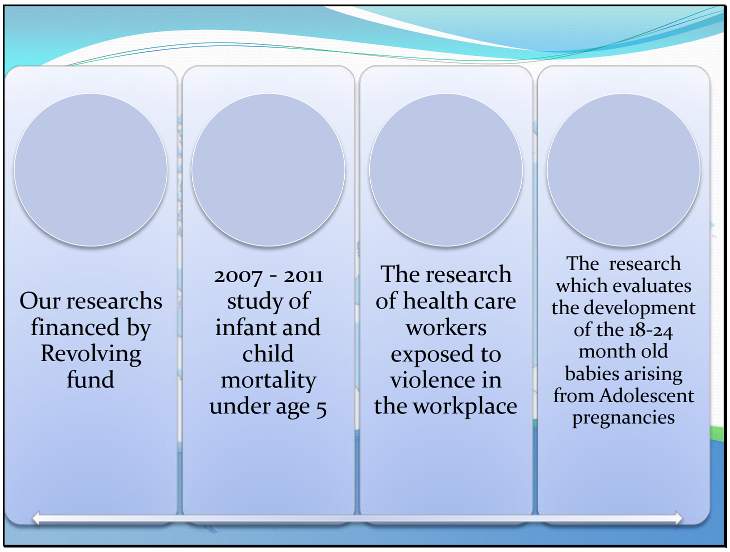


Figure 16.

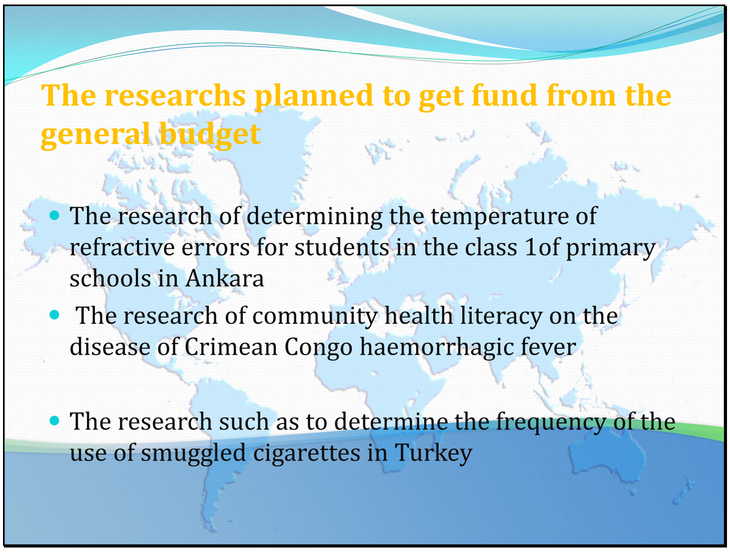


Figure 17. The research planned to get funds from the general budget.

Figure 18.

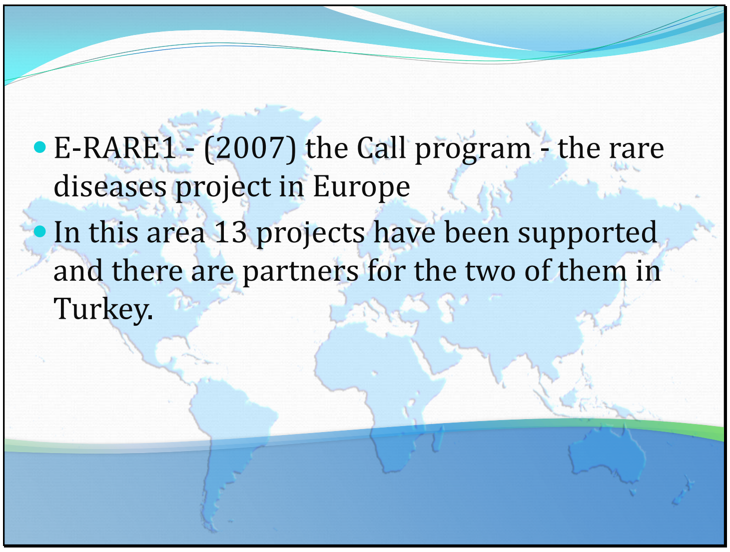


Figure 19.

Figure 20.

Figure 21.

Figure 22.

Figure 23.

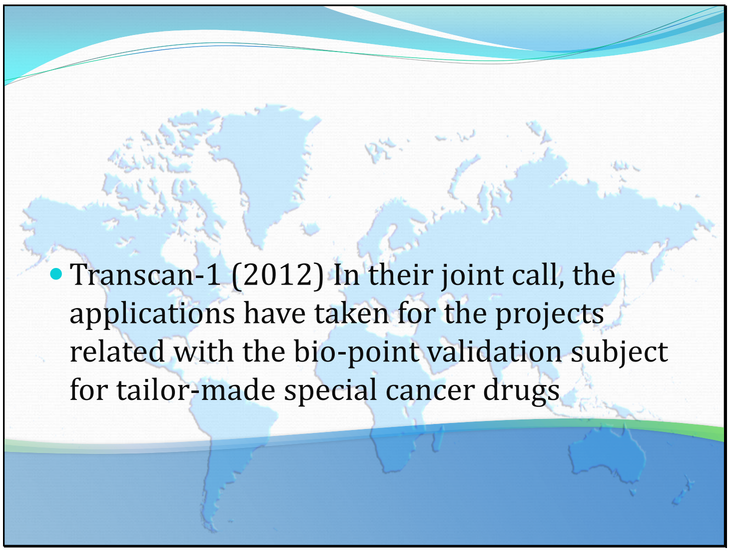


Figure 24.

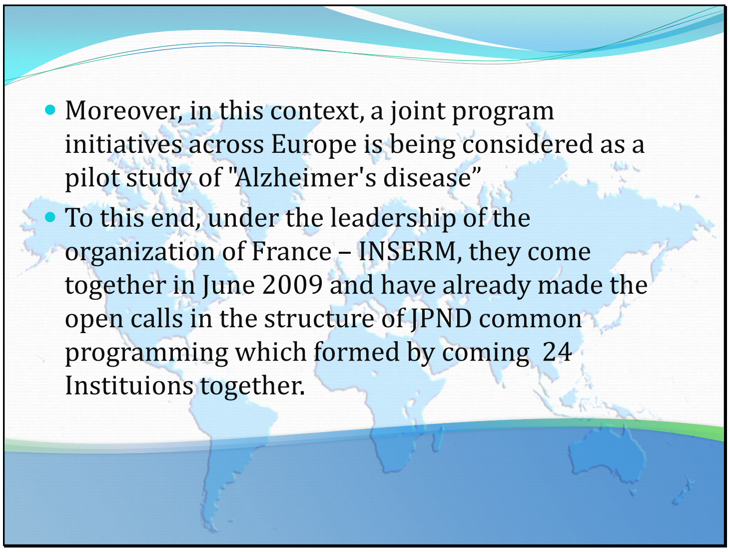
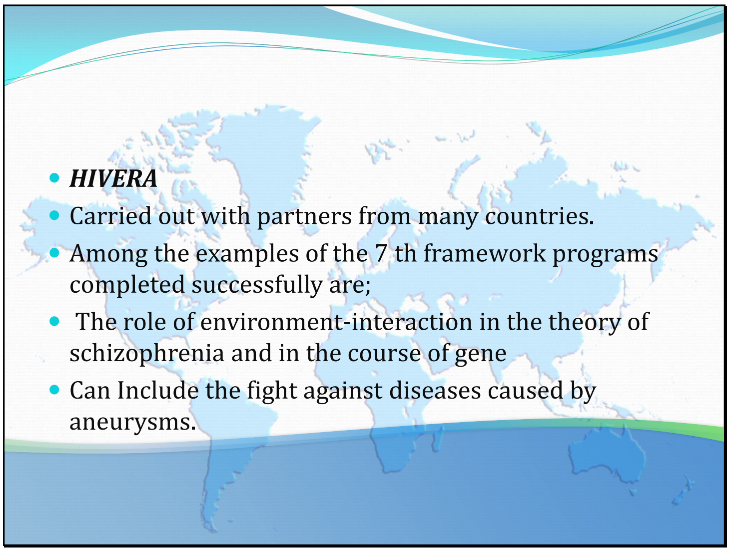


Figure 25.

Figure 26.

Figure 27.

Figure 28.



HIVERA
Carried out with partners from many countries.
Among the examples of the 7 th framework programs completed successfully are;
The role of environment-interaction in the theory of schizophrenia and in the course of gene
Can Include the fight against diseases caused by aneurysms.

Figure 29.

Health Equity and Universal Health Coverage

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ABSTRACT

Health systems across the world are characterized by a tendency towards inequities in health. This revealed behavior has been termed "inverse care" and its recognition has led governments, NGOs, multilateral organizations such as UNICEF and WHO, as well as private foundations such as the Bill and Melinda Gates and Rockefeller Foundations to mobilize in the name of improving health equity, or eliminating inequities in health.

More recently, growing out of efforts to renew Primary Health Care and acknowledging the need to transform financing systems for health, there has been a growing consensus around Universal Health Coverage. This consensus has taken the shape of resolutions in both the World Health Assembly and most recently in the United Nations General Assembly.

This talk will examine these two movements in global health, consider the intersections, and discuss their implications for countries with a special focus on Bangladesh

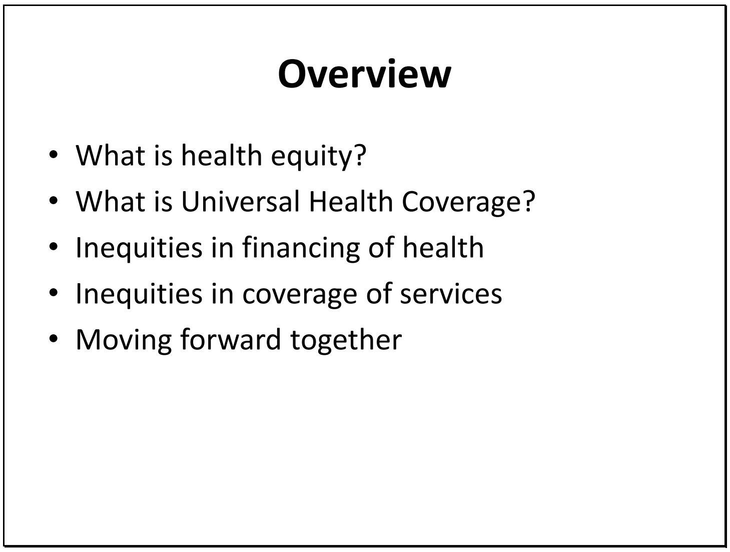

Figure 1. Overview.

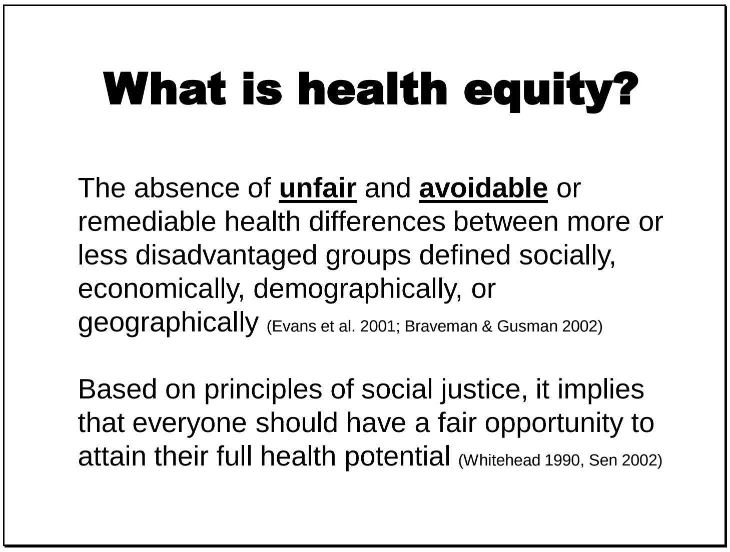

Figure 2. What is health equity?

3 important observations regarding this definition:

- The concept of equity is concerned with the fair distribution of health between groups.
- At the individual level health will always be unequally distributed due to biological variation, individual choice, chance.

- What is unacceptable is when these variations are non-randomly distributed, skewed by gender SES occupation, race, and ethnicity.

So how do you determine what is an unfair distribution?
While this is essentially a philosophical question, something that is unfair is usually marked by:

1) Injustice (Implying justice dictated by reason, conscience , natural sense of what is fair),
2) Partiality (an inclination to favour one group over another) and/or
3) Deception (the act of deceiving= be dishonest)

Not all health inequalities are unjust or inequitable.
Take for example, differences in life expectancy comparing men and women. Would you consider the fact that the life expectancy of Canadian females is 84 and males, 77, an example of an inequitable distribution of health that should be of urgent policy concern?

Women are biologically predisposed to greater longevity - in general, they live longer than men. Because this difference is likely to be a consequence of biological sex differences, and is not, therefore, inequitable.

However, in cases where women have the same or lower life expectancy as men – that is, where social conditions act to reduce the natural longevity advantage of women – this inequality is a mark of gross inequity (Sen, 2003).

" there is no good biological reason why someone living in Sierra Leone's life expectancy should be a full 50 years lower than someone living in Japan".

Sir Michael Marmot, the Chair of the Commission on Social Determinants of Health

"spectacular progress, spectacular inequities".

– Bill Foege, looking back on progress in health in the 20th century,

Figure 3.

"The poor are getting poorer, but with the rich getting richer it all averages out in the long run."

Figure 4.

- Massive gains in health status over the last 50 years even in poor countries such as Bangladesh.
- Unprecedented gains in female life expectancy and improvement in child survival.
- In the aggregate successful, but if you scratch the surface, very different picture emerges.
- Dramatic increases in health inequities in many countries in the world.

Why does health inequity matter?

For social justice:

–health is foundational for all human capabilities and well-being, and is a right that all should enjoy

For economic development:

–undermines social cohesion, weakens economic growth

For health sector efficiency:

–improving health status of disadvantaged groups may be best way to raise overall population health

Figure 5. Why does health inequity matter?

<u>Social justice:</u>

•appeals to ethical commitment to relieving the poverty and suffering of the least healthy helps assuage guilt associated with unequal opportunity esp among vulnerable groups like women and children.

•health is foundational for all human capabilities and well-being; therefore, inequities in health opportunity are seen as especially destructive (Anand, Sen).

•Health is a barometer of the fairness of the underlying social order.

•Rawls principle of justice that inequalities are justifiable only if eco soc pol institutions do not require sacrifices from worst off groups to benefit better off groups.

<u>For economic development</u>:

poor health status in some groups may undermine social cohesion, weaken economic growth.

<u>For health sector efficiency</u>:

improving health status of disadvantaged groups may be best way to raise overall population health.

"Without health nothing is of any use, not money nor anything else" *Democrit, 5th Century B.C.*

"The preservation of health is … without doubt the first good and the foundation of all other goods of this life" *Descartes,1637*

"The health of the people is really the foundation upon which all their happiness and all their powers as a state depend" *Disraeli,1877*

Figure 6.

Why is health equity important?
Health seen as an intrinsic and instrumental good throughout the ages, and something that every group in society should enjoy.

Why are poorer populations...

- 2x more likely to have TB?
- 3x less likely to access TB care?
- 4x less likely to complete TB treatment?
- 5x more likely to suffer impoverishment due to the costs of TB care?

Figure 7. Why are poorer populations?

Let's think about the immediate determinants of TB: exposure to infection mycobacteria, close living quarters, vulnerability due to undernutrition. Intermediate determinants: living and employment conditions, health service provision, education. Structural determinants: Gender, how might gender relate to determinants that produce inequities in health?

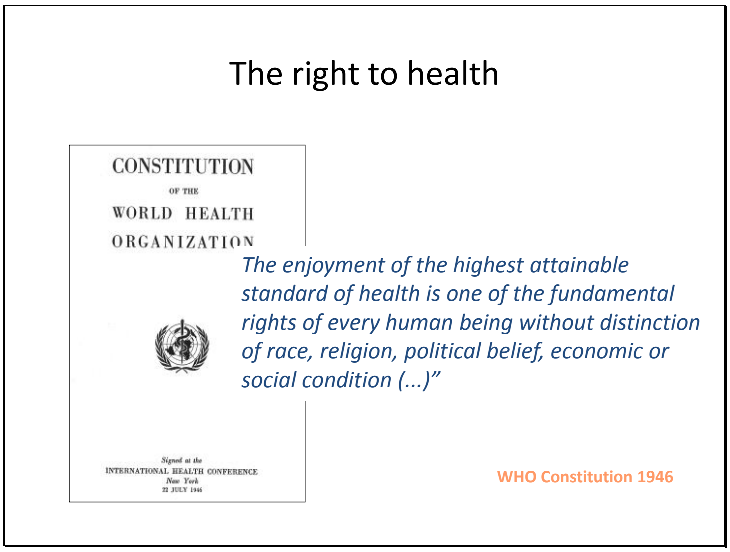

Figure 8. The right to health.

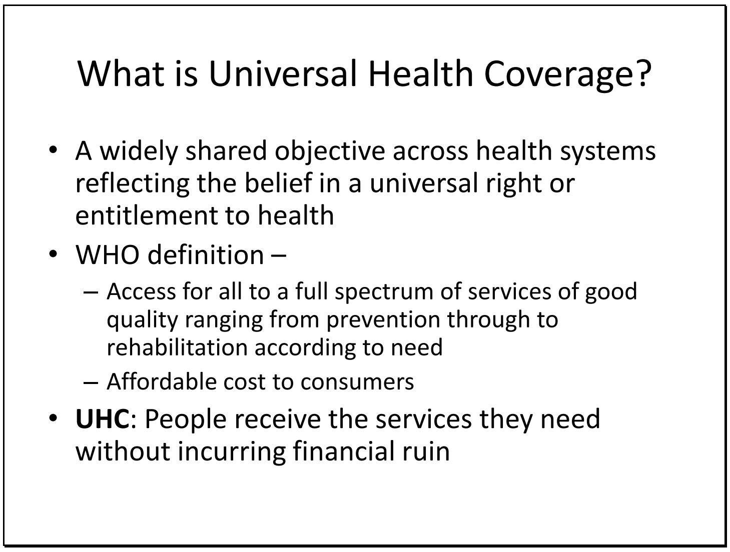

Figure 9. What is Universal Health Coverage?

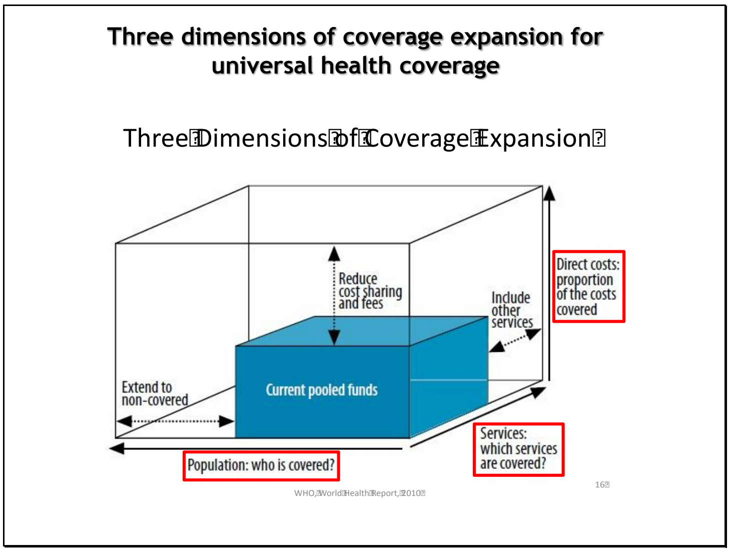

Figure 10. Three dimensions of coverage expansion for universal health coverage.

Why Focus on Universal Health Coverage

- Policy relevance:
  - – World Health Assembly Resolutions 2005, 2011
  - – Commission Social Determinants of Health 2008
  - – First World Social Security Report 2010, ILO
  - – World Health Reports 2008, 2010
- Focus of major reforms in many countries
  - – Thailand, India, China, South Africa
  - – Ghana, Rwanda, Vietnam

Figure 11. Why focus on Universal Health coverage?

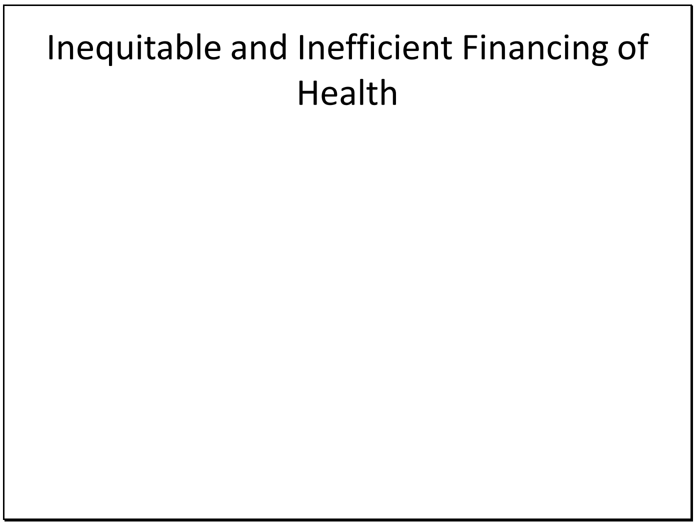

Figure 12. Inequitable and Inefficient Financing of Health.

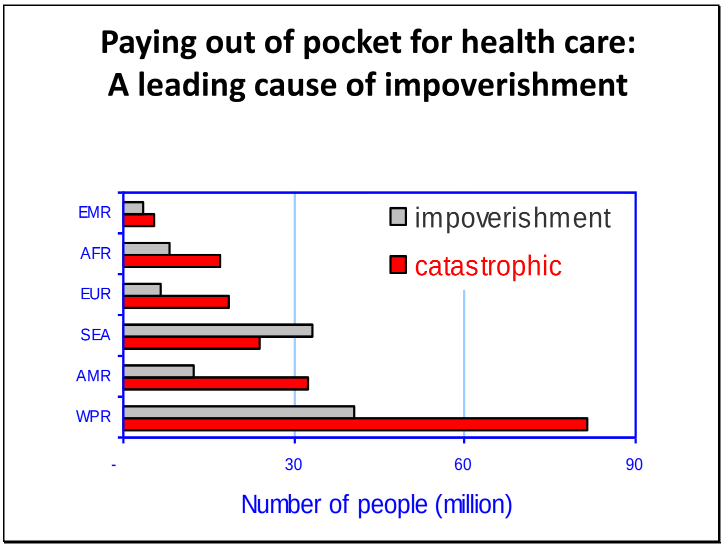

Figure 13. Paying out of pocket for health care: A leading cause of improvement.

The primary mode of financing of health care in low income countries is out of pocket payments at point of service - this is the most inequitable form of financing possible.
In some countries where patients are not released from hospital until they have paid their bill, young children on the maternity ward are said to be teething!!
OOPPOS are often impoverishing. The incidence of impoverishing payments may be so great that they are compromising the MDG goal #1 of halving poverty!!!
The financially impoverishing prospect of accessing health services means many are not accessing services.

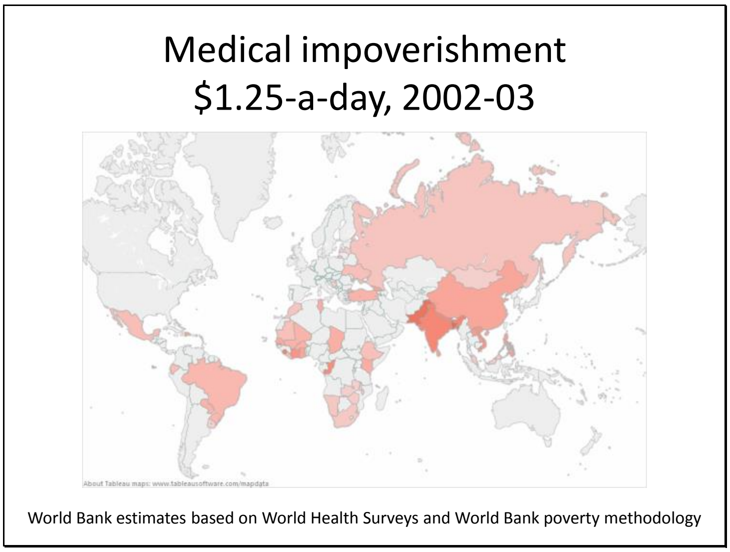

Figure 14. Medical impoverishment, $1.25-a-day, 2002-03.

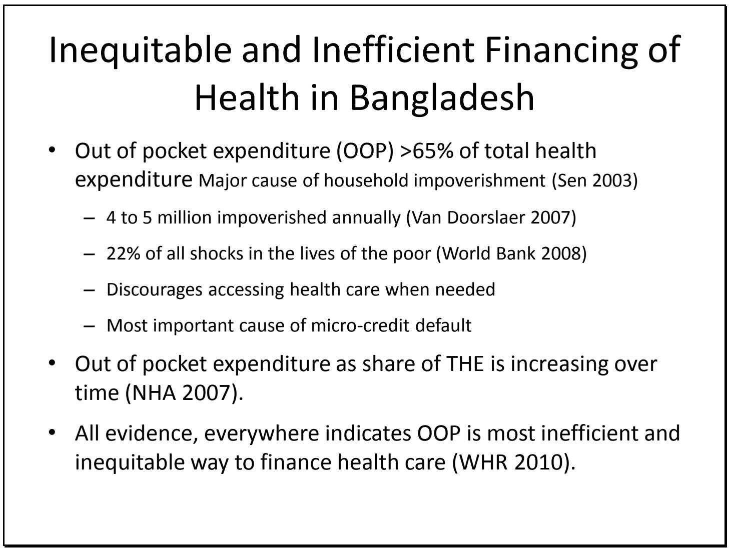

Figure 15. Inequitable and Inefficient Financing of Health in Bangladesh.

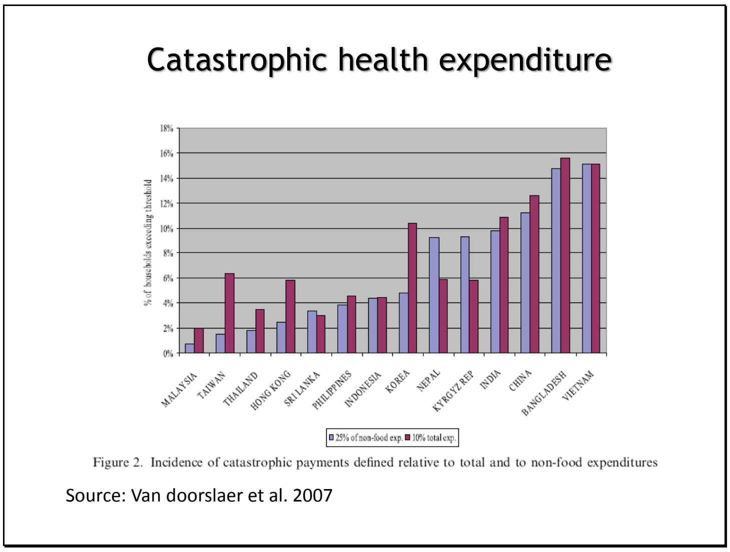

Figure 16. Catastrophic health expenditure.

Households catastrophic expenditure[1)] on healthcare by asset quintile

	Rural	Urban	Total
Threshold	**40%**	**40%**	**40%**
Poorest	14.7%	9.8%	14.5%
2nd	11.4%	8.0%	11.1%
3rd	10.8%	7.4%	10.3%
4th	8.6%	6.0%	7.5%
Richest	8.1%	2.3%	3.7%
Total	11.6%	4.4%	9.7%
Concentration Index (negative value=inequitable distribution)	**-0.078**	**-0.139**	**-0.181**

[1)] OOPP share of total non-food household consumption expenditure

18

Figure 17. Households catastrophic expenditure on health care by asset quintile.

A major deficit in fair financing

- Government health expenditure:
  - Vastly insufficient (<1% GDP)
  - decreasing as share of total health expenditure
  - regressive – rich benefit more than the poor
  - demand side financing – innovative but not clear that is “scalable” to whole country or beyond MNH
- Private health expenditure:
  - 99% out of pocket
  - Micro-health insurance has failed to scale
  - Private health insurance nascent but growing

Figure 18. A major deficit in fair financing.

Inequities in service coverage

Figure 19. Inequities in service coverage.

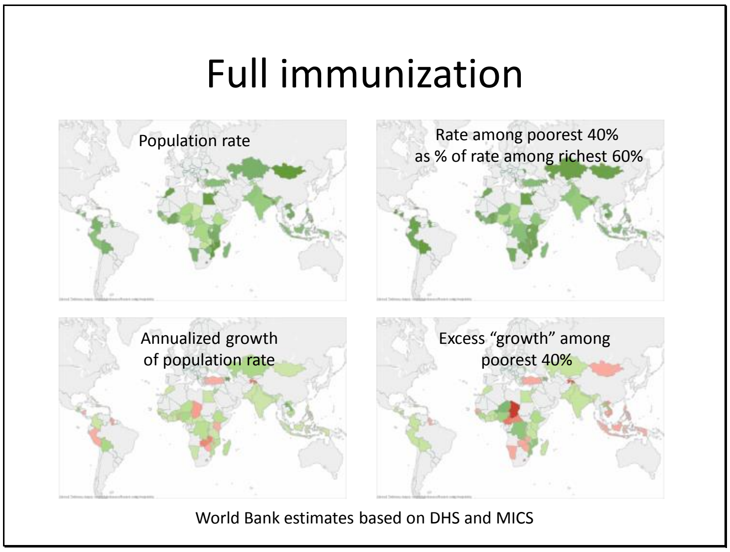

Figure 20. Full immunization.

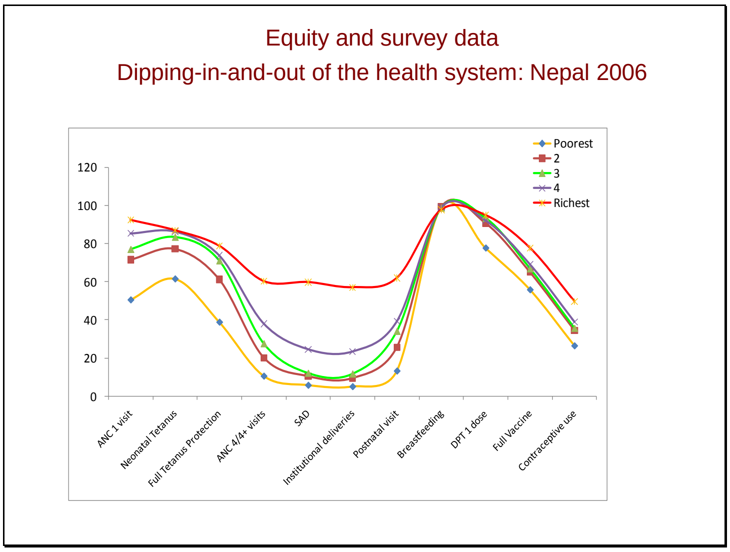

Figure 21. Equity and survey data
Dipping in-and-out of the health system: Nepal 2006.

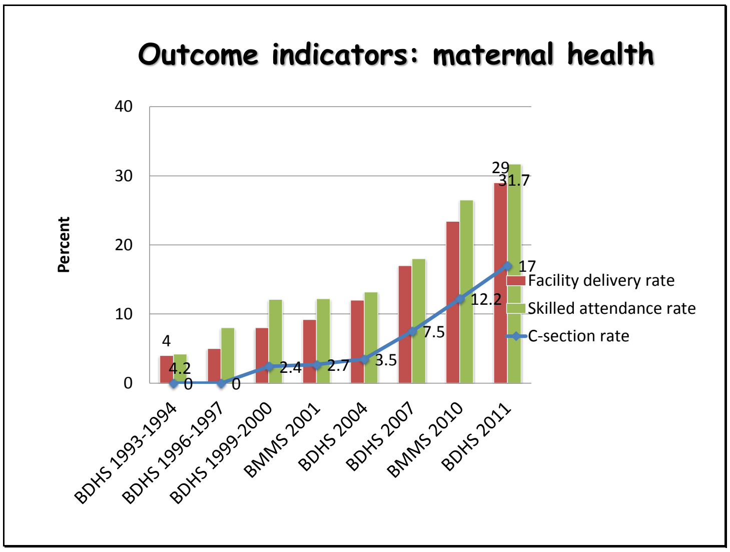

Figure 22. Outcome indicators: maternal health.

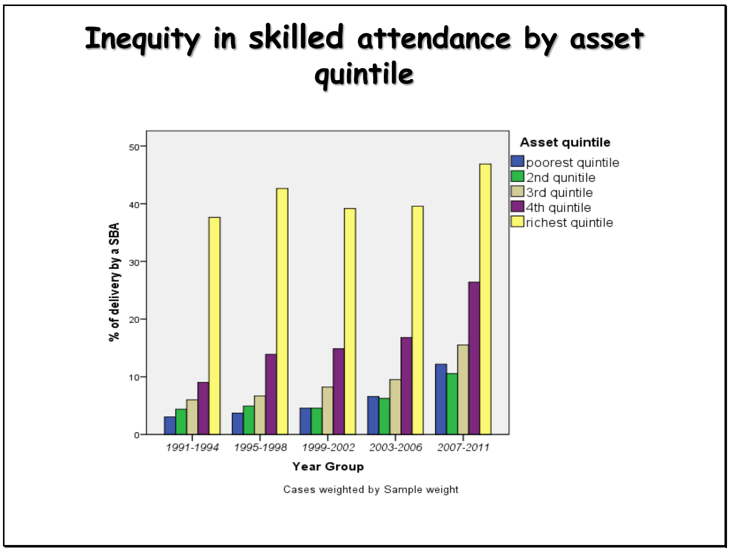

Figure 23. Inequity in skilled attendance by asset quintile.

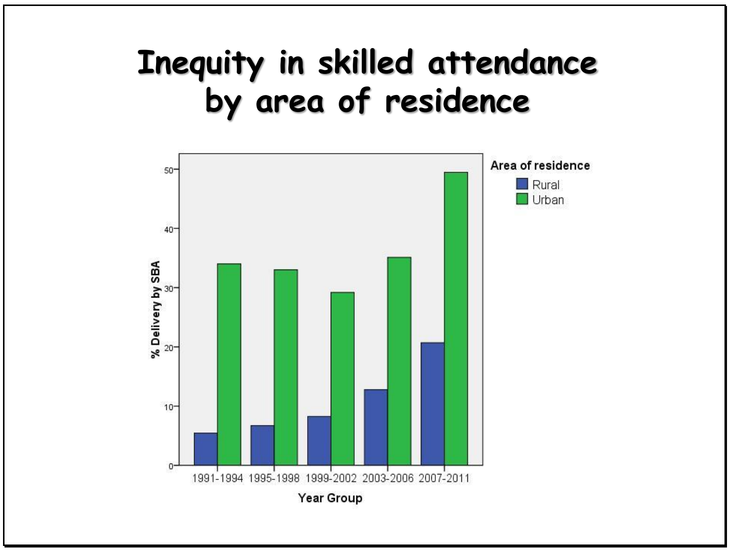

Figure 24. Inequity in skilled attendance by area of residence.

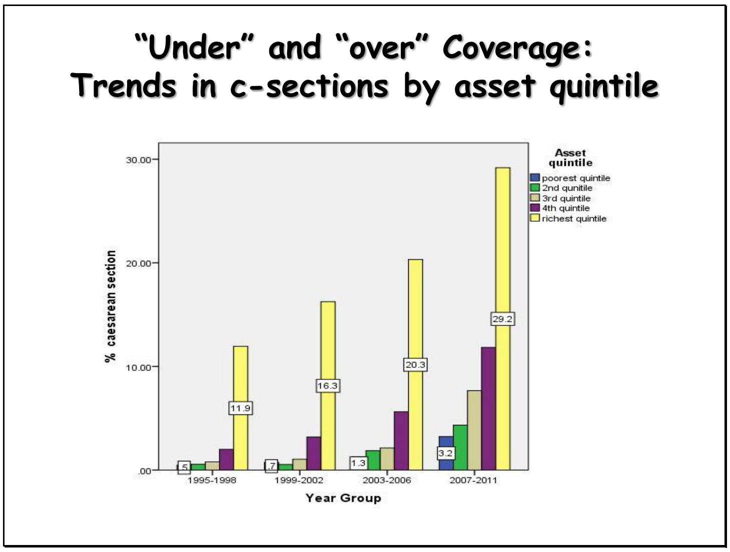

Figure 25. "Under" and "over" Coverage: Trends in C-section by asset quintile.

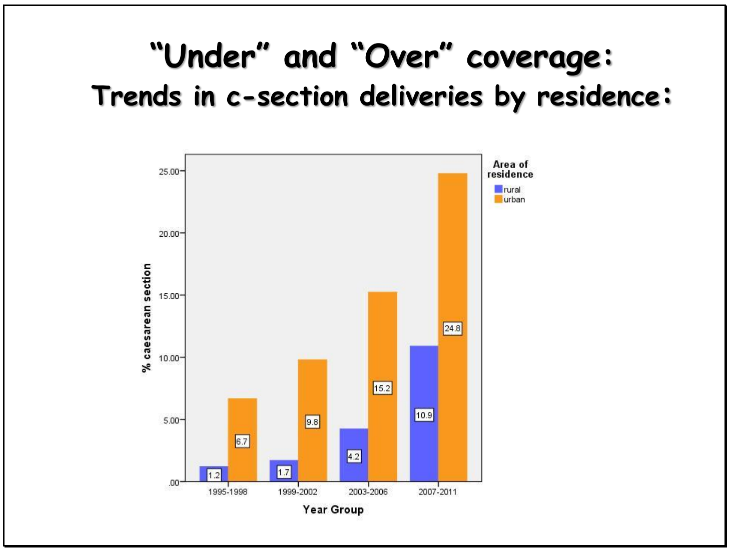

Figure 26. "Under" and "over" Coverage: Trends in C-section by residence.

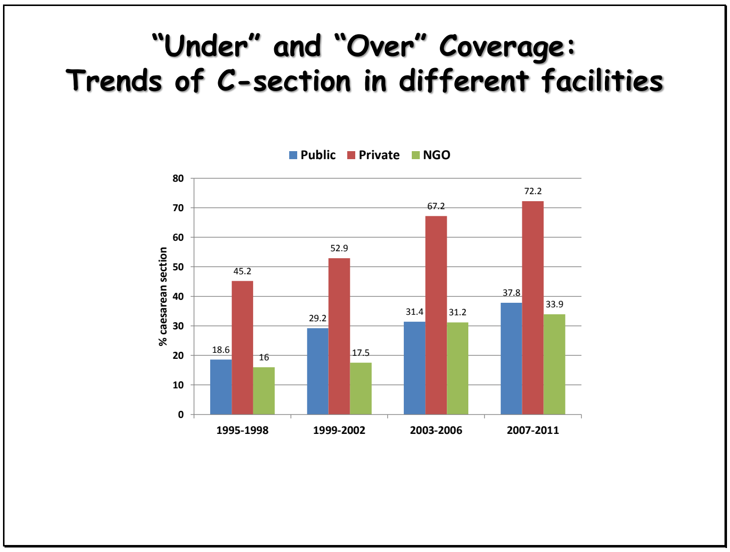

Figure 27. "Under" and "over" Coverage: Trends in C-section in different facilities.

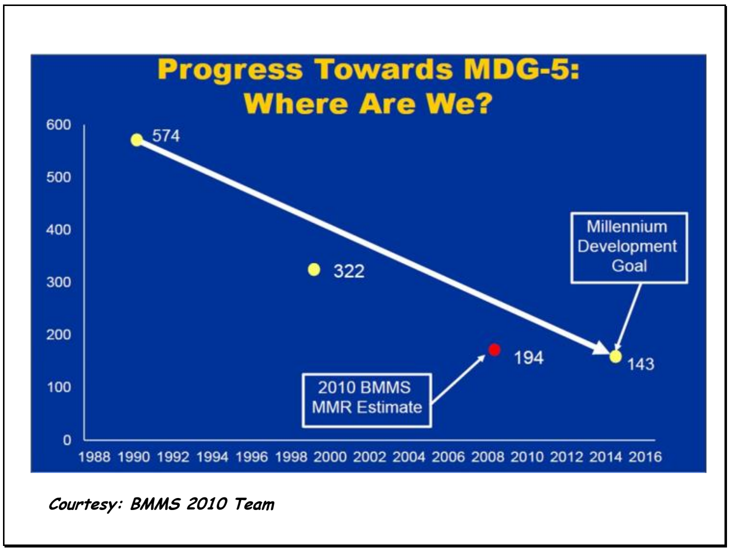

Figure 28. Progress Towards MDG-5: Where are we?

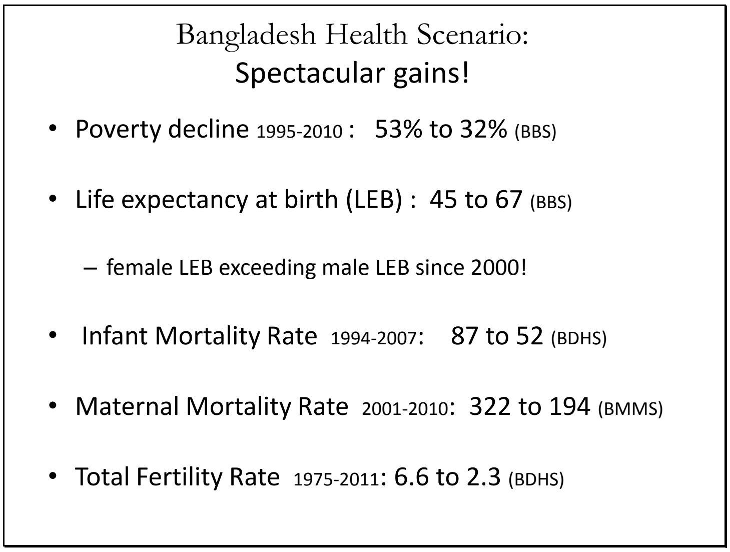

Figure 29. Bangladesh Health Scenario" Spectacular gains!

In this intro chapter, the concept of UHC is introduced and its link to poverty alleviation strategies explained. Next, the role of OOP in health expenditure and its consequences discussed and the need of some for of pre-payments emphasized. In this relation, the successful experiences of some countries such as Thailand detailed and its relevance for Bangladesh discussed.

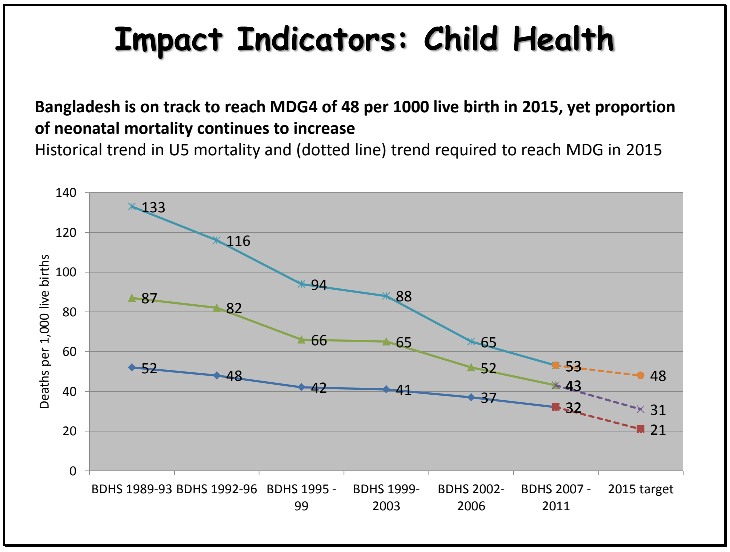

Figure 30. Impact Indicators: Child Health.

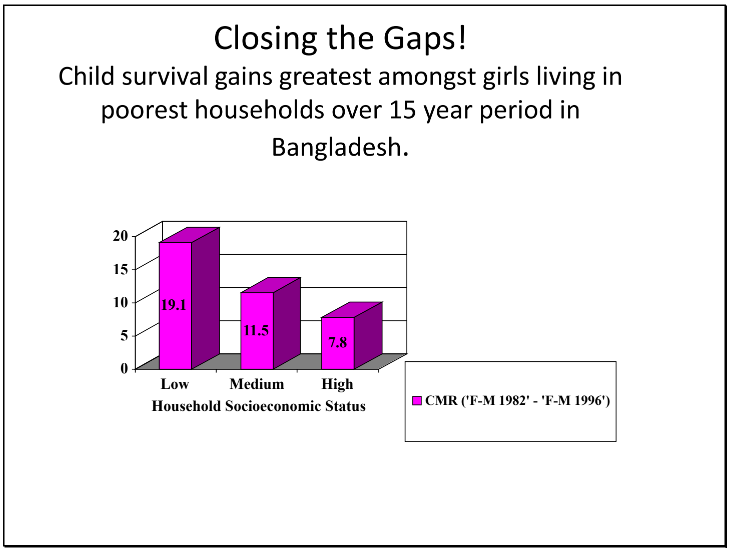

Figure 31. Closing the Gaps!

This is evidence of reversing the gradient. Greatest gains in child survival amongst girls in the lowest socioeconomic groups!
Not clear how this came about!!!

- MCH programs – universally accessible - problem of secularity.
- Broader investments in the empowerment of women such as education.

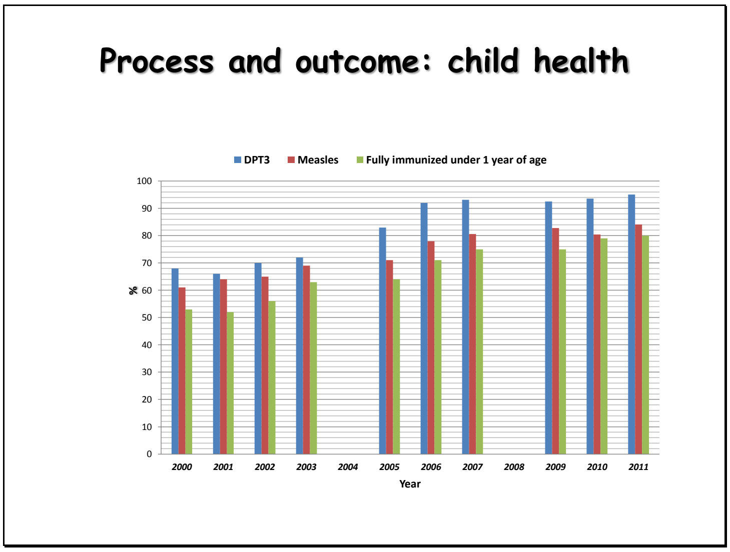

Figure 32. Process and outcome: child health.

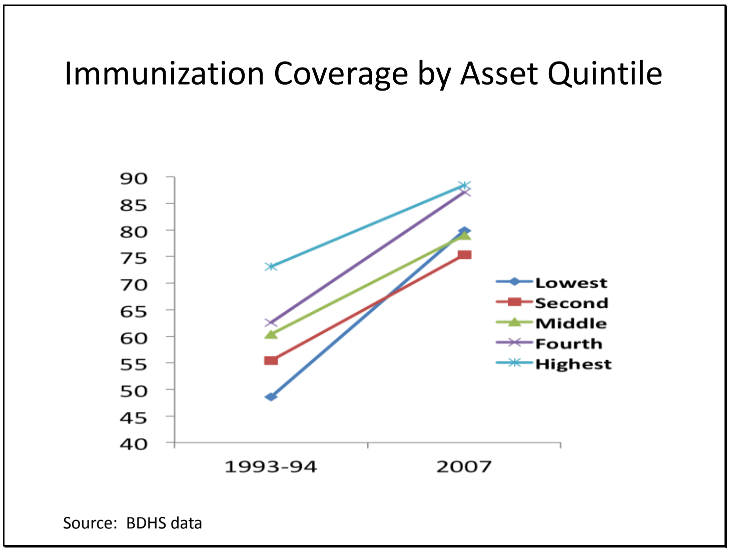

Figure 33. Immunization Coverage by Asset Quintile.

Universal Health Coverage

requires

Bridging the gaps!

Figure 34. Universal Health Coverage requires bridging the gaps.

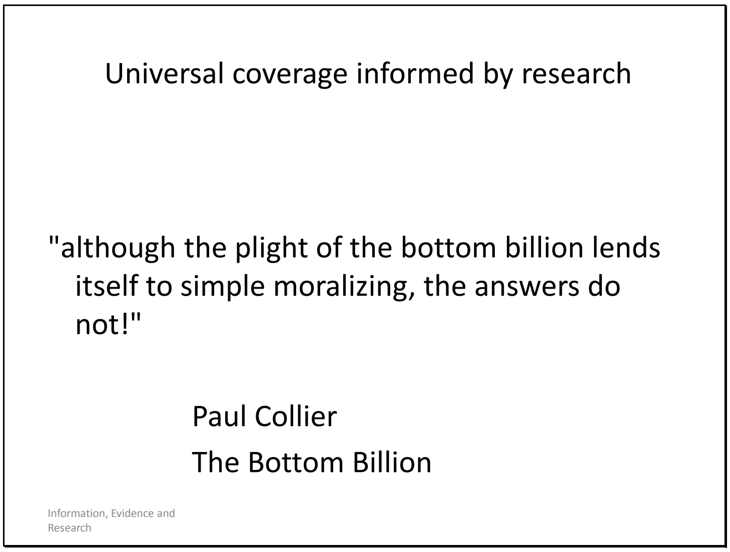

Figure 35. Universal coverage informed by research.

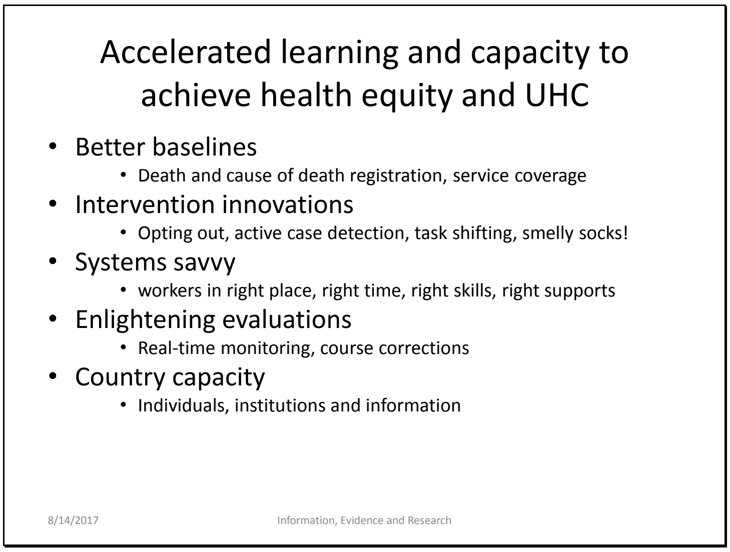

Figure 36. Accelerated learning and capacity to achieve health equity and UHC.

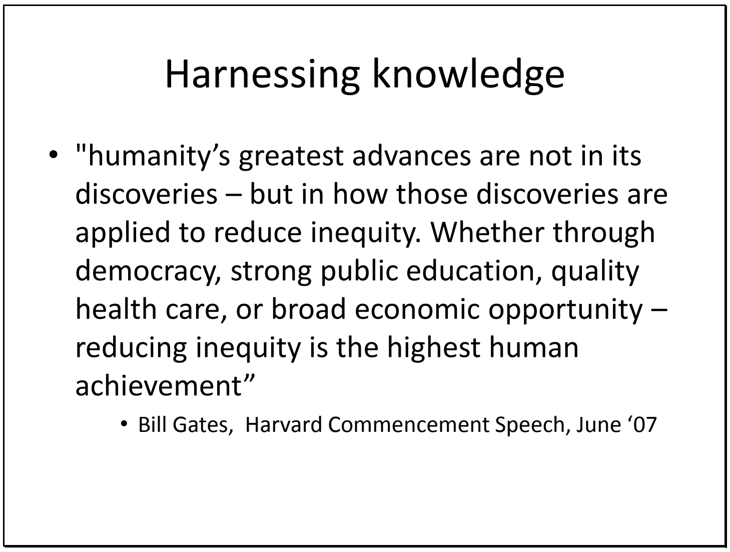

Figure 37. Harnessing Knowledge.

Quantitative Detection of Carcinogenic Polycyclic Aromatic Hydrocarbons in Wheat Crops Infected with Tilletia Caries.

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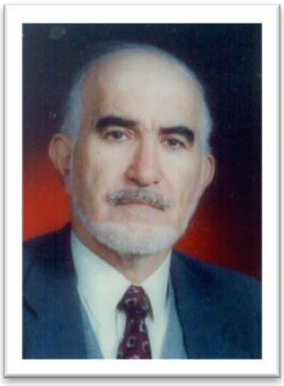
Department of Chemistry, College of Science
University of Baghdad
Jadiriya, Baghdad
Iraq

ABSTRACT



Wheat is the most important economic crop of the world. The annual world consumption of wheat is ca. 500-600Mi. tons. Prerequisite for wheat (and other harvesting crops such as barley, corn...etc.) consumption is the absence of harmful contaminations of the grain. This should be secured through adequate standard specifications. The international standard specifications of wheat and barley deal with the type of grain i.e. its humidity, odor, presence of smut…etc. Chemical consequences due to the smut presence are not mentioned. Accordingly, smutty wheat (or barley) is classified depending on the percent presence of smut kernels. The American specification distinguishes between two types of smut wheat: light smutty wheat and smutty wheat. The Canadian act defines the classes of wheat on the basis of the percent presence of smutty kernels. Smut and bunt of crops result from fungal infections causing spore formations in and around the grain as well as in its plant segments. It causes the "carbonization of the grain". The German word for such fungus is *Brandpilz*. Our chemical Analysis shows that smut wheat is heavily contaminated with carcinogenic polycylic aromatic hydrocarbons (PAH), the detected concentrations of which are far beyond the acceptable limit recognized internationaly (WHO). The results demand the alteration of standard specifications for wheat, and possibly for other crops, in order to exclude the presence of the carcinogenic PAH in the crops consumed by humans and livestocks. *Chemical analysis limits should be added to the physico-optical chriteria within the standard specification*.

Wheat is the most important economic crop of the world.

The annual world production of wheat is 500-600 Mi. Tons

Prerequisite for wheat consumption is the absence of harmful contaminations. This should be secured through adequate standard specifications of wheat.

Figure 1.

Examples for wheat specifications:
American Act.

GRAIN INSPECTION, PACKERS AND STOCKYARDS ADMINISTRATION
Technical Services Division January 2001
.
-CLASSES
Wheat is divided into eight classes based on color , kernel and varietal characteristics:

-Durum Wheat.
-Hard Red Spring Wheat.
-Hard Red Winter Wheat.
-Soft Red Winter Wheat.
Hard White Wheat

Figure 2.

U.S. WHEAT INSPECTION
-Soft White Wheat..
-Unclassed Wheat..
-Mixed Wheat
-SPECIAL GRADES
***Ergoty**
***Garlicky Wheat..**

***Infested Wheat.**

Light Smutty Wheat. Wheat that has an unmistakable odor of smut or which contains, in a 250-gram portion, smut balls, portions of smut balls, or spores of smut in excess of a quantity equal to 5 smut balls, but not in excess of a quantity equal to 30 smut balls of average size.

Smutty Wheat. Wheat that contains in a 250-gram portion, smut balls, portions of smut balls, or spores of smut in excess of a quantity equal to 30 smut balls of average size.

Figure 3.

- **WHEAT GRADING STEPS**

- **STEP 1. Examine the sample for heating, odor, animal filth, castor beans,**
- **crotalaria seeds, garlic, glass, insectinfestation, unknown foreign substances, and other unusual conditions.**
- **STEP 2. Determine the moisture content.**
- **STEP 3. Determine the percentage of dockage in the sample.**
- **STEP 4. Examine the dockage-free sample for ergot, smut, and stones.**
- **STEP 5. Determine the test weight per bushel of the dockage-free sample.**
- **STEP 6. Divide out a representative portion from the dockage-free sample and determine the percentage of shrunken and broken kernels (SHBN).**
- **STEP 7. Divide out representative portions from the SHBN-free sample and determine the percentage of class, contrasting classes, damaged kernels, heat-damaged kernels, foreign material, subclass, and wheat of other classes.**

Figure 4.

Canadian Act.

Economic Threshold

The maximum percentage of smutty barley kernels (true loose smut) permitted under the Canadian Seeds Act, July 1, 1987, are as follows:

	Maximum % of smutty barley kernels		
Canada Foundation #1	2		
Canada Foundation #2	4	Registered #1	2
Registered #2	4		
Certified #1	2		
Certified #2	4		
Common #1	4		
Common #2	6		

Figure 5.

In both cases, smut and bunt of wheat is regarded as degrading and unwanted property, but seemingly tolerable up to a definite amount. In some cases acceptable for living feedstock, and in some 3rd world countries for human consumption.

Figure 6.

The fishy odor from bunted wheat is detectable at less than 0.01 per cent thus rendering grain unsuitable for food even at this very low level of contamination.

Heavily smutted or bunted grain will not be accepted at the elevator and may even be difficult to sell as feed owing to respiratory or feed refusal problems that might result.
Smuts and bunts are not toxic to livestock.

How dangerous is smut and bunt of wheat ???.

Smut and bunt of crops result from fungal infections causing spore formations in and around the grain as well as in its plant segments.

It causes the "carbonization of the grain". (Brandpilz).

Figure 7.

Loose smut in wheat.

Figure 8.

Common bunt of wheat (Tilletia foetida) . Healthy head right diseased head left.
All the grain in the diseased head has been replaced with fishy smelling black bunt balls.

Figure 9.

- ***Toxicity and refused properties of smut wheat.***

  Loose smut in wheat

Figure 10.

Bunt of wheat. The bunt bulls or bunted grain release masses of black spores that contaminate healthy grain.

A 2 % bunt infestation because of the fishy smell and black soot colour can downgrade #1 wheat to sample

Figure 11.

True loose smut of barley infection of healthy embryo's (seeds) takes place at flowering.

Figure 12.

Figure 13.

Infected Areas reported: USA, Canada, Mexico, China, Nepal, India, Pakistan, Iran and newly, Iraq.

Treatment of partly infected grains does not ensure 100% removal of smut or bunt.

Use a hot water seed treatment for loose smut.

Dip seeds in 20 degrees Celsius water for 5 hours, drain and then dip in 49 degrees Celsius water for 1 minute, then 52 degrees Celsius water for exactly 11 minutes, then immediately in cold water until seeds cool off. Some seed may be killed by hot water treatment.

In 2002 heavily infected wheat harvest appeared in the fields of north and northwest of Iraq.

Figure 14.

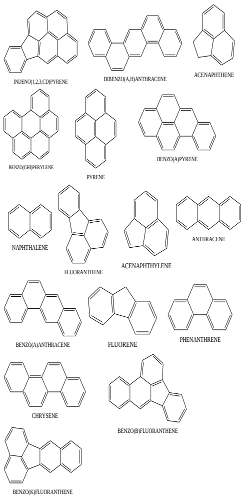
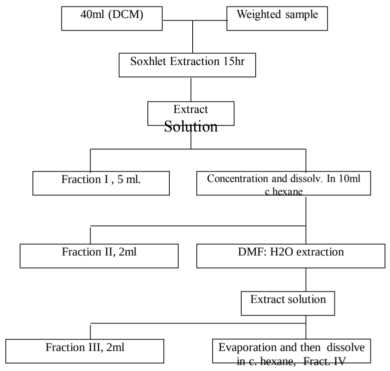


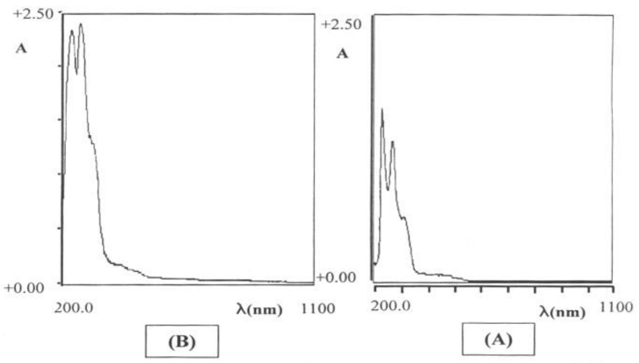
Figure 15.

Figure 16.



Extraction Flow Chart of PAH's from Infected Wheat with Tilletia Fungus

Figure 17.



(شكل 3): طيف الامتصاص الجزيئي لمقطعي الاستخلاص II_{a1}, I_{a1} الناتجين عن استخلاص الحنطة السوداء المصابة، بالمذيب ثنائي كلورو ميثان (I) (A) واعادة اذابة المستخلص بالهكسان الحلقي (II) (B).

Figure 18.

.Polyaromatic Compounds isolated from Infected Wheat

No.	Compound	R_t (standard) (min)	R_t (Test) (min)
1	Naphthalene.	11.73	11.68
2	Acenaphthylene.	14.04	14.17
3	Acenaphthene	16.16	16.13
4	Fluorene.	16.98	16.55
5	Phenanthrene.	18.31	18.21
6	Anthracene.	19.5	20.4
7	Fluoranthene.	20.92	20.27
8	Pyrene.	21.73	21.82
9	Benzo(a) pyrene.	29.29	29.58
10	Dibenzo(a,h) anthracene.	32.1	32.18
11	Benzo(ghi) Perylene,	32.68	32.76
12	Indeno (1, 2, 3, cd) pyrene	33.44	33.45

Figure 19.

HPLC Chromatogram of the Extract Solutions of Smut Wheat Infected

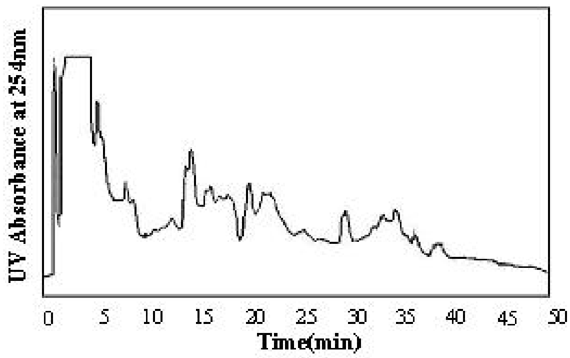


Figure 20.

Concentrations of the PAH's found in the Extracts of Infected Smut Wheat

No.	Compound	Concentration (ppm)
1	Naphthalene.	3.40
2	Acenaphthylene.	14.03
3	Acenaphthene.	8.60
4	Fluorene.	3.00
5	Phenanthrene.	0.20
6	Anthracene.	0.30
7	Fluoranthene.	1.40
8	Pyrene.	1.50
9	Benzo(a) Pyrene.	0.08
10	Dibenzo (a,h) anthracene	0.20
11	Benzo (ghi) perylene. Total	0.70

Figure 21.

Conclusions

The presence of the carcinogenic PAH's in smut wheat requires the <u>introduction of new standards for grain specifications based on the chemical analysis of the crops to be consumed</u> .Many consuming countries, particularly of the developing area, tolerate infected wheat which includes high concentrations of smut grains, 0.1 – 0.3%. Such concentrations are seen, on the basis of simple arithmetic, to have higher contaminations of carcinogenic PAH's , as allowed by the envorimental standards. Similar considerations should apply for other grain crops, e.g. oat, barlin, corn etc.

Figure 22.

The International Centre for Chemical and Biological Sciences: An *Example of the R&D Value-Chain*

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and
ATTA-UR-RAHMAN FIAS
International Center for Chemical and Biological Sciences (H. E. J. Research Institute of Chemistry, Dr. Panjwani Center for Molecular Medicine and Drug Research)
University of Karachi, Karachi-75270
Pakistan

ABSTRACT

The designing of drugs is a process for developing new pharmaceuticals. It combines the quest for a scientific understanding of natural phenomena with the use of technology and integrates epistemic and practical aims of research and development. Rational drug design became possible in the 1950s when theoretical knowledge of drug–target interaction and experimental drug testing were employed in combination which resulted into major advancement.

Despite major increase in investment in research and development, there has been a steady decline in the number of drugs brought to market over past 40 years. This has had serious impact in developing world. Today the developing world is not only facing food security but also drug insecurity challenges. The current drug development paradigm is cost, time and labor intensive, in which developing country cannot afford to invest. There is therefore a need of appropriate, efficient and cost effective strategies for drug development, based on indigenous knowledge, S&T capacity and people-friendly drug approval process.

The International Center for Chemical and Biological Sciences (ICCBS) is involved in the discovery of drug like entities and in accelerating new discoveries into potential therapies for improving human health. Its drug discovery capabilities are built around interdisciplinary team of scientists and world-class infrastructure especially suited for innovative, multidisciplinary, and collaborative research. Researchers at the ICCBS use state-of-the-art protocols for identifying therapeutic targets, and lead compounds. The ICCBS also serves as a think-tank to brainstorm ways to gain efficiencies and productivity in early drug discovery research and to improve the process of technology transfer. The ICCBS has recently developed two drug candidates for the treatment of epilepsy and leishmaniasis, which are in clinical trials. Based on the epidemiology, we screened a large number of medicinal plants used for the treatment of epilepsy in isolated valleys of Pakistan. As a result of this long and systematic search, two potent antiepileptic constituents, isoxylitones A and B, along with their precursors, were isolated from *Delphinium denudatum* and *Aconitum lavae*. These studies have resulted in the identification of several classes of novel pharmacophores, which were then used to develop libraries of analogues to study their structure-activity relationship.

Similarly due to high prevalence of leishmaniasis in our region and associated morbidity, we conducted a systemic study on folk medicines used against leishmaniasis in Pakistan. We have isolated antileishmanial agents of natural origin and conducted *in vitro* screening as well as animal toxicity assays. We also conducted human clinical trials on leishmaniasis patients by applying topical applications of new ointment based formulations. A total of 110 patients were recruited with clinical leishmaniasis, diagnosed by smear examination on lesions. The results of this clinical study unambiguously established the efficacy, safety and cost

effectiveness of the *Physalis minima* extracts-based topical gel against cutaneous leishmaniasis.

During this presentation, underlying philosophy and approach of our research on cost-effective discovery of lead molecules at the International Center for Chemical and Biological Sciences will be discussed. The presentation will also highlight the capacity (human resources and infrastructure) of the ICCBS in the field of drug discovery and development.

Establishment of a World Class Research Institute in a Developing Country: The HEJ Experience

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International Center for Chemical and Biological Sciences (H. E. J. Research Institute of Chemistry, Dr. Panjwani Center for Molecular Medicine and Drug Research)
University of Karachi, Karachi-75270
Pakistan

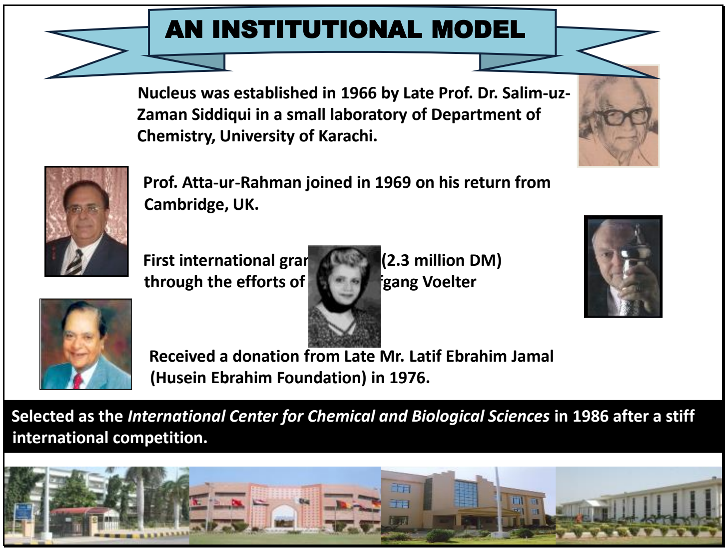

Figure 1. An Institutional Model.

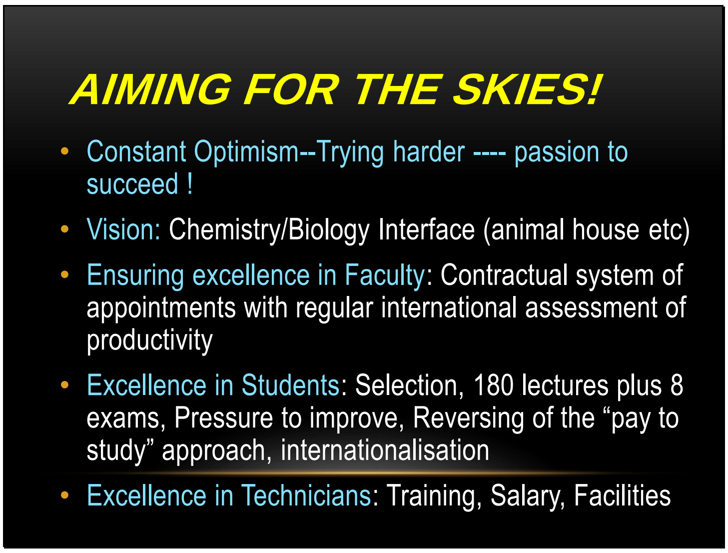

Figure 2. Aiming for the Skies.

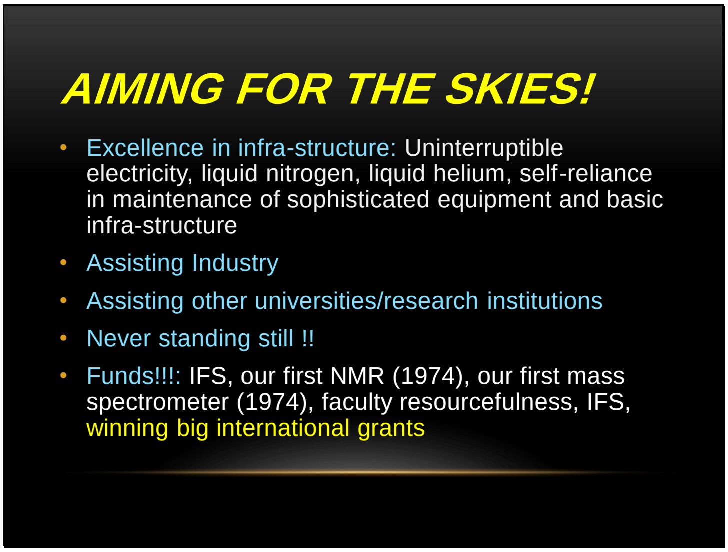

Figure 3. Aiming for the Skies.

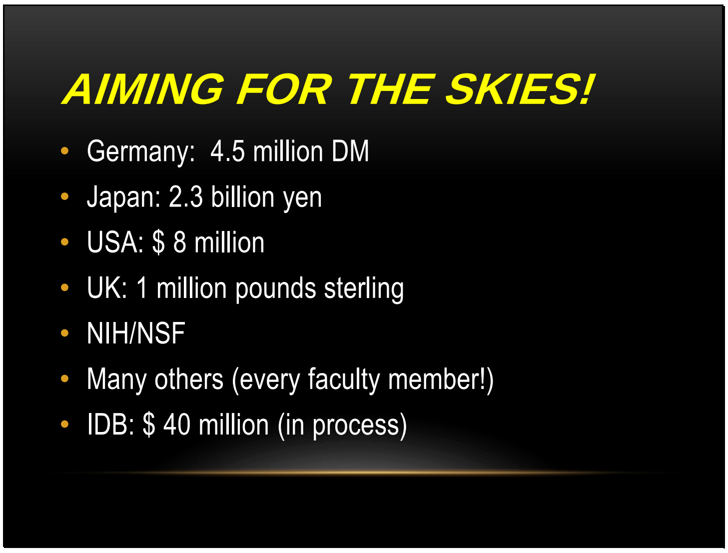

Figure 4. Aiming for the Skies.

Figure 5.

Figure 6.

GOOD RESEARCH OUTPUT

✶ Research publications in top international journals:	Over 4,500
Patents (national and international)	130
✶ Books published internationally (117 by Prof. Atta-ur-Rahman):	180
✶ Total scientific impact factor:	Over 7,500
✶ Total Ph.D.'s produced:	Over 500
✶ Total Citations	Over 25,000

Figure 7. Good Research Output.

US Patents (2012)

Method of Producing Tibolone Metabolites by Fermentation with *Gibberella fujikuroi,* Atta-ur-Rahman, Muhammad Iqbal Choudhary, Syed Adnan Ali Shah, Shamsun Nahar Khan, United States Patent 8148557, Application Number:13/015559, Publication Date: 04/03/2012.	USA
Method of Producing Tibolone Metabolites by Fermentation with *Fusarium lini*, Atta-ur-Rahman, Muhammad Iqbal Choudhary, Syed Adnan Ali Shah, Shamsun Nahar Khan, United States Patent 8148558 , Application Number, 13/015554, publication Date, 04/03/2012.	USA
Anti-inflammatory Compounds, Saif Ullah, Saifullah Khan, Muhammad Ahmed Mesaik, Zaheerul Haq, Almas Jabeen, S. A. Halim, Muhammad Iqbal Choudhary, United States Patent 8329678 , 13/184551 Date of Patent December 11, 2012	USA
Formulations Against Cutaneous Leishmaniasis, Atta-ur-Rahman, Muhammad Iqbal Choudhary, Sammer Yousuf,, Samreen Khan, Farooq Rahman Soomro, Shahida Perveen, United States Patent 8287921, Application Number, 13/189509, Publication Date, 10/16/2012.	USA
Method of Producing Tibolone Metabolites by Fermentation with *Rhizopus stolonifer* Atta-ur-Rahman, Muhammad Iqbal Choudhary, Syed Adnan Ali Shah, Shamsun Nahar Khan, United States Patent 8148556, Application Number, 13/015551, Publication Date, 04/03/2012.	USA
Method of Producing Tibolone Metabolites by Fermentation with *Cunninghamella elegans*, Atta-ur-Rahman, Muhammad Iqbal Choudhary, Syed Adnan Ali Shah, Shamsun Nahar Khan, United States Patent 8198041, Application Number, 13/015553, Publication Date, 06/12/2012.	USA
7-Nitro-2-(3-nitro phenyl)-4H-3,1-benzoxazin-4-one or Derivatives Thereof for Treating or Preventing Antiviral Infections, Shaikh Riazuddin, Atta-ur Rahman, Usman Zafar, Muhammad Iqbal Choudhary, Usman Ali Ashfaq, Khalid M Khan, Tayyab Husnain, Zulfiqar Ali Khan, Javed Akram, United States Patent 8148368, Application Number, 2/876999 Publication Date,04/03/2012.	USA
Novel Hydroxylated Enantiomers of (-) 3A, 6,6,9A-Tetramethylperhydronaphtho[2,1-B]furan as Perfuming Agents Derived from a Fungal Fermentation Process, Atta-ur-Rahman, Muhammad Iqbal Choudhary, Syed Ghulam Musharraf, Amtul Sami, United States Patent US 2012/0301956 A1, Publication date: November 29, 2012	USA
	USA

Figure 8. US Patents (2012).

Figure 9.

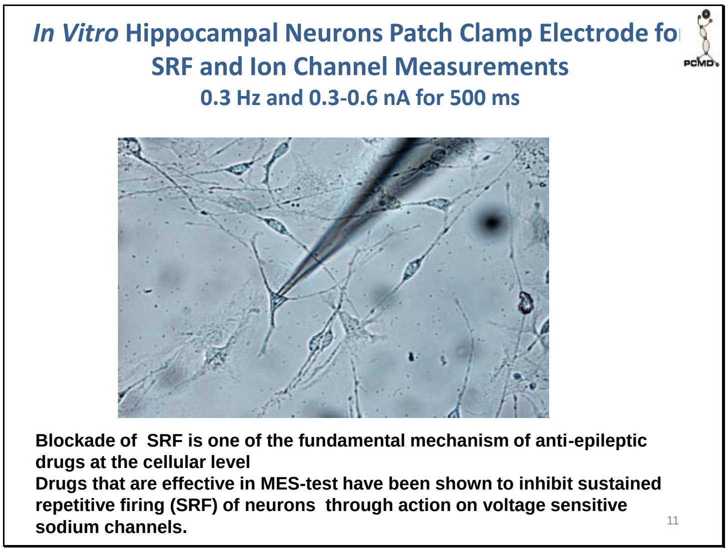

Figure 10.

Figure 11.

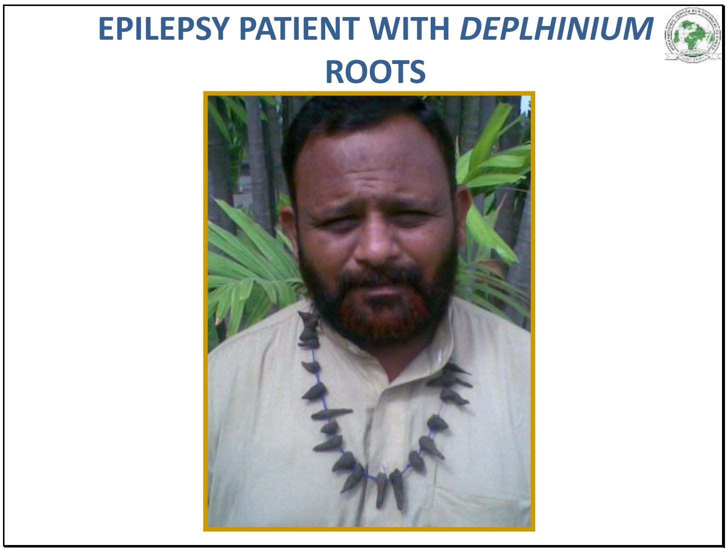

Figure 12.

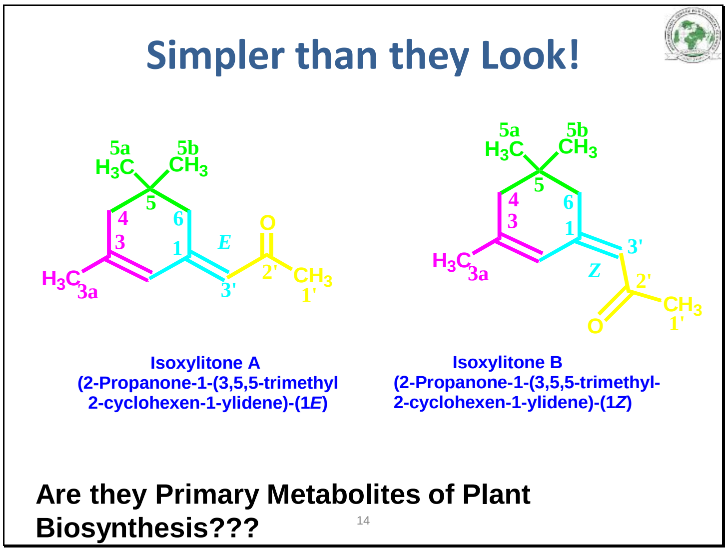

Figure 13. Simpler than they look.

PATENT

- Title:
- New Anticonvulsant Compounds
- Publication Date: 15/07/2008
- Document Type and Number: *United States Patent 7399888*

- Abstract:
- The invention relates to novel isoxylitones and their use as anticonvulsant and in the treatment of a variety of disorders
- Application Number: 11/307251
- Filing Date: 07/01/2006

15

Figure 14. Patent.

Figure 15. Clinical Trials.

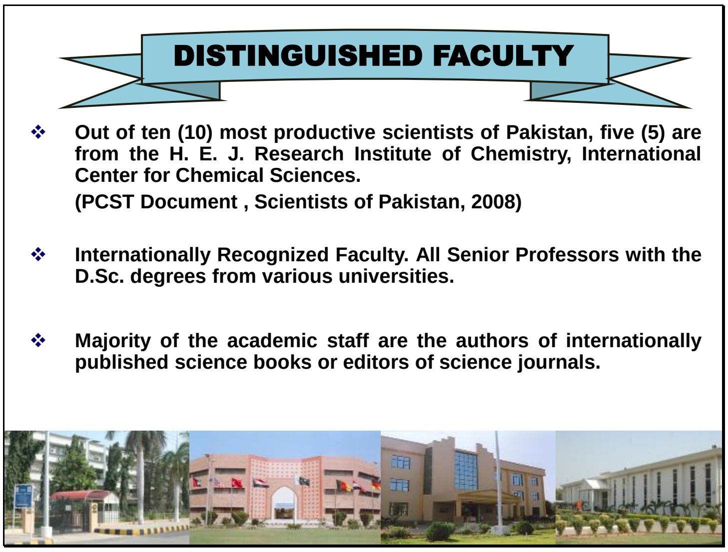

Figure 16. Distinguished Faculty.

MOST DECORATED ACADEMIC SCIENCE INSTITUTION

❖ Fellow of Royal Society (*FRS*)	1
❖ UNESCO Science Prize	1
❖ D. Sc.	8
❖ Khawarizmi International Award	5
❖ ECO Award and Prize	2
❖ Nishan-e-Imtiaz	1
❖ Hilal-e-Imtiaz	4
❖ Sitara-e-Imtiaz	11
❖ President's Pride of Performance	1
❖ Tamgha-e-Imtiaz	8

Figure 17. Most Decorated Academic Science Institutions.

DR. PANJWANI CENTER FOR MOLECULAR MEDICINE

- Established in 2004 by Dr. Muhammad Husein Panjwani Memorial Trust
- An endowment of US $ 1 million was created
- Focused areas include molecular immunology, stem cell research, diabetes, neurophmacology, enzymology, computational medicinal chemistry, structural biology, molecular oncology, tissue culture, etc
- Diagnostic and Clinical Research facility was established as service wing

Figure 18. Dr. Panjwani Center for Molecular Medicine.

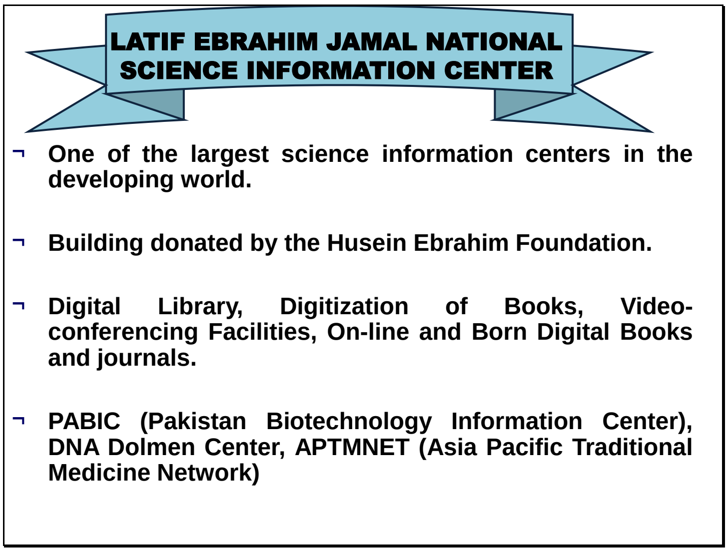

Figure 19. Latif Ebrahim Jamal National Science Information Center,

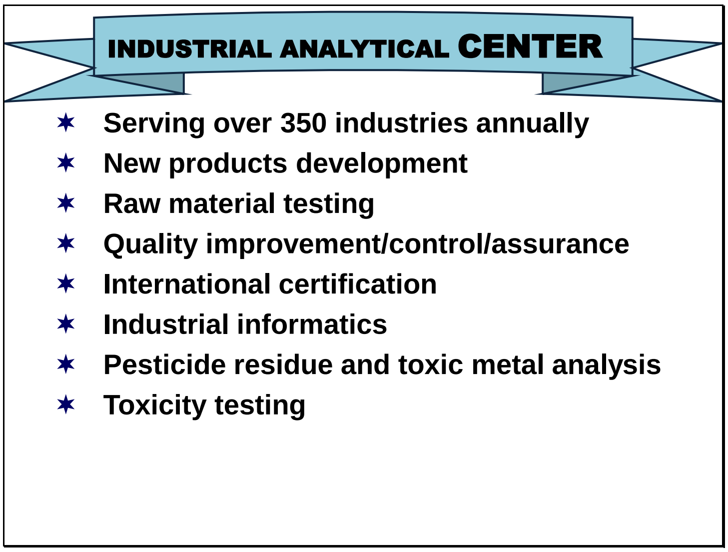

Figure 20. Industrial Analytical Center,

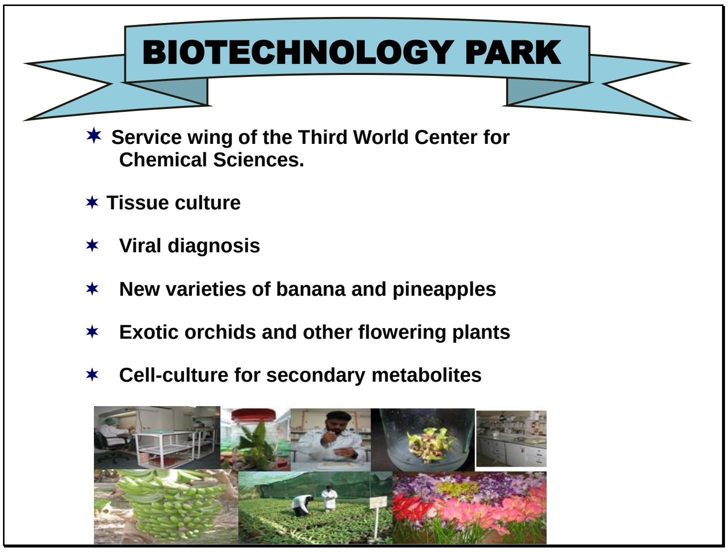

Figure 21. Biotechnology Park.

Figure 22. Prof. Dr. M. Iqbal Choudhary.

ICCBS- UNIQUE FEATURES

- Role of leadership (Salimuzzaman Siddiqui, Atta-ur-Rahman, Iqbal Choudhary).
- Role of private sector.
- Contractual appointment of faculty members.
  International evaluation of research productivity.
- Good salaries and grades to engineering staff.
- Strong international linkages.
- Well subscribed library system and other information sources.
- More funds for R&D (70% of the annual budget).
- Institution whichs invite and facilitates external review.

Figure 23. ICCBS-Unique Features.

<u>REMARKS OF Prof. Herbert C. Brown</u>
Nobel Laureate
R. B. Wetherill Professor of Chemistry
USA

" Under (Prof. ----------------'s) able guidance, this Institute has become one of the finest in the world, in terms of the facilities, the quality of work and the scientists that it produces".

Figure 24. Remarks of Prof. Herbert C. Brown.

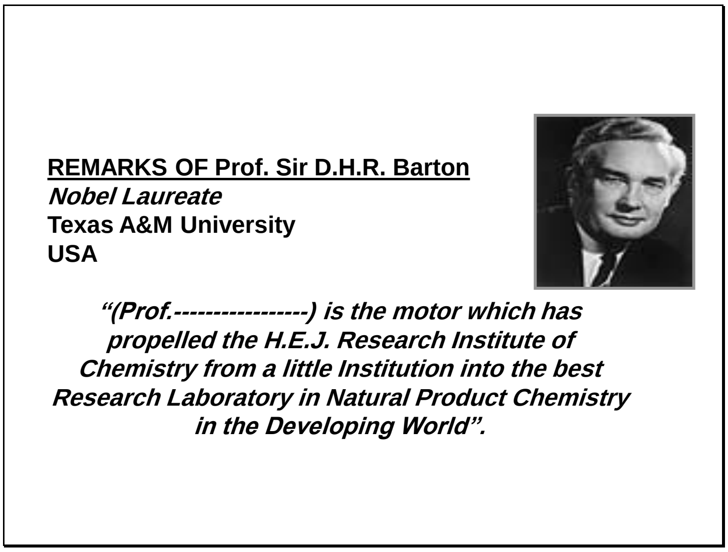

Figure 25. Remarks of Prof. Sir D.H.R. Barton.

Figure 26. HEJ Research Institute of Chemistry.

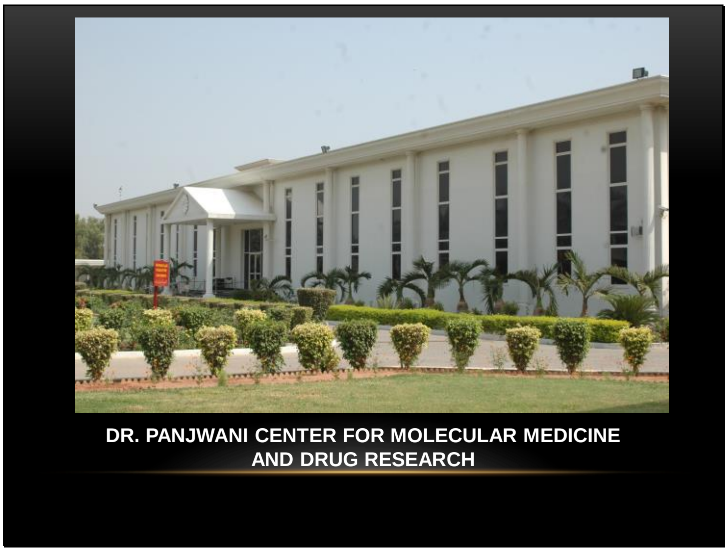

Figure 27. Dr Panjwani Center for Molecular Medicine and Drug Research.

**Figure 28. Prof. Dr Atta-ur-Rahman Laboratories
Third World Center Chemical Sciences.**

Figure 29. Latif Ebrahim Jamal National Science Information Center One of the Largest Paperless Libraries with 31,000 On-line Journals.

Figure 30. HEJRIC New Research Laboratory.

Figure 31. Industrial Analytical Center (IAC).

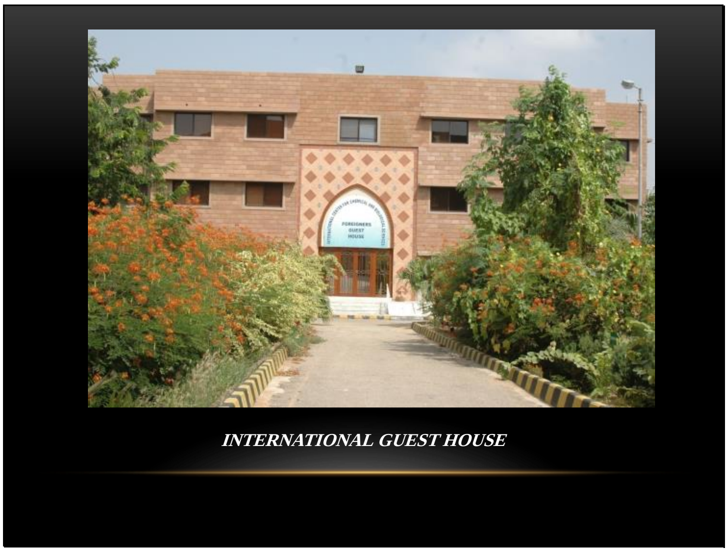

Figure 32. International Guest House.

Figure 33. Tissue Culture Technology Park.

Figure 34. Center for Bioequivalence Studies and Bioassay Research.

Figure 35. MALDI-TOF (Ultra-flex-III).

Figure 36. Single-Crystal X-Ray Diffraction Laboratory.

Figure 37. Nuclear Magnetic Resonance Spectrometers.

Figure 38. Nuclear Magnetic Resonance Spectrometers.

Figure 39. Mass Spectrometer (Electron Bombardment System).

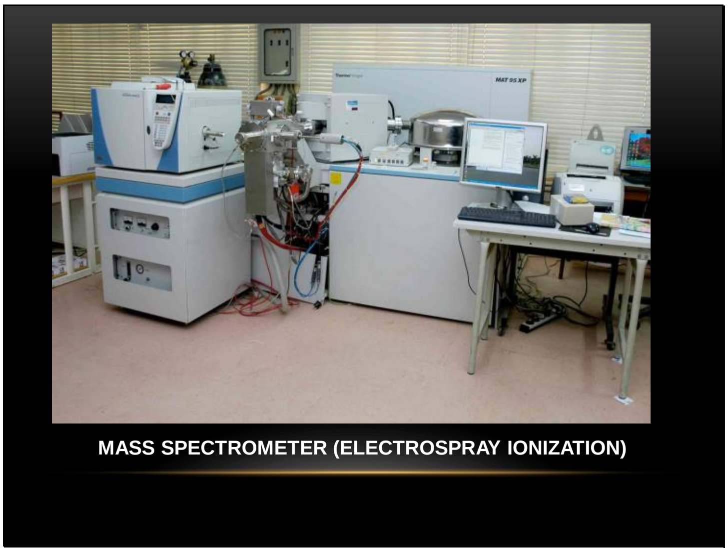

Figure 40. Mass Spectrometer (Electrospray Ionization).

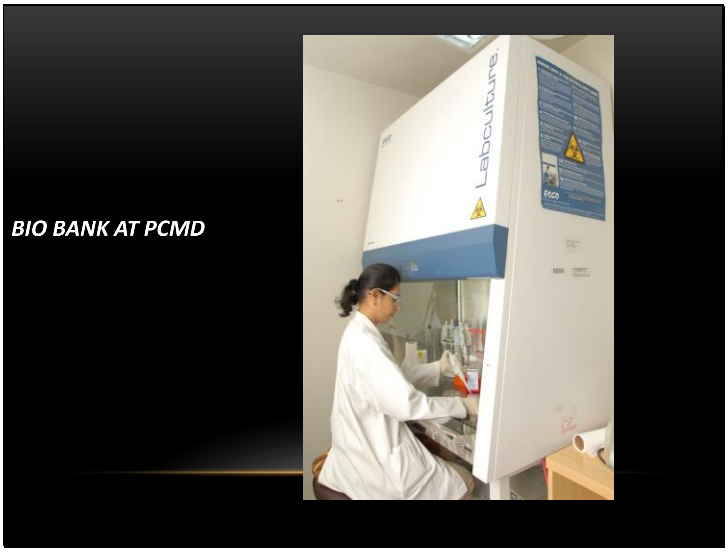

Figure 41. Bio Bank at PCMD.

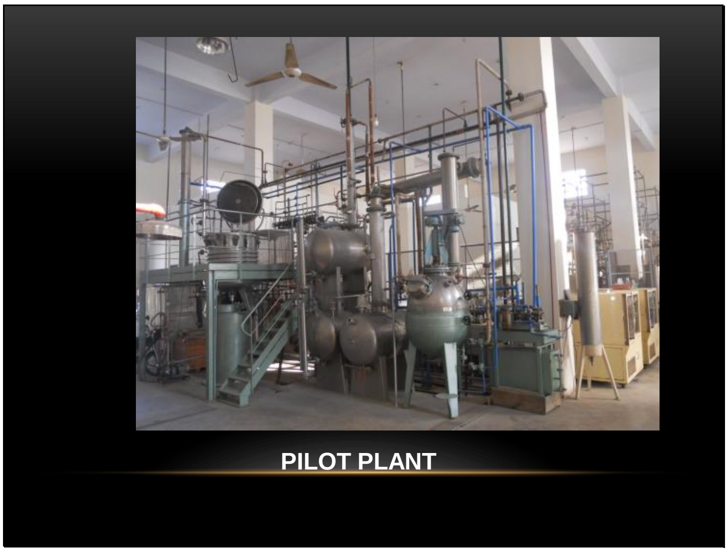

Figure 42. Pilot Plant.

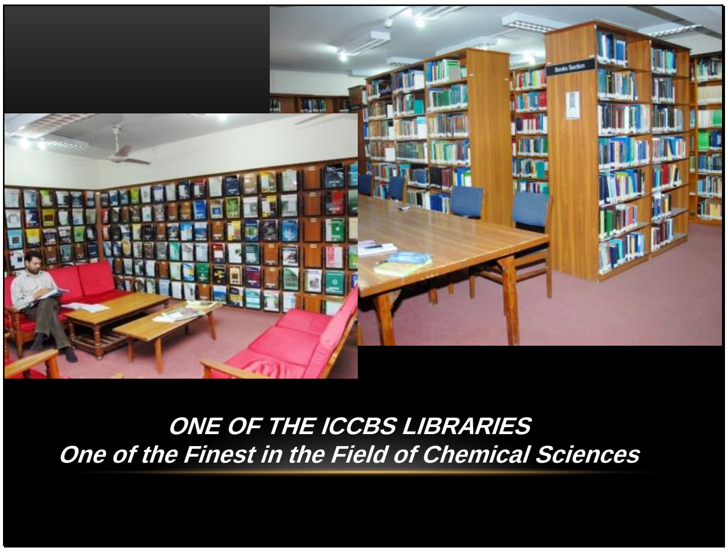

Figure 43. One of the ICCBS Libraries
One of the Finest in the Field of Chemical Sciences.

Figure 44. UPLC.

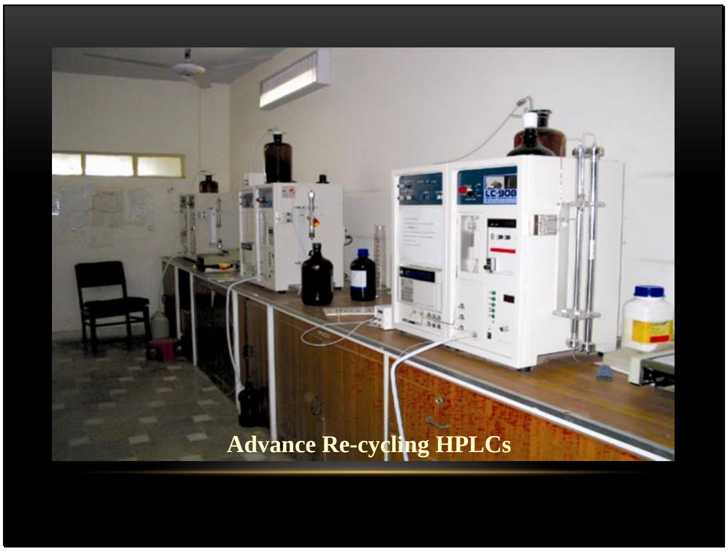

Figure 45. Advance Recycling HPLCs.

Figure 46.

Figure 47. Plant Biotechnology Division.

Figure 48. Plant Biotechnology Division.

Figure 49. Compound Bank at the PCMD.

Figure 50. Compound Bank at the PCMD.

Figure 51. Diagnostic Laboratory at the PCMD.

Figure 52. Patch Clamp Facility PCMD.

Figure 53. Tissue Culture Facility at the PCMD.

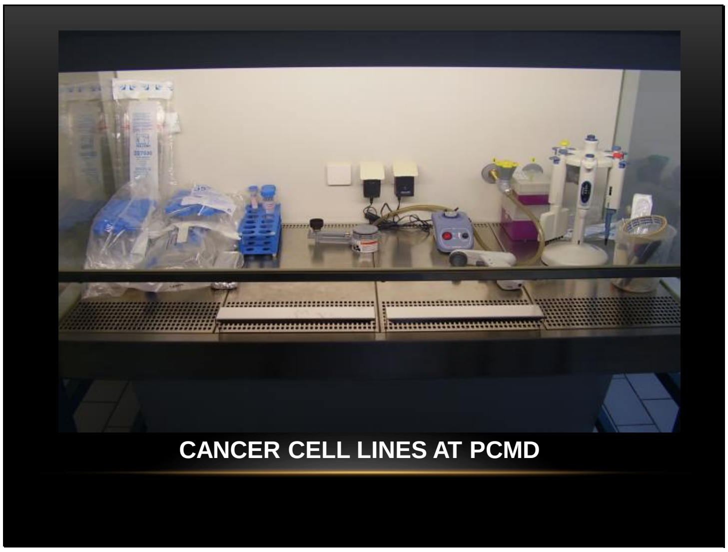

Figure 54. Cancer Cell Lines at PCMD.

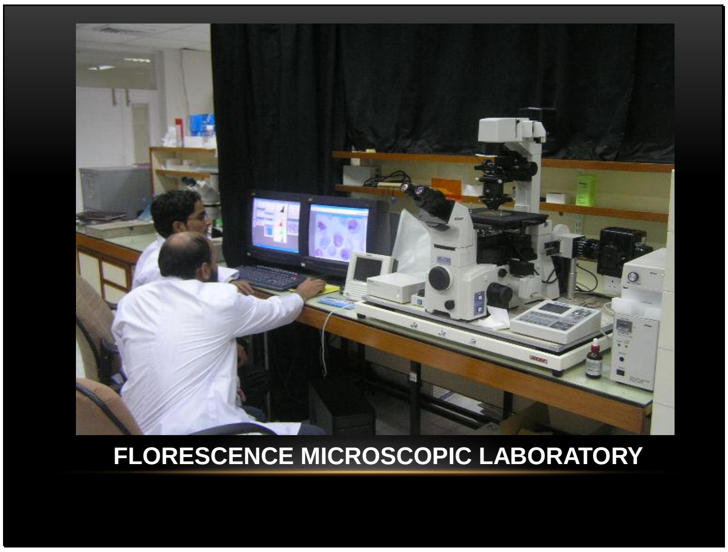

Figure 55. Florescence Microscopic Laboratory.

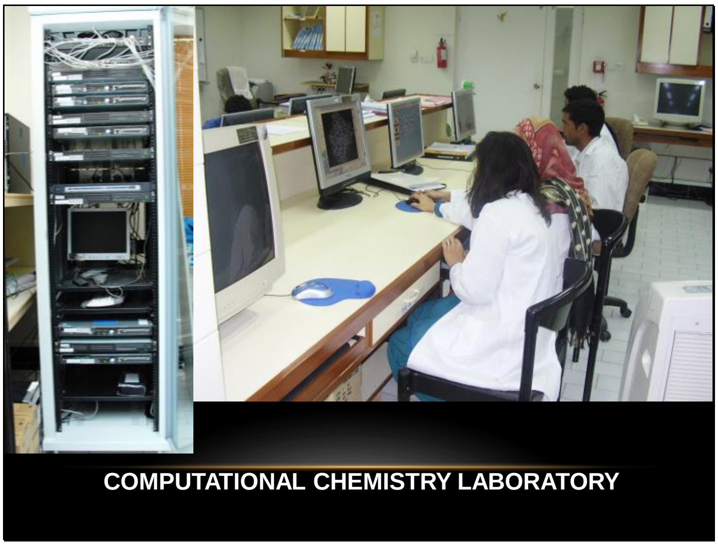

Figure 56. Computational Chemistry Laboratory.

Figure 57. Immunology Laboratory.

Figure 58. Neuropharmacology Laboratory.

Figure 59. Pharmacology Laboratory.

Figure 60. Stem Cell Research Laboratory.

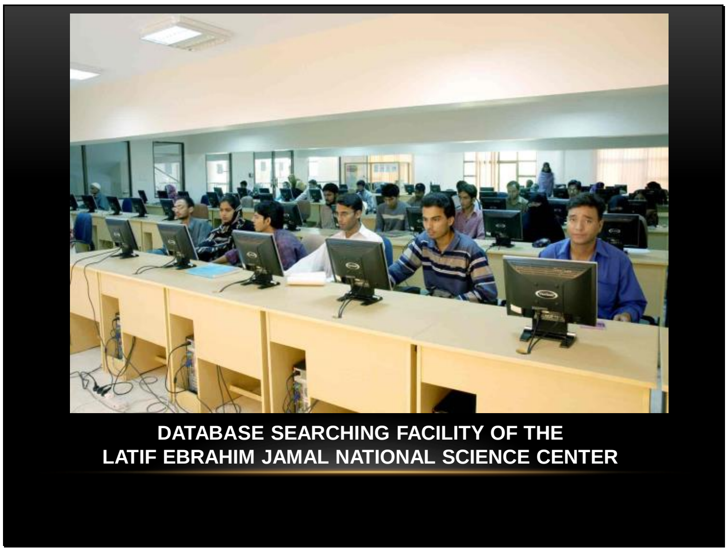

Figure 61. Database Searching Facility of the Latif Ebrahim National Science Center.

Figure 62. video Conferencing of the Latif Ebrahim Jamal National Science Center.

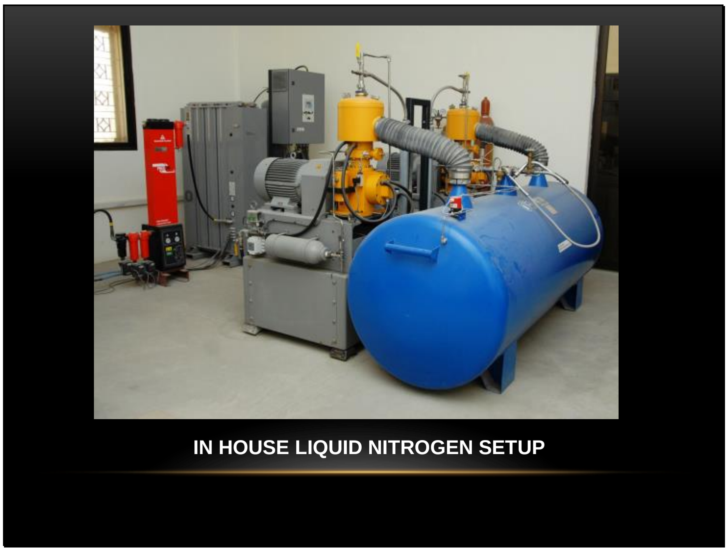

Figure 63. In House Liquid Nitrogen Setup.

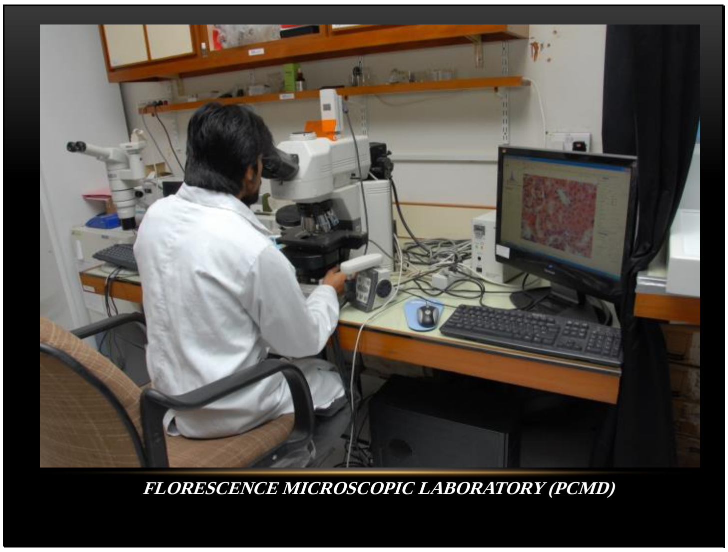

Figure 64. Florescence Microscopic Laboratory (PCMD).

Figure 65. Pictures of Some German Students Visiting the Institute.

Figure 66. ISO 17025 and 9001: 2000 Certified Industrial Analytical Center (IAC) is serving over 350 industries in Pakistan.

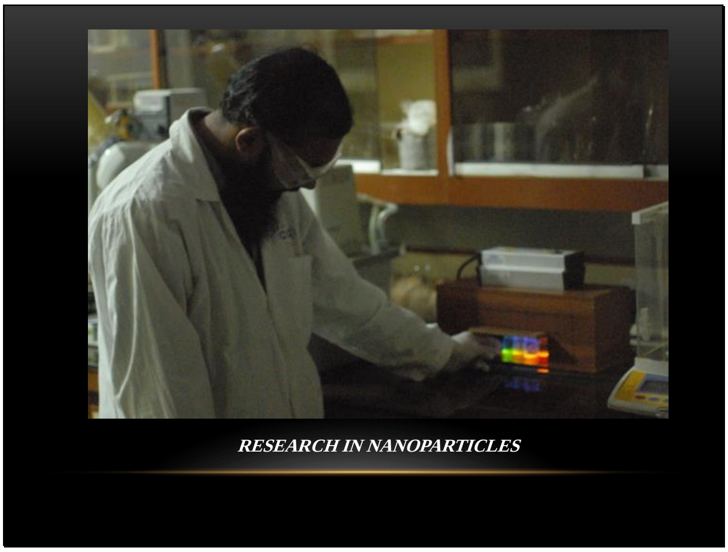

Figure 67. Research in Nanoparticles.

Figure 68. Inauguration of Jamil-Ur-Rahman Center for Genomic Research.

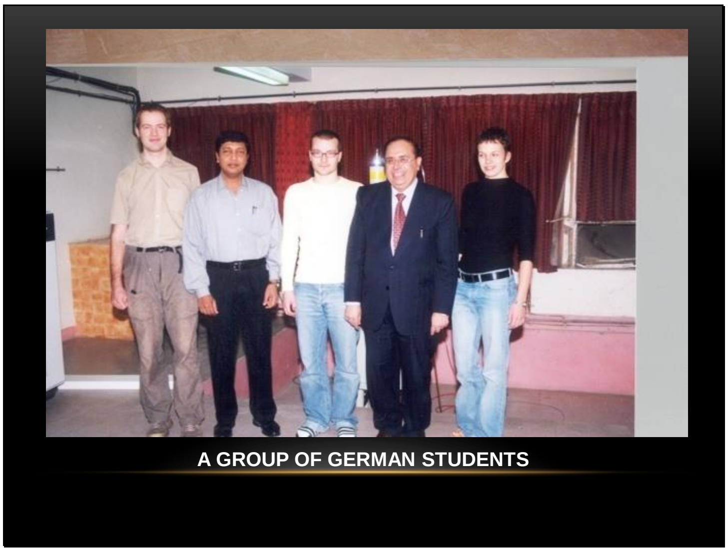

Figure 69. A Group of German Students.

Figure 70. Foreign Faculty and Students.

Figure 71. ICCBS Group Photograph, 2011.

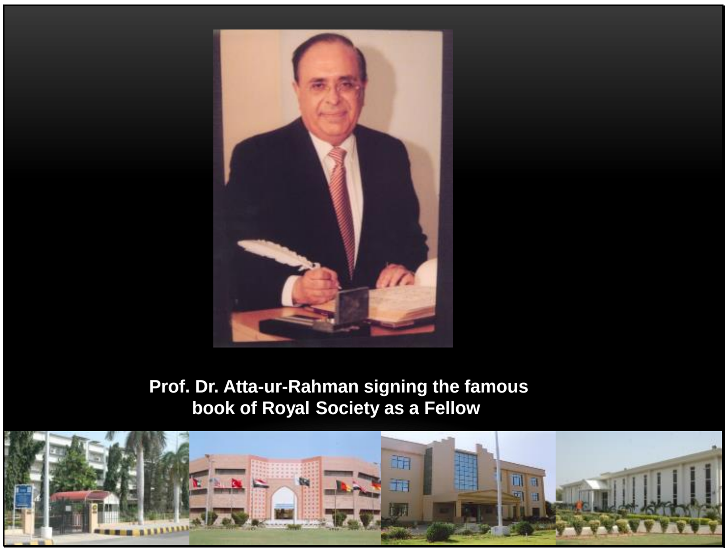

Figure 72. Prof. Dr Atta-ur-Rahman signing the famous book of Royal Society as a Fellow.

A Drug Discovery and Development Plan for the Islamic World based on Indigenous Knowledge, Natural Products and Modern Technologies

AHMED A. AZAD FIAS
Incepta Visiting Professor
Bangladesh University of Health Sciences
Dhaka, Bangladesh

1 ABSTRACT

Most of the scientifically lagging and least developed countries of the developing world are largely concentrated in a geographical region that includes Southern and Central Asia, the Near East, North Africa and Sub-Saharan Africa, a region that is also home to the overwhelming majority of the OIC-member countries. The poorer and least developed countries in the OIC region are in the greatest need of effective and affordable drugs and vaccines against diseases that continue to cause devastation to the health and economies of these countries. Unfortunately these countries are unable to carry out effective indigenous research to meet their needs for new drugs because of their weakness in scientific proficiency and lack of research capacity.

This is a proposal for the establishment of a Drug Discovery and Development Programme in the OIC region with a major focus on research capacity development. The initiative will draw on indigenous knowledge, natural products and existing scientific resources, and will foster multidisciplinary research collaboration between diverse research groups with complementary expertise and facilities. The drug development process, even before commercialization, is extremely expensive and requires extensive capacity development. This is beyond the capability of any single scientifically lagging country, but could be achieved through focused collaboration within a regional research network. This major initiative could result in much needed therapeutic products and, in collaboration with local industry partners, lead to the establishment of a research-based pharmaceutical industry dedicated to the health care needs of the region.

Cutting edge technologies in the molecular biosciences and core facilities set up for this initiative will also be available to all other biotechnology based activities in the region and lead to increased research productivity, capacity development and a well-trained scientific manpower. These are all very important steps needed to raise the science and technology base to the level required to transform the region from being scientifically lagging to being scientifically proficient. Since scientific and technological proficiency underpins sustainable development, this initiative should be treated as a priority by regional governments, and supported by national and international science academies (IAS, TWAS, AAS), multinational science organizations (ICGEB, COMSTECH), regional development banks (IDB, ADB) and international development partners that subscribe to science and technology-based sustainable development in the least developed and scientifically lagging countries.

2 INTRODUCTION

Since ancient times traditional medicines, based on indigenous knowledge of the flora and fauna, have been extensively used for the management of various ailments. Even today they are the remedies of choice in most of the developing world because of their affordability and long-held traditional belief in their usefulness as a result of the knowledge being passed from generation to generation. The Islamic world is endowed with unique and rich flora and fauna and a wealth of indigenous knowledge of traditional medicines which could be the basis for the development of new drugs needed to meet the health care needs of OIC countries. There is also great potential for export of traditional medicines from the Islamic world to the West. Even though imported natural product-based medicines are not currently required to provide data from human clinical trials, that is required for modern medicines, they are nevertheless required by regulatory authorities to provide relevant clinical information on product safety and reliability.

Among the huge collection of traditional remedies based on the biota from different parts of the world there are undoubtedly many useful therapeutic products. Indeed many of the most commonly used modern medicines, such as Artemesin and the anti-cancer drug Taxol, have been developed from chemicals isolated from plants. Traditional medicines of plant and animal origin are crude mixtures of chemical compounds which besides the putative active ingredient may also contain harmful substances. Therefore, in order to safeguard the continued use and acceptability of traditional medicines any harmful substances in the formulation need to be identifies and removed. The identity and quantity of the "active agent" in the crude mixture is needed to ensure that the efficacy does not vary in different batches of the drug. This should be the minimum requirement for a traditional medicine in the modern era if it is to be nationally and internationally competitive.

3 RATIONALE FOR AN ALTERNATIVE APPROACH

The identification of an "active agent" that has a specific effect on any stage of disease pathogenesis is a very important stepping stone in the development of a modern medicine. Scientists in the Islamic world, and in the developing countries, have been very actively engaged in the identification, isolation, purification and chemical characterization of secondary metabolites from indigenous flora and fauna, and especially medicinal plants which have been reported to have therapeutic value. Indeed in the Islamic world phytochemists have been the most prolific publishers of scientific papers among all scientific disciplines. In the process they have built up very impressive lists of publications and a catalogue of new chemical compounds. Why then have there been so few, if any, modern medicines that have reached the market place? The answer lies in the fact that often the identification and characterization of novel molecules has been the primary aim and finding a relevant biological role in disease control for them has usually been an afterthought. Rarely have the initial identification or the subsequent characterization and further development been guided by disease- specific bioassays based on mechanistic considerations.

An alternate approach where both the discovery and development of new drugs from indigenous biota is guided by a cellular or molecular bioassay based on a disease-specific molecular target could not only be much more effective in finding a relevant medicine but also lead to very important intellectual property development. Combining the knowledge base of traditional medicines with modern cutting edge technologies will result in faster development of new drugs that are more efficacious and patient friendly. The cost of production would also be much cheaper in the Islamic World because of highly competitive labour and associated costs.

While no single country in the Islamic World is likely to possess all the required cutting edge technologies required for the development of modern medicines, the existing expertise and infrastructure could be coordinated to form the nucleus of a drug discovery and development network, which could be the launching platform for regional sufficiency in critically required medicines. However, for the success of this initiative the pooled research capacity would still need to be strengthened considerably and this would require very considerable new funding from indigenous sources and development partners. The following is a proposal for the development of such an initiative within the Islamic world:

4 OBJECTIVES OF THE PROPOSAL

The establishment of a *Drug Discovery and Development Network* in the Islamic world would be based on building upon existing strengths and resources such as:

- Indigenous knowledge systems and accumulated information on traditional medicines developed over a very long time in different parts of the Islamic world.
- The very extensive and diverse range of flora and fauna, including the sources of traditional medicines, that exists in different regions of the Islamic world.
- Combining strengths in traditional knowledge with cutting edge molecular biosciences expertise and facilities.
- Fostering and strengthening multidisciplinary collaboration between research groups and “centres of excellence” involved in drug discovery and development.

5 SELECTION OF RESEARCH PROJECTS

While all diseases affecting the different regions of the Islamic world need to be addressed, it will not be possible initially to find cures or prophylactics for all of them at the same time as this would spread the existing resources too thin. The projects to be included in the proposed Drug Discovery and Development Network would need to be rationally selected on the basis of the following criteria:

- There would be a need to select a small number of manageable projects that are focused on the most significant diseases affecting the OIC countries, which would include not only the most prominent infectious diseases (HIV/AIDS, TB, Malaria etc.) and non-communicable diseases (diabetes, hypertension, cancer etc.) but also region-specific and “neglected diseases” of the poor.
- Project selection would be guided to a great extent by the knowledge and availability of disease-specific molecular targets so that there is rational discovery of potential drugs.
- All selected projects would be expected to be multidisciplinary and if necessary also multi-site and multinational.
- The selected projects would be expected to bring together isolated and disparate research groups possessing complementary expertise, facilities and biological resources.
- Projects that have existing links with industry, or propose to establish them, would also have priority.

Any drug discovery and development project would need to be a long-term and multi-stage one where different stages would require different expertise, resources, facilities and different levels of funding and collaborations. As such these need to be discussed under different headings.

6 STAGE 1: RESEARCH AND DISCOVERY

The different activities that would need to be covered under Stage 1 include:

- Prepare a comprehensive list of medicinal plants, and life forms with reported therapeutic properties, from different parts of the Islamic world from which extracts can be prepared for further biological and chemical studies. (The rights of traditional healers who provide any information must be respected and ensured).

- Carry out an audit and prepare an organized *catalogue of various natural product libraries* (both crude extracts and isolated chemical compounds) held and owned by different national and regional research groups.
- *Identify and validate disease-specific molecular targets* (enzymes, hormones, receptors, pathogenic molecules etc.) that may have a role in disease progression or arrest. Besides opening up a new avenue for including biomedical research in the prevalent natural product-based drug discovery pathway, this could also help in the development of new *intellectual property* (IP).
- *Develop molecular target-based bioassays* (cellular or molecular) suitable for screening and monitoring of bioactive molecules at different stages of drug discovery and development. This could also help in the development of new IP.
- *Identify lead molecules* through screening of natural product and chemical libraries in bioassays based on disease-specific molecular targets and cellular assays to test cytotoxicity. This could lead to the development of new IP.

It is unlikely that lead molecules identified after the first screening in molecular and cell-based bioassays will be sufficiently efficacious and, if so, will they also be water-soluble and non-toxic. They may need to be chemically optimized to make them suitable for pre-clinical studies in animal models.

Some of the above activities are already underway in different parts of the Islamic world and much of the required expertise can be accessed by bringing phytochemists and biomedical scientists together in collaborative multidisciplinary projects.

7 STAGE 2: LEAD OPTIMIZATION TO DEVELOP CANDIDATE DRUG

Development of candidate drugs is perhaps the most technology-intensive stage in the drug discovery process and the following essential tasks need to be performed:

- Chemically modify lead molecule using cutting edge technologies such as combinatorial and analog synthetic chemistry (*lead optimization*) to produce a range of new chemical compounds with improved performance.
- Subject the new range of chemical compounds to a second round of screening assays to identify molecules with increased efficacy and solubility, and decreased toxicity (*optimized lead molecules*).
- Further rounds of rationalized chemical modifications guided by disease-specific bioassays and cell-based toxicity assays may needed to identify the desired optimized lead molecules suitable for *in vivo* studies.
- Subject the most promising optimized lead molecules to *pre-clinical studies in appropriate animal models* to determine *in vivo* efficacy, biosafety (lack of adverse side effects) and bioavailability.
- If the optimized lead molecules show enhanced efficacy, bioavailability and biosafety in animal models then they could qualify as *candidate drugs*.
- The syntheses of candidate drugs would need to be substantially scaled up (under GMP conditions) to produce sufficient quantities for *human clinical trials*.
- If required, the most promising candidate drug molecules could be further engineered for improved therapeutic performance by employing rational drug design approaches (structural biology, computational chemistry). Such a candidate drug designed and developed on structural and mechanistic considerations, if successful in human clinical trials would be considered the ideal modern medicine.

The developmental research for Stage 2 requires a level of sophistication, and a range of expertise and cutting edge technologies, that are not expected to be widely available in the

Islamic World or in most of the developing world. The success of Stage 2 of the initiative requires the establishment of a number of capacity building initiatives such as:

- *National and Regional Centres of Excellence:* These would possess special expertise, major cutting edge research facilities with skilled and dedicated operators, and critical mass in one or more of scientific disciplines such as molecular biosciences, cell biology, medicinal chemistry, structural biology, computational and synthetic chemistry and process biotechnology. Such centres of excellence could host research groups in different projects and serve as training hubs and high-end technology resource centres for different collaborating research teams.
- *Specialist Core Facilities* (for Stage 2 and Stage 3 R&D)**:** Depending on the cost and complexity these could be established as national, regional or OIC-wide facilities. These core facilities would need to be strategically and conveniently located to provide the highest level of specialist support to all the projects in the entire drug discovery and development network. Some examples of key core facilities required are given below:

  a. *Animal Research Facility* with specific pathogen free (SPF) and appropriate biological containment levels, and for housing disease-specific animal models, for testing toxicity and efficacy in pre-clinical trials, and biosafety of manufactured drugs.
  b. *Pilot Plant* for large-scale fermentation and down-stream processing of recombinant proteins, biopharmaceuticals and vaccines.
  c. *Scale-up Synthetic Chemistry Facility* for the large-scale production (under GMP conditions) of candidate drugs.
  d. IT, Technology Transfer and Commercialisation Centre.
  e. Clinical Trials Facility (In preparation of Stage 3).

- A vigorous *Training and short-term Visiting Fellowship Scheme.* This is important for all three stages but critical for Stage 2 R&D.

8 STAGE 3: TECHNOLOGY TRANSFER AND COMMERCIALISATION

The major components of Stage 3 include:

- *Human Clinical Trials (Phases 1, 2 and 3) of Candidate Drugs.*
- *Regulatory Processes to facilitate Commercialisation.*
- *Manufacture.*
- *Marketing.*

One of the biggest costs in the development of new drugs is extensive clinical trials carried out by multinational drug companies. The cost of clinical trials in the Islamic world could be drastically reduced if these were conducted by local clinicians on home grown products whose intellectual property was locally owned. This would also provide the leverage to ensure that there is actual technology transfer to local companies so that the drug is manufactured in the developing Islamic World. In this respect Bangladesh is particularly well placed because of the resident expertise in clinical research and the international competitiveness of the local pharmaceutical industry. A very important aspect of this final stage would be building a productive partnership with the local pharmaceutical industries using the IP/patents developed during Stages 1 and 2 of the project.

9 OPPORTUNITIES AND OBSTACLES:

The time it takes from the start of the initial research to market availability of a new modern medicine ranges from 15-20 years. A drug discovery and development initiative in the Islamic World based on indigenous knowledge systems, well developed natural products chemistry research, and already established safety profiles of many natural medicines could potentially reduce the development time considerably. The process is also very expensive. In the developed countries of the Western World the final stages (human clinical trials and market access) are so expensive that it can only be undertaken by multinational drug companies. In the Islamic World the 3rd stage could be much cheaper and is already feasible in some countries such as Bangladesh. So the Islamic World is well positioned to productively participate in Stage 1 and Stage 3 of the drug discovery and development process. The lack of capacity to undertake Stage 2 R&D is the major stumbling block.

Without building the capacity to successfully undertake Stage 2 research, the "R&D schism" that exists between discovery (Stage 1) and commercialization (Stage 3) will remain unbridgeable. While the initiation of Stage 1 multidisciplinary research collaboration within an Islamic world-wide drug discovery and development network would by itself be a great achievement in getting the initiative off the ground, the ultimate objective should be to produce modern medicines and get them to the patients and the market. So some of the major decisions very early on should be to assess the feasibility of the entire project, build partnerships with industry, obtain the support of governments of OIC member countries, and to prepare a research and funding proposal to help secure funds for the development of research capacity required for the success of the project.

10 OUTLINE OF PROPOSAL FOR INITIATION AND IMPLEMENTATION OF STAGE 1 (RESEARCH AND DISCOVERY)

The foremost tasks would be to convene a feasibility and planning workshop, initiate and support collaboration for Stage 1 R&D based on information gathered, and prepare a comprehensive research and funding plan within a specified time to help secure resources for commencing Stage 2 of the initiative.

The outlines of the proposal for implementing Stage 1 are given below:

1. Convene a planning workshop to help assess the relevant resources available in OIC countries, determine the feasibility of the proposed drug discovery and development network, and specifically identify the following:

   - The availability of disease-specific molecular targets and novel bioassays within the biomedical research community in the Islamic World, and any existing or potential IP owned.
   - Research groups in possession of natural product and chemical libraries, and any existing IP position.
   - Most important disease-specific projects based on what molecular targets or bioassays are, or will become, available.
   - Prospective research partners and scientific leaders.
   - Special expertise and facilities that can be complemented and shared.
   - Existing and potential Centres of Excellence and Specialist Core Facilities.
   - Potential Industry Partners with relevant expertise and capabilities, and interested in establishing a research-led pharmaceutical industry in the OIC region. Funding for the workshop could be requested from one or more of the following: Islamic Development Bank (IDB), COMSTECH, International Centre for Genetic

Engineering and Biotechnology (ICGEB), TWAS, and potentially generous and progressive host governments in the Islamic world.

2. Based on the information gathered at the workshop, facilitate and support collaboration between research groups in possession of novel disease-specific bioassays and other groups possessing natural product and chemical libraries. The *lead molecules* identified from this research collaboration could result in development of new IP and industry partnership, and justify progression to Stage 2 (development of candidate drugs). The initial funding for the collaborative research could be requested from existing funding sources such as: TWAS and ICGEB Collaborative Research Funds; TWAS, ICGEB and IDB Training Fellowships and Visiting Fellowships.
3. Develop collaborations and partnerships with local and regional drug companies, especially those interested in establishing a research-led pharmaceutical industry in the Islamic World, to fund developmental research for product development and for the generation and protection of IP.
4. Based on the data obtained at the workshop and the resulting collaborations, prepare a formal *Research and Funding Proposal*, within a specified time (*ca.* 2 years), for the initiation and implementation of Stage 2 of the plan.
5. Submit Research and Funding Proposal to various funding agencies and development partners to secure resources for Stage 2 R&D and necessary capacity development activities such as Centres of Excellence and Training and Fellowship Programmes.
6. Persuade wealthy and strategically-located OIC governments to contribute to capacity development in their own countries and in their region through supporting the establishment of Specialist Core Facilities.

Transition to Phase 3: Stage 2 remains the rate limiting step, and if it is properly resourced and the development research is satisfactory, then strategic alliances made with clinical researchers and industry partners, and the IP developed during Stages 1 and 2 will attract the funding required for product development and commercialization during Stage 3. As mentioned earlier clinical trials carried out on home-grown products, and the manufacture and marketing of these would be very cost-effective in some parts of the Islamic world which already possess many of the appropriate expertise and facilities.

11 MAJOR EXPECTED OUTCOMES OF THE PROPOSED DRUG DISCOVERY AND DEVELOPMENT INITIATIVE IN THE ISLAMIC WORLD

This is undoubtedly an ambitious project, but it has a very high chance of success as it aims to build on existing strength within the Islamic world and bring together research groups with complementary expertise and resources, and places a very high value on IP development and partnership with the local pharmaceutical industry. Some of the major expected outcomes are listed below:

1. New and improved drugs, which are also affordable and patient-friendly, against diseases that devastate the health and economies of OIC member countries.
2. Development of much needed research and technical capacity through:

- Consolidation and strengthening of existing expertise and facilities.
- Strengthening and establishing “Centres of Excellence” as national and regional technology and training hubs.
- Establishment of “Core Facilities”, that because of cost and complexity cannot be readily replicated, as regional and OIC-wide specialist technology centres.
- Focused multidisciplinary collaboration between research groups possessing complementary expertise and facilities.

3. Pooling of resources, and access to high-end technology, should lead to a marked improvement of research proficiency due to:

   - Increased research productivity in the relevance, quantity and quality (high impact) research publications.
   - Awareness, development and protection of IP and patents.
   - Utilisation of IP and partnership with the pharmaceutical industry resulting in technology transfer and commercialization of research.
   - Training and deployment of trained manpower.

4. Establishment of a research-led pharmaceutical industry dedicated to:

   - Health priorities of the OIC member countries.
   - Training partnerships and support of developmental research in academic and research institutions.
   - Employment of trained manpower in industry.
   - Sustainable socio-economic development of OIC member countries involved in the drug discovery and development network.

12 CONCLUSION

The proposed Drug Discovery and Development initiative, built on existing strengths in indigenous knowledge systems and bio-diverse biological resources in the Islamic World, could enable isolated research groups with complementary expertise and resources to work together to achieve what would not be possible on their own. Collaborative research for discovery of target molecules (Stage 1) can be initiated and modestly supported through access to existing resources and available competitive research funds.

The successful development of candidate drugs (Stage 2) is largely dependent on the availability of cutting edge technologies, a critical mass of trained scientists and an active partnership with industry, something that currently does not exist to an acceptable degree in the Islamic world. This stage of the initiative, which is critical for bridging the R&D chasm between discovery and technology transfer, is very much a capacity development phase for which substantial funding is required from national and international sources and from the local pharmaceutical industry.

The final Stage 3 (Clinical Trials and Technology Transfer) is extremely expensive to carry out in the developed countries of the West, but can be carried out at a fraction of the cost through local clinical trials of home grown candidate drugs, by building partnerships with the pharmaceutical industry and by leveraging the IP developed during the first two stages.

In conclusion, it is feasible to establish a research-led drug development program in the Islamic world that can be less time consuming and much cheaper than similar operations carried out by multinational pharmaceutical companies in the West. Hopefully this will result in the establishment of a research-led pharmaceutical industry dedicated to the health care needs and socio-economic development of the Islamic world. Besides strong possibility of useful products, this initiative will also elevate the science and technology base in the Islamic World and lead to much needed research capacity development. This should also result in job and wealth creation, and socio-economic development of the Islamic world.

This proposal if properly implemented could possibly result in the production "block-buster" drugs with huge export potential, and will pay very high dividends in achieving socio-economic development in the Islamic world. However, this is possible only if the scientific community, the local pharmaceutical sector and the OIC governments are willing to take on the challenge, and are prepared to collaborate and cooperate for the common good.

The Climate Change Question: The Role of Scientists and Science Academies

MICHAEL CLEGG
Foreign Secretary
US National Academy of Sciences
USA

ABSTRACT

The effort to understand Climate Change involves an extremely broad range of lines of evidence. Included are such topics as evidence related to past changes in climate and the process that let to those changes, the current set of drivers of change, the interactions and "feed-backs" among these drivers, and, even more complex, projecting the future course of climate change and understanding the costs and benefits of potential measures to adapt to and mitigate climate change. A large part of the science community is potentially involved.

Extensive interdisciplinary and international cooperative research is needed. All partners in the global research enterprise, including of course those working on research related to climate change, should have a common understanding of the many aspects of scientific responsibility. An important new resource is the IAC report, *Responsible Conduct in the Global Research Enterprise*, 2012, available at www.interacademycouncil.net

Given the extraordinary importance of understanding climate change and its drivers and impacts, how scientists and the science community relate to policy makers and the public is particularly important.

As stated in the IAC report, "Researchers need to communicate the policy implications of their results clearly and comprehensively to policy makers and the public—including a clear assessment of the uncertainties associated with their results—while avoiding advocacy based on their authority as researchers.

Scientific policy advice to governments, industry, or nongovernmental organizations should undergo peer review and should not be made from an advocacy perspective."

Academies of Science, including the IAS and its over 100 fellow members of the IAP, include among their central institutional goals the provision of sound, evidence-based inputs to the public and policy-makers of their countries and the world. Aspects of the continuing progress of research and growing lines of evidence related to climate change are among the most important topics on which the academies can help inform their countries. Academies aspire to be merit-based institutions capable of convening top-level expertise, and assuring that summarized evidence is balanced and not distorted by conflicts of interest.

Most academies, including the US NAS, do not contain among their members all of the many aspects of expertise needed for a comprehensive view of the state of understanding related to climate change. Indeed, overall, the membership of the many NAS advisory committees includes a large majority who are not members of any one of our three cooperating academies, the NAS, NAE, and IOM. The IAS and academies in the countries heavily represented in IAS membership will also need to cast a broad net to convene advisory processes with appropriate breadth and balance in addressing topics such as climate change.

Academies of Science might consider the special importance, in the case of climate change, of conveying accurately to the public and to policy makers the current state of understanding. That can be done in many ways—perhaps the most important being provision

of carefully reviewed consensus reports on the topic, or provision of perspective on global efforts such as the IPCC.

Among other steps now being considered by academies would be convening public presentations and discussions of the lines of evidence on climate change. For example, academies might arrange for public presentations by scientists from the IAS or national experts who participate in the IPCC, addressing specific aspects of climate change evidence that is important to that country.

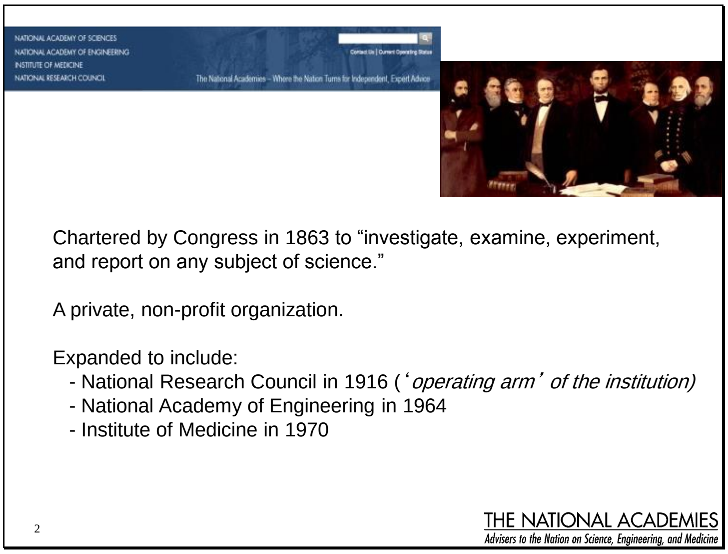

Figure 1.

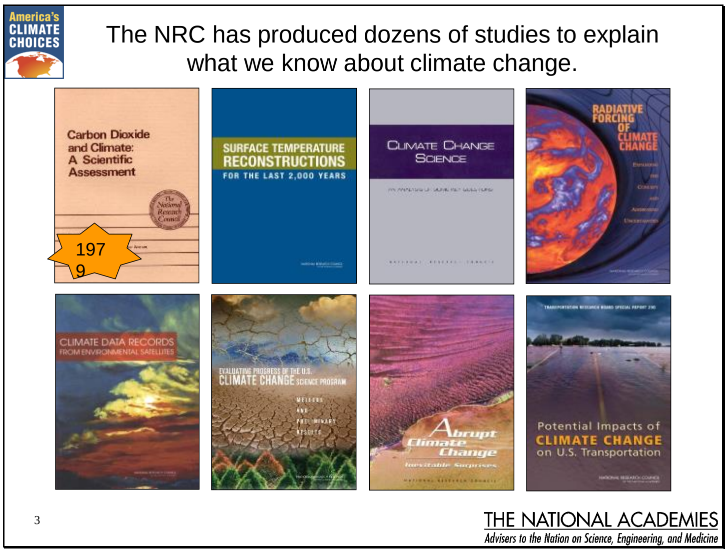

Figure 2.

NAS has been carrying out studies related to climate change for over three decades. Going back to the ‘Charney report’ 1979.

Mostly, these studies were presenting the state of scientific understanding of <u>what we know</u> about particular aspects of climate change sciences.

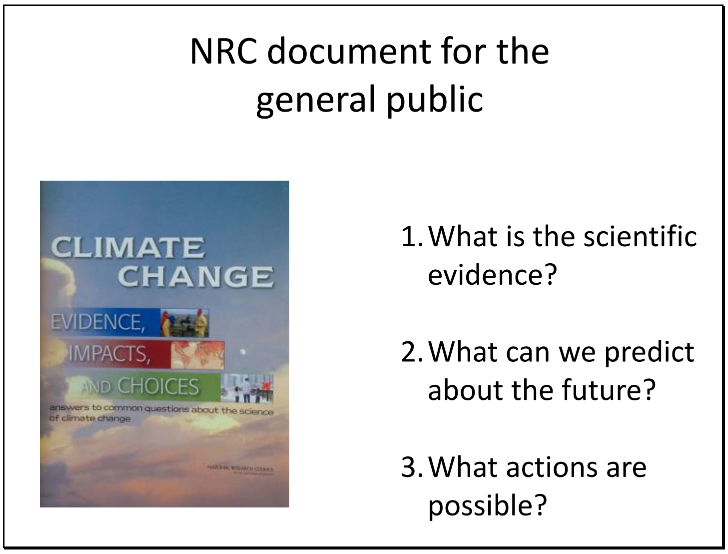

Figure 3. NRC Document for the General Public.

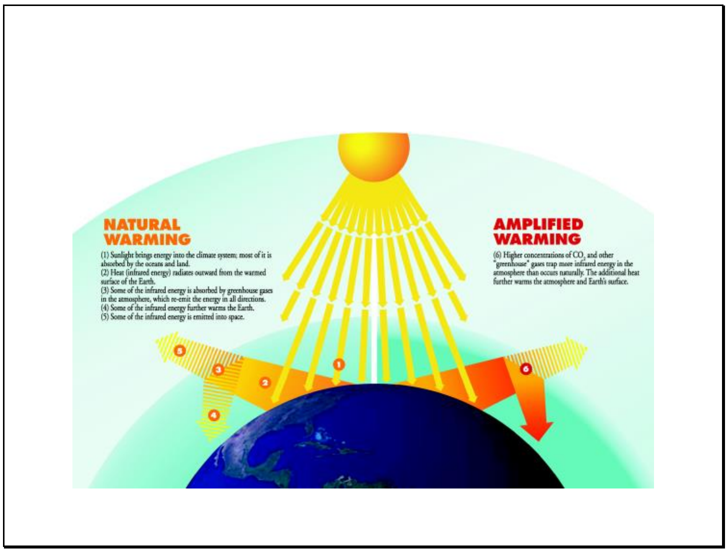

Figure 4.

The greenhouse effect is a natural phenomenon that is essential to keeping the Earth's surface warm. Like a greenhouse window, greenhouse gases allow sunlight to enter and then prevent heat from leaving the atmosphere. These gases include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and water vapor. Human activities - especially burning fossil fuels - are increasing the concentrations of many of these gases, amplifying the natural greenhouse effect.

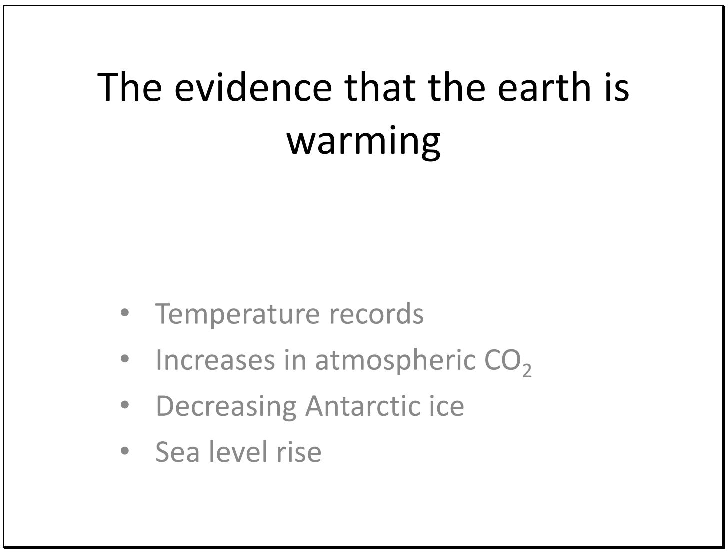

Figure 5. The Evidence that the Earth is Warming.

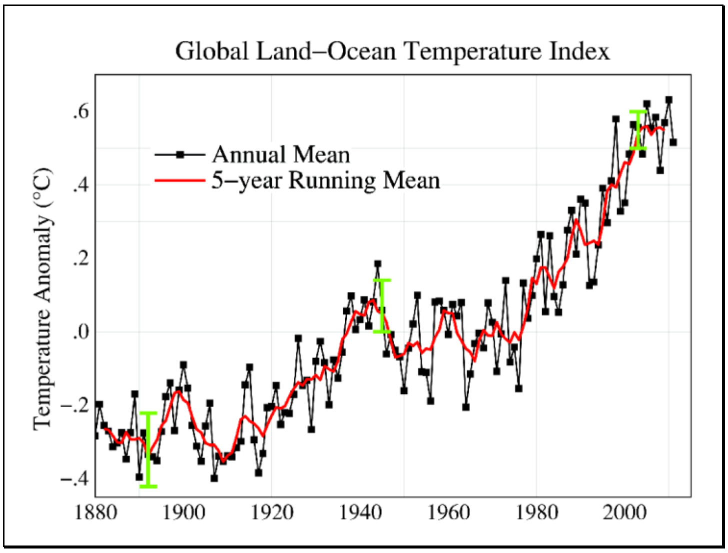

Figure 6. Global Land – Ocean Temperature Index.

Estimates of global surface temperature change, relative to the average global surface temperature for the period from 1951 to 1980, which is about 14°C (57°F) from NASA Goddard Institute for Space Studies show a warming trend over the 20th century. The estimates are based on surface air temperature measurements at meteorological stations and on sea surface temperature measurements from ships and satellites. The black curve shows average annual temperatures, and the red curve is a 5-year running average. The green bars indicate the margin of error, which has been reduced over time.
Source: National Research Council 2010a.

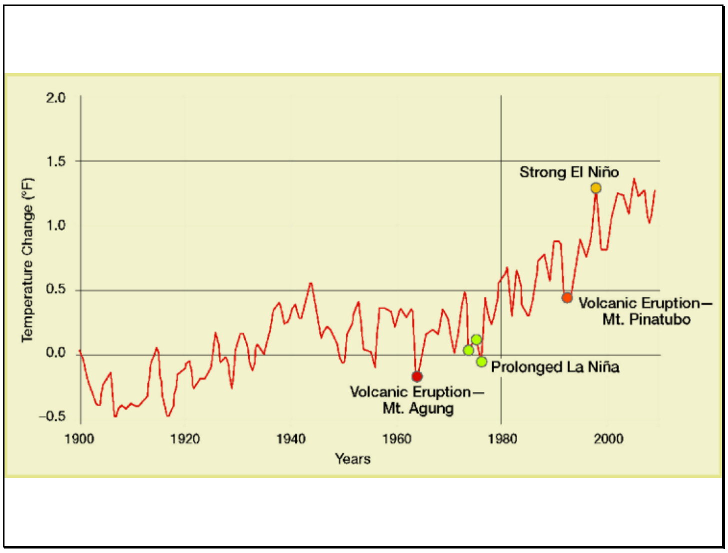

Figure 7.

Natural factors, such as volcanic eruptions and El Niño and La Niña events, can cause average global temperatures to vary from one year to the next, but cannot explain the long-term warming trend over the past 60 years.

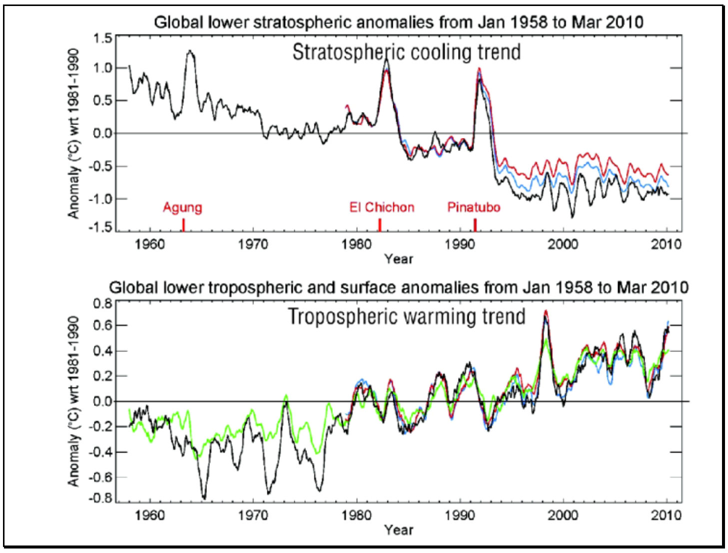

Figure 8.

Data from weather balloons and satellites show a warming trend in the troposphere, the lower layer of the atmosphere, which extends up about 10 miles (lower graph), and a cooling trend in the stratosphere, which is the layer immediately above the troposphere (upper graph). This is exactly the pattern expected from increased greenhouse gases, which trap energy closer to the Earth's surface.

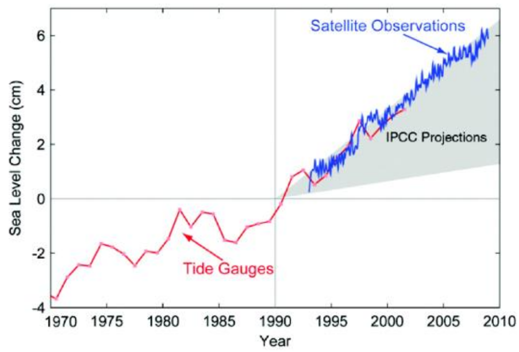

Figure 9.

Observed sea-level change since 1990 has been near the top of the range projected by the Intergovernmental Panel on Climate Change Third Assessment Report, published in 1990 (gray-shaded area). The red line shows data derived from tide gauges from 1970 to 2003. The blue line shows satellite observations of sea-level change.

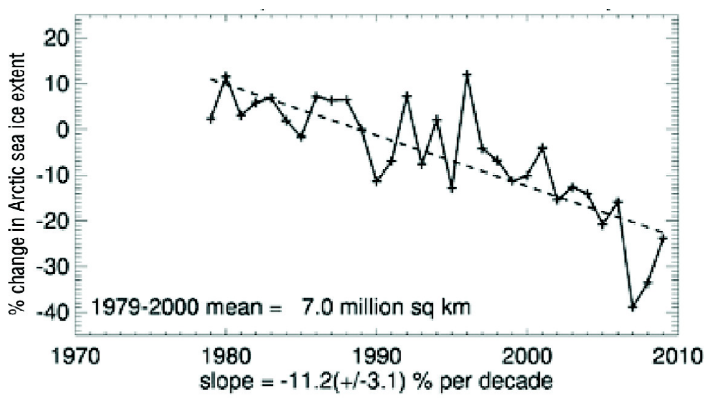

Figure 10.

Satellite-based measurements show a steady decline in the amount of September (end of summer) Arctic sea ice extent from 1979 to 2009 (expressed as a percentage difference from

1979- 2000 average sea ice extent, which was 7.0 million square miles). The data show substantial year-to-year variability, but a long-term decline in sea ice of more than 10% per decade is clearly evident, highlighted by the dashed line.

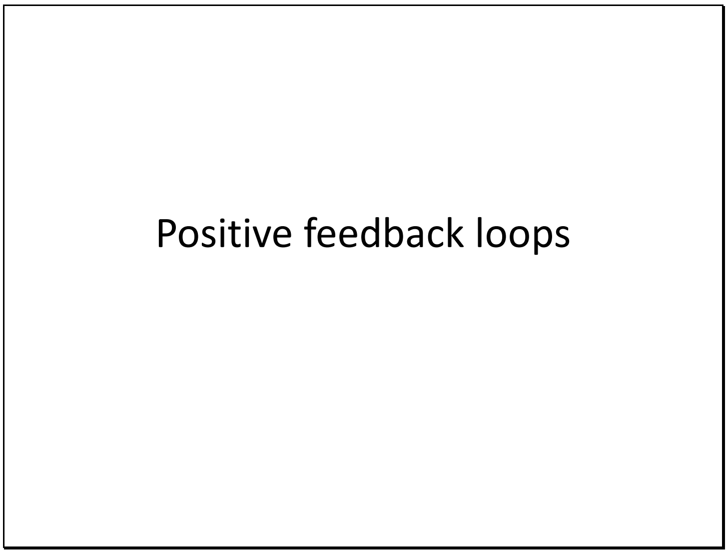

Figure 11.

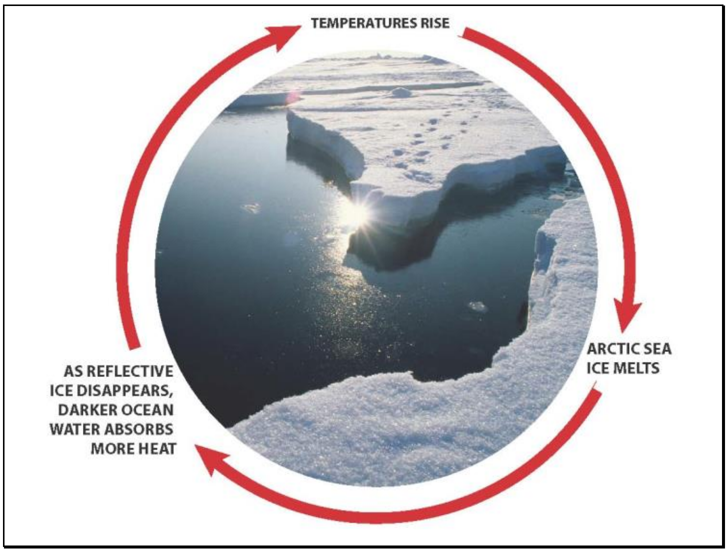

Figure 12.

The amount of warming that occurs because of increased greenhouse gas emissions depends in part on feedback loops. Positive (amplifying) feedback loops increase the net temperature change from a given forcing, while negative (damping) feedbacks offset some of the temperature change associated with a climate forcing. The melting of Arctic sea ice is an example of a positive feedback loop. As the ice melts, less sunlight is reflected back to space and more is absorbed into the dark ocean, causing further warming and further melting of ice.

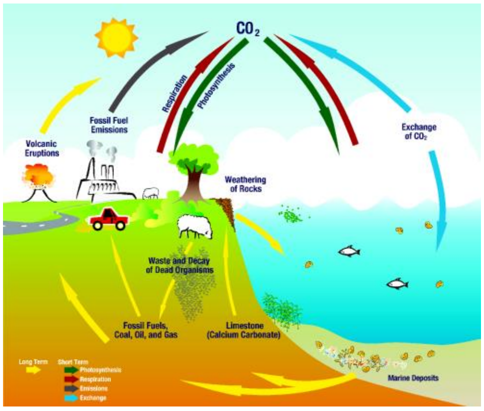

Figure 13.

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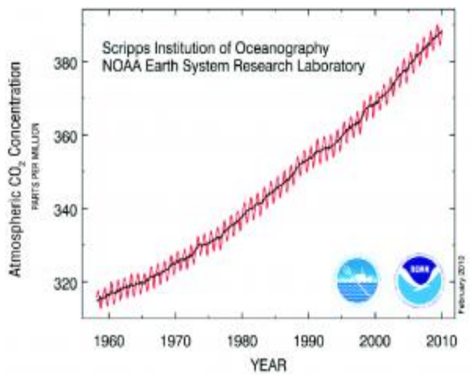

Figure 14.

The "Keeling Curve" is a set of careful measurements of atmospheric CO2 that Charles David Keeling began collecting in 1958. The data show a steady annual increase in CO2 plus a small up-and-down sawtooth pattern each year that reflects seasonal changes in plant activity (plants take up CO2 during spring and summer in the Northern Hemisphere, where most of the planet's land mass and land ecosystems reside, and release it in fall and winter).

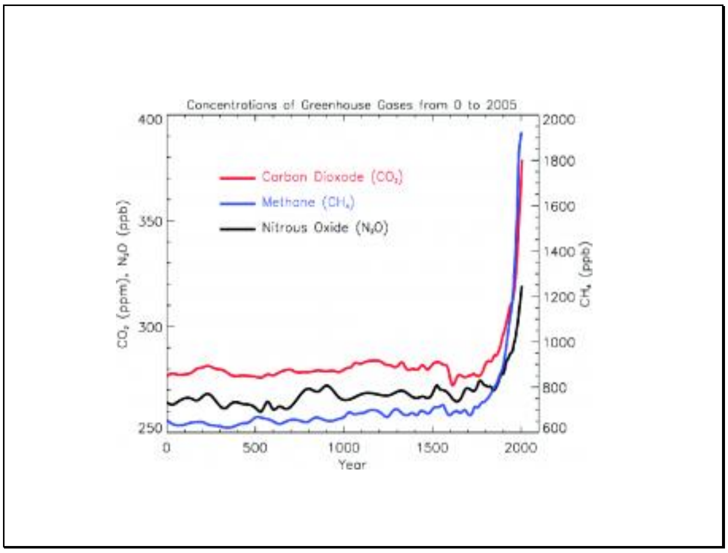

Figure 15.

The "Keeling Curve" is a set of careful measurements of atmospheric CO2 that Charles David Keeling began collecting in 1958. The data show a steady annual increase in CO2 plus a small up-and-down sawtooth pattern each year that reflects seasonal changes in plant activity (plants take up CO2 during spring and summer in the Northern Hemisphere, where most of the planet's land mass and land ecosystems reside, and release it in fall and winter).

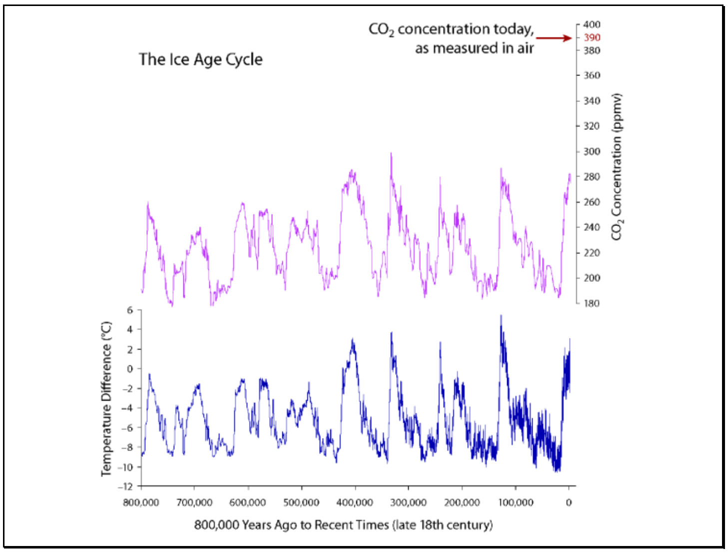

Figure 16.

As ice core records from Vostok, Antarctica, show, the temperature near the South Pole has varied by as much as 20°F (11°C) during the past 800,000 years. The cyclical pattern of temperature variations constitutes the ice age/interglacial cycles. During these cycles, changes in carbon dioxide concentrations (in red) track closely with changes in temperature (in blue), with CO2 lagging behind temperature changes. Because it takes a while for snow to compress into ice, ice core data are not yet available much beyond the 18th century at most locations. However, atmospheric carbon dioxide levels, as measured in air, are higher today than at any time during the past 800,000 years.

Geographic distribution of temperature increases over forty years

Figure 17.

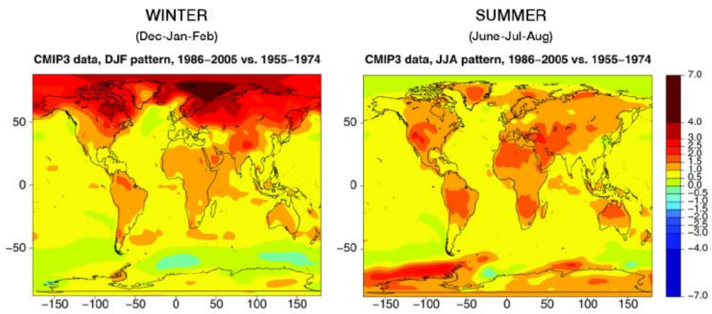

Figure 18.

Twenty-year average temperatures for 1986-2005 compared to 1955-1974 show a distinct pattern of winter and summer warming. Winter warming has been intense across parts of Canada, Alaska, northern Europe, and Asia, and summers have warmed across the Mediterranean and Middle East and some other places, including parts of the U.S. west. Projections for the 21st century show a similar pattern.

Storm intensity data

Figure 19.

Billion dollar weather/climate disasters 1980-2011

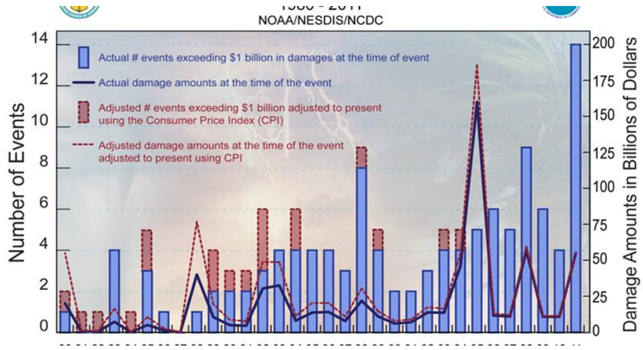

Figure 20. Billion Dollar Weather/ Climate Distaters 1980-2011.

The role of human activity on the global carbon budget

Figure 21.

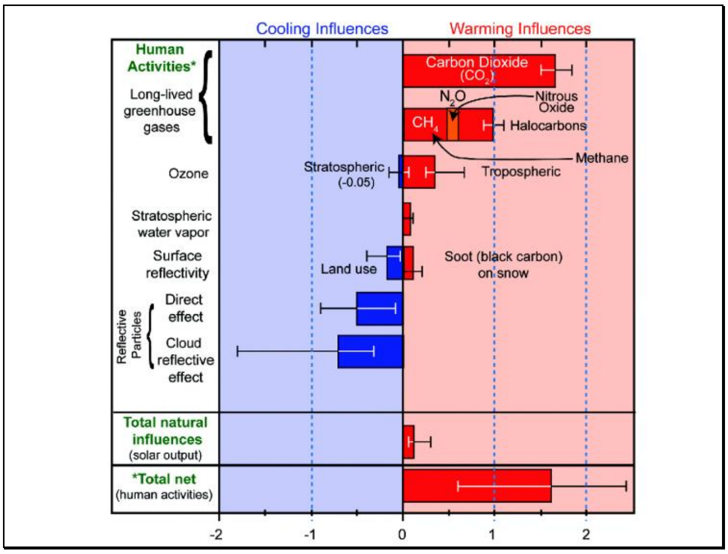

Figure 22.

The “Keeling Curve” is a set of careful measurements of atmospheric CO2 that Charles David Keeling began collecting in 1958. The data show a steady annual increase in CO2 plus a small up-and-down sawtooth pattern each year that reflects seasonal changes in plant activity (plants take up CO2 during spring and summer in the Northern Hemisphere, where most of the planet’s land mass and land ecosystems reside, and release it in fall and winter).

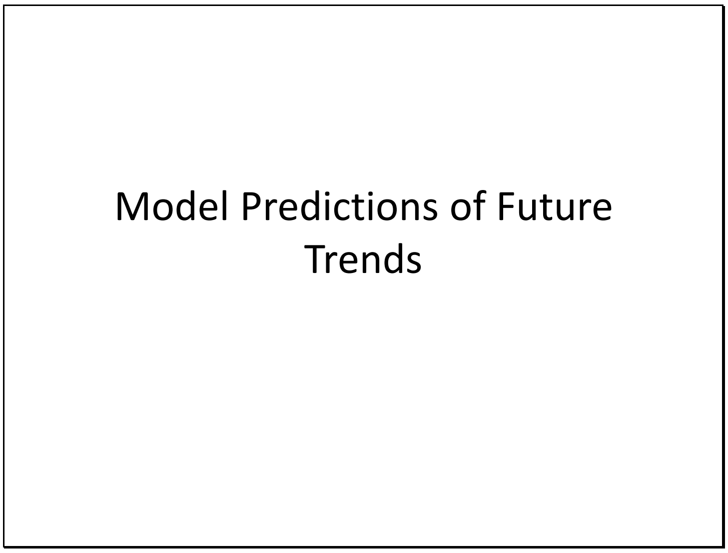

Figure 23.

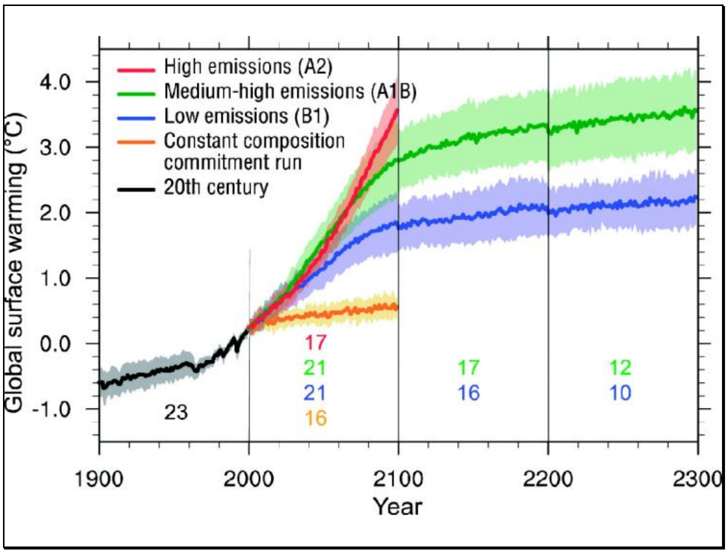

Figure 24.

Models project global mean temperature change during the 21st century for different scenarios of future emissions — high (red), medium-high (green) and low (blue) — each of which is based on different assumptions of future population growth, economic development, life-style choices, technological change, and availability of energy alternatives. Also shown are the results from "constant concentrations commitment" runs, which assume that atmospheric concentrations of greenhouse gases remain constant after the year 2000. Each solid line represents the average of model runs from different modeling using the same scenario, and the shaded areas provide a measure of the spread (one standard deviation) between the temperature changes projected by the different models.

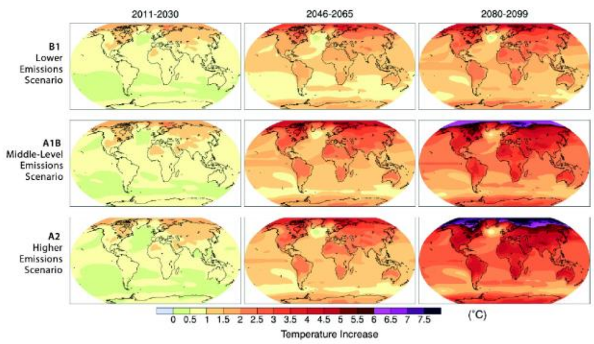

Figure 25.

Models project the geographical pattern of annual average surface air temperature changes at three future time periods (relative to the average temperatures for the period 1961–1990) for three different scenarios of emissions. The projected warming by the end of the 21st century is less extreme in the B1 scenario, which assumes smaller greenhouse gas emissions, than in either the A1B scenario or the A2 "business as usual" scenario.

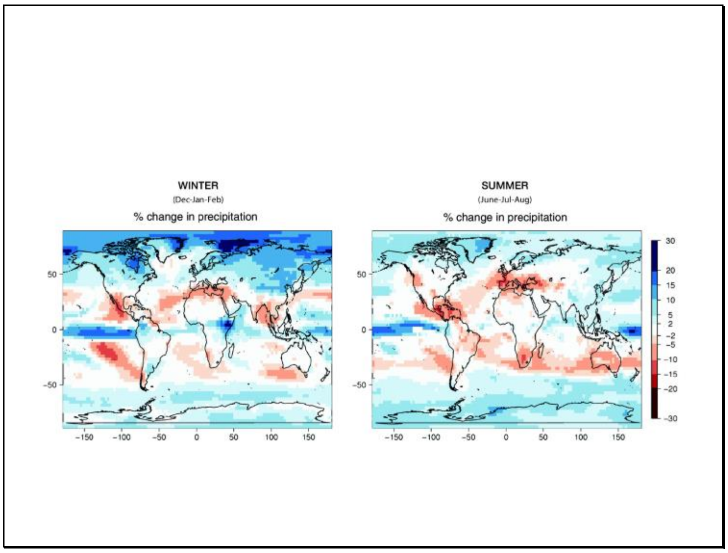

Figure 26.

Higher temperatures increase evaporation from oceans, lakes, plants, and soil, putting more water vapor in the atmosphere and, in turn, producing more rain and snow in some areas. However, increased evaporation also dries out the land surface, which reduces precipitation in some regions. This figure shows the projected percentage change per 1°C (1.8°F) of global warming for winter (December-February, left) and summer (June-August, right). Blue areas show where more precipitation is predicted, and red areas show where less precipitation is predicted. White areas show regions where changes are uncertain at present, because there is not enough agreement among the models used on whether there will be more or less precipitation in those regions.

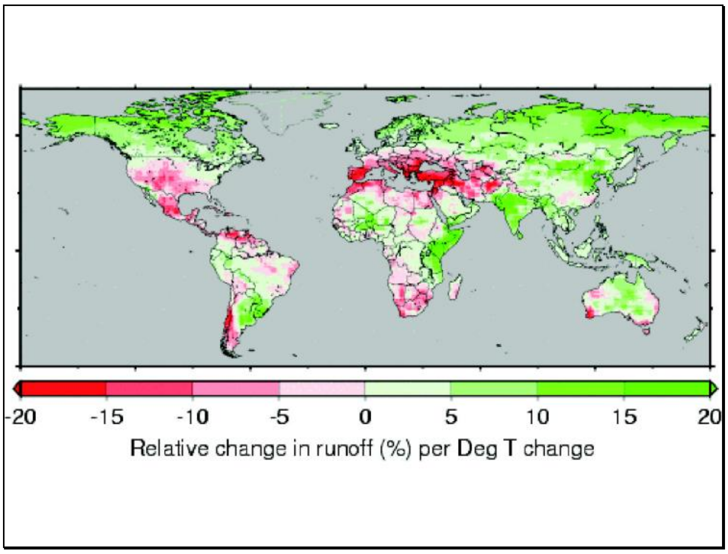

Figure 27.

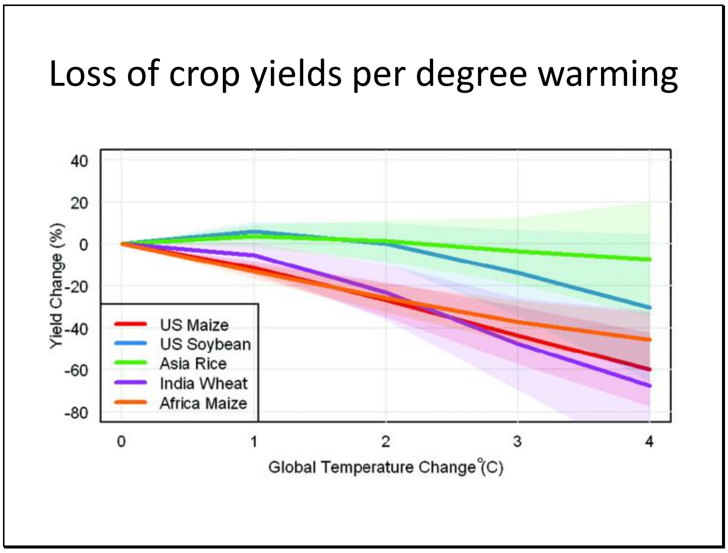

Figure 28. Loss of Crop Yields per Degree Warming.

Yields of corn in the United States and Africa, and wheat in India, are projected to drop by 5-15% per degree of global warming. This figure also shows projected changes in yield per degree of warming for U.S. soybeans and Asian rice. The expected impacts on crop yield are from both warming and CO2 increases, assuming no crop adaptation. Shaded regions show the likely ranges (67%) of projections. Values of global temperature change are relative to the preindustrial value; current global temperatures are roughly 0.7°C (1.3°F) above that value.

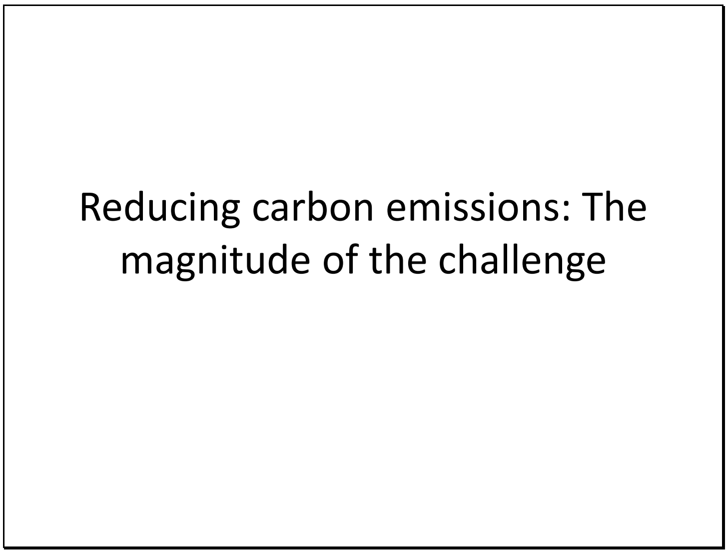

Figure 29.

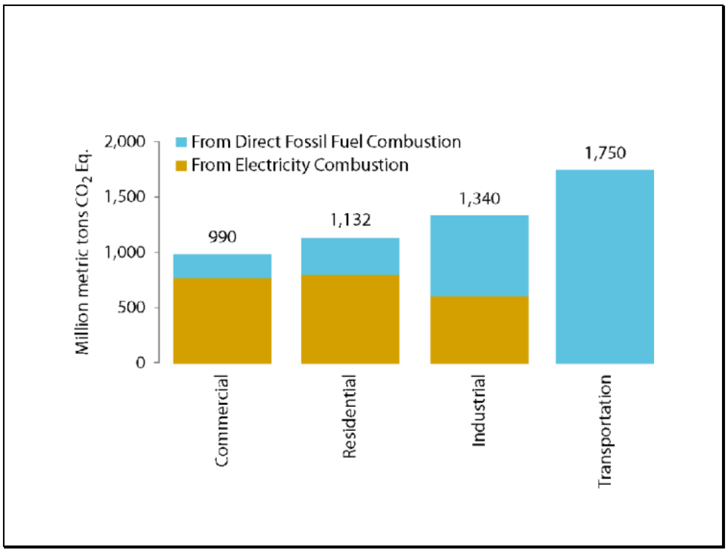

Figure 30.

U.S. greenhouse gas emissions in 2009 show the relative contribution from four end-uses: residential, commercial (e.g., retail stores, office buildings), industrial, and transportation. Electricity consumption accounts for the majority of energy use in the residential and commercial sectors. Image courtesy:

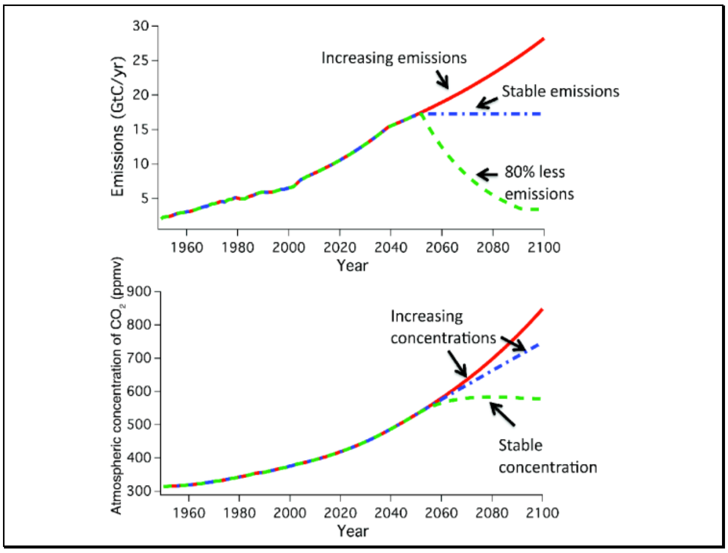

Figure 31.

Sharp reductions in emissions are needed to stop the rise in atmospheric concentrations of CO2 and meet any chosen stabilization target. The graphs show how changes in carbon emissions (top panel) are related to changes in atmospheric concentrations (bottom panel). It would take an 80% reduction in emissions (green line, top panel) to stabilize atmospheric concentrations (green line, bottom panel) for any chosen stabilization target. Stabilizing emissions (blue line, top panel) would result in a continued rise in atmospheric concentrations (blue line, bottom panel), but not as steep as a rise if emissions continue to increase (red lines).

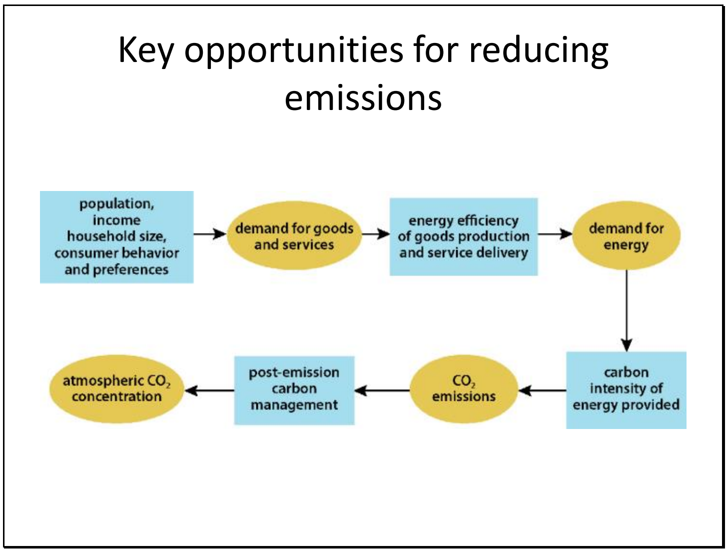

Figure 32.

A chain of factors determine how much CO2 accumulates in the atmosphere. Better outcomes (gold ellipses) could result if the nation focuses on several opportunities within each of the blue boxes.

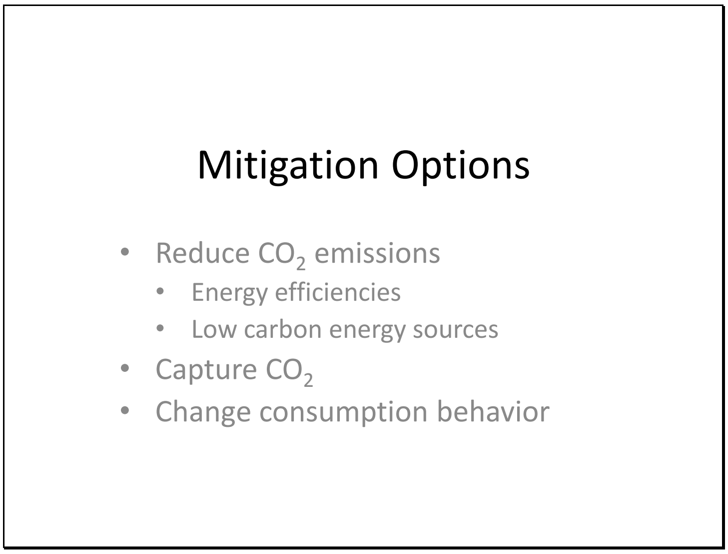

Figure 33.

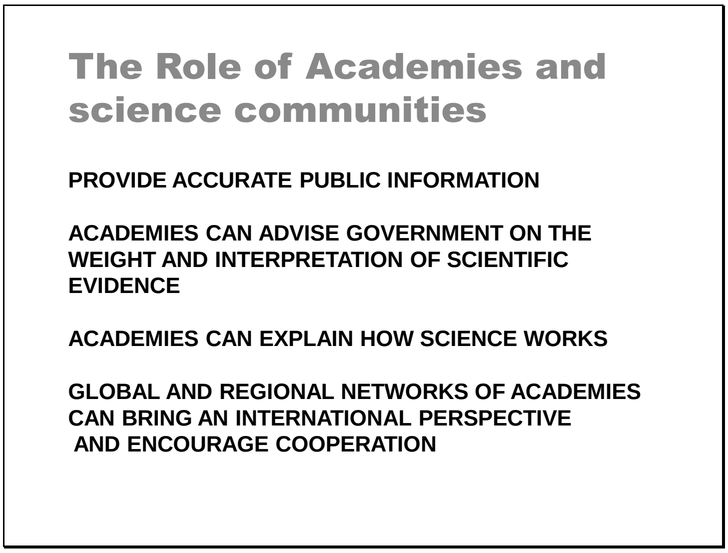

Figure 34.

Production of Stress Tolerant Rice for Bangladesh by Use of Biotechnological Tools

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1 ABSTRACT

Bangladesh is very small fertile country with a total land area of 14.8 Mha and cultivable area of 9.1 Mha (62%). The total irrigated land area is 52% with a cropping intensity of 181%. The share of agriculture in the GDP is 19.95%. The paddy production has so far been almost adequate for the growing population of rice eaters at 33.5 Mt (~150 million people), with the exception of import of ~1 Mt to mitigate floods or similar disasters. Another 100 million is likely to be added to the population, before stabilizing by the middle of this century. Therefore rice production has to nearly double. Abiotic stresses like salinity affects 1.2 Mha in the South. Drought affects 2.7 Mha in the North. In addition there is 1 Mha of flash flood-prone areas and 3.2 Mha of rainfed low-lying areas in Bangladesh.

Use of biotechnological tools like DNA marker-assisted breeding with the help of IRRI and currently funded by the Gates Foundation with the project STRASA (Stress tolerant Rice for Africa and South Asia) has resulted in the release of submergence tolerant rice like BRRIdhan 51 and 52. Some traditionally bred drought tolerant varieties as well as IR64 introgression lines with QTLs from drought tolerant donors have been produced and are in the pipeline. Our own work at Dhaka University helped incorporate salinity tolerance QTLs (*Saltol*) into farmer-popular BR11 and BRRIdhan 28, which are currently undergoing field trials in the South of Bangladesh. STRASA is also funding for pyramiding of multiple traits into farmer-popular rice through marker-assisted breeding. For example, the submergence tolerance trait, *Sub1* is being combined with each of stagnant flood tolerance (SF), anaerobic germination (AG), drought tolerant yield (DTY) and salinity tolerance (*Saltol*). Marker-assisted breeding for introgression of the kinase gene, *Pstol1*, which confers tolerance of phosphorous deficiency and drought and results in 20% increase in yield has just been initiated for Bangladesh.

Rice genetic transformation for incorporation of genes with multiple downstream effects has been shown to be effective in producing field level tolerance to drought, salinity and providing water-use efficiency. Moreover, tolerant traits coded for by different mechanisms can be pyramided providing more durable tolerance. Some of the target genes are those for antiporters, helicases, transcription factors like, HARDY and SNAC1 as well as detoxification genes like Glyoxalase 1 and II. These genes are being cloned and incorporated into rice at Dhaka University. Some of these are collaborative efforts like those of Pea DNA Helicase and Glyoxalase I and II with ICGEB, India.

2 INTRODUCTION

Tolerance to abiotic stresses such as drought, salinity or flooding is controlled by quantitative trait loci (QTLs) or multiple genes. In order to produce tolerant crops, for example, rice, these genes need to be combined with those responsible for good agronomic performance resulting in high yielding abiotic stress-tolerant genotypes suitable for cultivation. Breeding for high yield in rice has been in practice for several decades now and with help and inputs from the International Rice Research Institute (IRRI), the Bangladesh Rice Research Institute (BRRI) has produced at least 50 high yielding rice cultivars (www.brri.gov.bd). Climate change scenarios and scarcity of water resources has however now made introgression of stress tolerance genes necessary into these high-yielding cultivars.

One approach is the use of DNA markers associated with the tolerance genetic loci to guide introgression of the latter into the background of a high yielding cultivar. This is referred to as DNA-marker assisted backcrossing and involves the crossing of a donor genotype (having the tolerance genetic locus) with the high-yielder or the farmer-popular. This is followed by 2-3 backcrosses with the high-yielder, while selecting progenies having the tolerance loci aided by DNA markers. The backcross with the high-yielder ensures retention of its genetic background and the good agronomic traits associated with it. One very successful example of this approach was the introgression of the submergence tolerance locus or *Sub1A* from the rice landrace FR13A into the agronomically superior Swarna and BR11 (Neeraja et al. 2007 and Iftekharuddaula, et al. 2011). These two genotypes were released as BRRIdhan 51 and 52 respectively in Bangladesh (BRRI, 2011). One important factor in the success of this approach is that the targeted tolerant genetic locus has to be responsible for a high proportion of the phenotype of interest, since multiple loci may be responsible for the latter. For the *Sub1A* locus, this was precisely the case as it turned out to encode a transcription factor called ERF1 which in turn affected many downstream genes (Xu et al. 2006, Bailey-Serres et al. 2010). It is likely that the *Pstol1* locus encoding a protein kinase gene will also affect multiple downstream genes and be a good target for introgression of drought tolerance as well as efficient phosphorous absorption in a DNA marker-assisted backcross approach (Gamuyao et al. 2012).

Knowledge of suitable DNA markers associated with abiotic traits of interest such as stagnant flooding (SF), anaerobic germination (AG) and drought tolerant yield (DTY) is essential for the success of the backcross breeding approach. Breeding programs for introgression and pyramiding of these traits are already underway (Mackill et al. 2010). A major salinity tolerance locus, *Saltol*, was described in rice Chr 1 (Bonilla et.al. 2002 and Islam 2006) and has been the focus of salinity tolerance marker-assisted backcross breeding at IRRI, BRRI and Dhaka University (DU) and is briefly described in this paper.

Genetic transformation is another approach to producing abiotic stress tolerant crops such as rice. Initial efforts were made to overexpress single genes encoding rate limiting enzymes of osmolyte production. This resulted in limited improvement in tolerance at the vegetative state of several crops (reviewed by Agarwal et al. 2013). Overexpression of the Na/H antiporter which sequesters Na in the vacuole provided good tolerance to dicots (Zhang and Blumwald, 2001, Zhang et al. 2001) but produced less dramatic effect in monocots like wheat (Xue et al. 2004) and limited in rice (Fukuda et al. 2004). Our own experience with the vacuolar Na/H antiporter transformation in rice has shown that its regulation is complex because it can produce 3 alternate transcripts from the single gene. We have also shown that inclusion of the 5′ and 3′ UTRs increases the level of tolerance compared to the cDNA only. Even so the vacuolar Na/H antiporter provides only moderate salt tolerance to rice (Seraj Z. I. unpublished results). Transformation with regulatory molecules like transcription factors and regulatory enzymes was more successful. These include the SNAC1 (Hu et al., 2006) and HARDY (Karaba et al. 2007) transcription factors as well as the RNA and DNA unwinding helicase enzyme (Sanan-Mishra et al. 2005; Amin et al. 2012). Work at Dhaka University, involving the cloning and transformation of these transcription factors and regulatory enzymes in rice, some of it in collaboration with the International Center for Genetic Engineering and Biotechnology (ICGEB, India) is described in this paper.

3 DNA MARKER-ASSISTED BACKCROSSING

Marker-assisted backcrossing (MABC) is now frequently used to introgress favorable alleles and major effect QTLs (Quantitative Trait Loci) in to mega varieties and elite genotypes for the improvement of complex abiotic and biotic stress tolerance traits specifically where conventional breeding fails to introgress stress tolerant traits to elite genotypes. *Saltol*, a major effect QTL for salinity tolerance was identified in rice chromosome 1, which was targeted for introgression to improve seedling stage salinity tolerance of two Bangladeshi mega rice variety BR11 (*Transplated Aman* or monsoon season) and BRRI dhan28 (BR28) (*Boro* or winter season). FL378, a tolerant F_8 Recombinant Inbred Line (RIL) was used as the donor to introgress *Saltol* alleles conferring seedling stage salinity tolerance into BR11 and BRRI dhan28 by MABC. Three-step marker aided selections i.e. Foreground, Recombinant and Background selection were employed to select progenies having precise QTL within a clean background of recurrent parent. In foreground selection 3 most tightly linked and robust SSR marker i.e. RM1287 (10.90 Mb), RM3412 (11.50 Mb) and RM493 (12.20 Mb) were used to locate the *Saltol* QTL in backcross progenies (Islam 2006, Ferdousi 2008, Thomson et. al. 2010 and Alam et al. 2011). Two to four SSR markers i.e. RM3627 (10.31 Mb) at the distal end of the QTL and RM10825 (13.30 Mb), RM10864 (14.20 Mb), RM562 (14.60 Mb), RM7075 (15.10 Mb) at the proximal end were used in recombinant selection to precisely limit the QTL segment (to reduce negative linkage drag). For the background selection 87-103 SSRs, InDel and gene-based markers were used to recover the recurrent genome (Septiningsih, et al. 2009). Three backcrosses and two selfs were done to transfer positive alleles of *Saltol* from FL378 into a clean and/or minimum background of BR11 and BRRI dhan28.

4 PROGENY SELECTION FOR TESTING AND RELEASE

Two and six Near Isogenic Lines (NILs) at BC_3F_3 stage were selected having 1.3-3.7 Mb introgression at the *Saltol* region with 97 to 99% recurrent parent genome for BR11 and BRRI dhan28 respectively. Figure 1 illustrates the MABC scheme for the development of introgression lines (BR11-*Saltol*) in a nutshell. Introgressing 1.3-3.7 Mb regions of target loci in to BR11 and BRRI dhan28 slightly improved their overall tolerance at seedling stage (SES score) (Figure 2). All introgression lines however showed improved agronomic performance i.e. showed good stature, long panicles, high and dense grains, etc. The NILs looked very similar to the recurrent parents (BR11, BRRIdhan28), some of which however, showed greater yield potential in both saline and non-saline conditions. Tolerance to salinity is highly polygenic in nature; three different types of stresses (Osmotic, Ionic and Oxidative) are associated with the trait. So, in all likelihood a single QTL is not enough to significantly increase the tolerance level. Pyramiding of multiple QTL controlling different physiological mechanisms with different genetic background could help to achieve a higher level of salt tolerance.

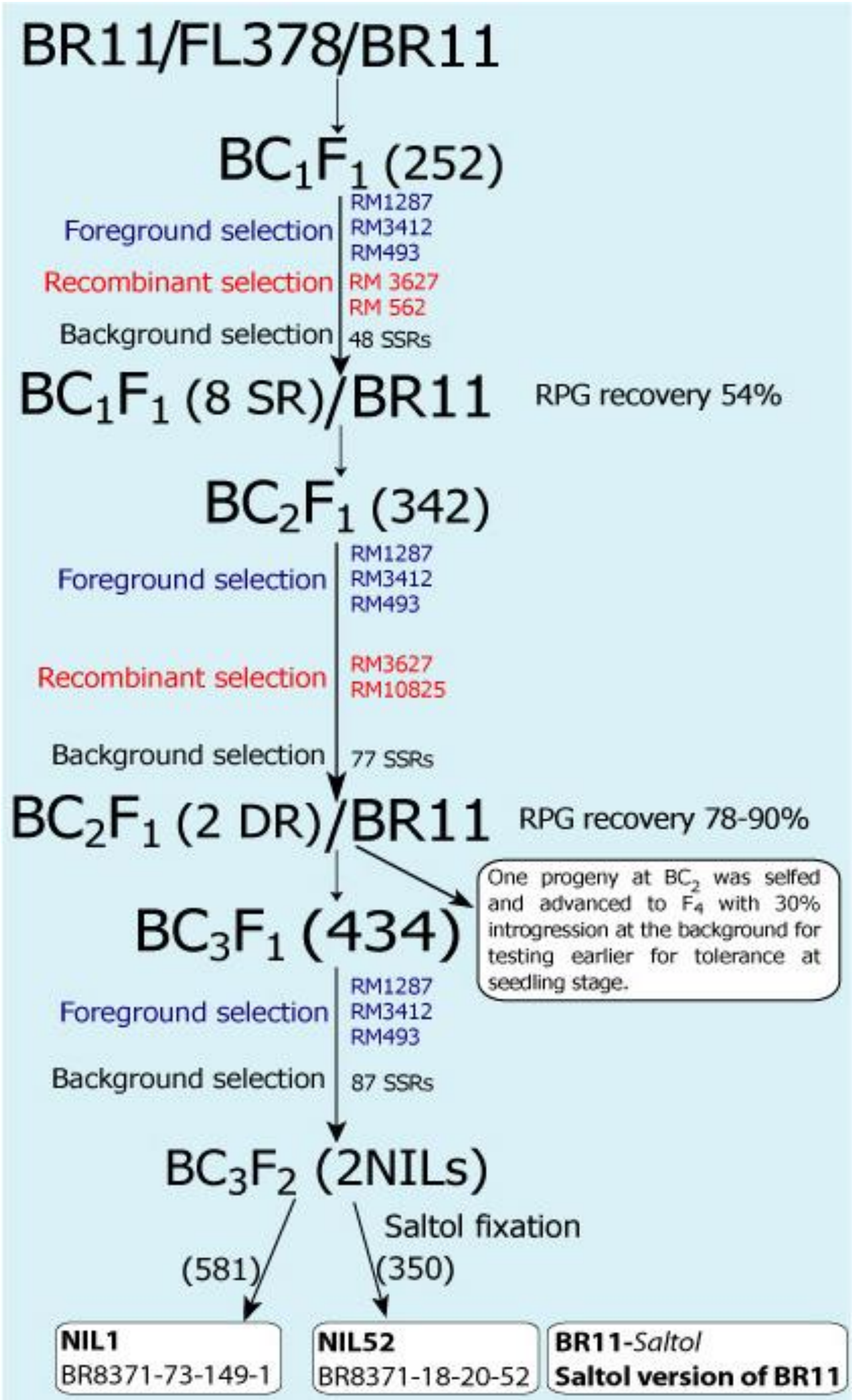

Figure 1. Flow chart of 3-backcross step MABC scheme for the development of BR11-*Saltol* introgression lines with DNA markers used and the numbers of progenies genotyped in different backcross generation.

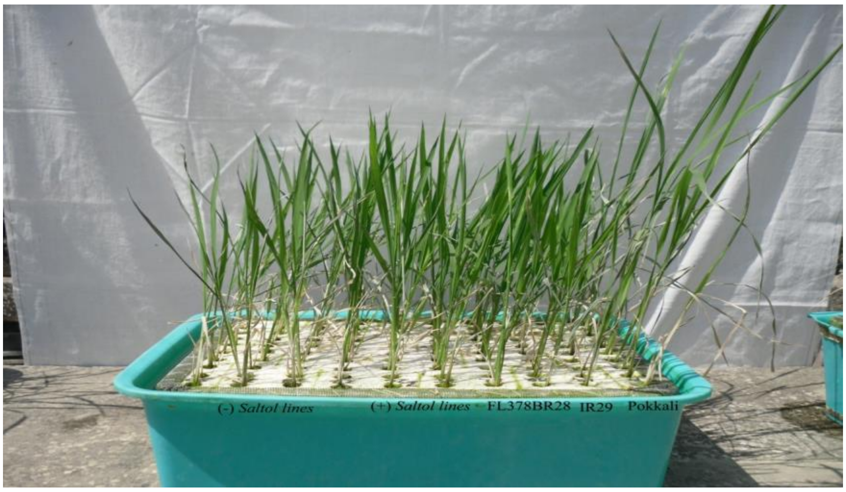

Figure 2. Photograph showing tolerance of introgression lines at seedling stage in hydroponics culture with stress @12 dSm^{-1} in Net house condition. From L-R, Rows 1-3 are the negative controls without *Saltol,* rows 4-6 are lines with *Saltol* (show increased vigor). Rows 7, 8, 9 and 10 are respectively, the donor FL378, the sensitive parent BR28, the sensitive control IR29 and the tolerant control Pokkali.

5 GENETIC TRANSFORMATION

The *Helicase* gene (*Pea DNA Helicase* or *PDH45*) construct was obtained from Dr. Narendra Tuteja of ICGEB under an MTA. This was transformed into *E.coli*, confirmed and subsequently transformed into *A. tumefaciens* for rice transformation as described in detail including testing of the transgenic rice, Binnatoa, for salt tolerance in Amin *et al.* (2012). Since Binnatoa is a traditional cultivar with poor agronomic traits, the gene was backcrossed into three farmer-popular Bangladeshi rice cultivars, BRRIdhan 28, 29 and 47 as described below. Progenies showing good tolerance score at the seedling stage were advanced and stable inheritance of the transgene was shown upto the F_5 generation. These F_5 progenies are now being tested for reproductive stage stress tolerance.

The *SNAC1* RNA was isolated from the salt tolerant rice landrace Pokkali, converted to cDNA and cloned into the InVitrogen directional cloning ENTR vector, confirmed by sequencing and restriction digestion before recombining it into the Gateway *Agrobacterium*-compatible Binary Destination vector, pH7WG2 (Abdullah-Al-Emran et al., 2010). Standard rice transformation and regeneration protocols were done, gene insertion and expression confirmed, plants advanced to T_2 and seedling salinity tolerance assays conducted as described in Amin et al. (2012).

Similar protocols were used for cloning of the HARDY gene, except that the RNA was isolated from *Arabidopsis thaliana* Landsberg. All these transformations were done in the tissue culture responsive rice variety Binnatoa which is a traditional cultivar and hence not high-yielding. In order to transform the transcription factor genes into high yielding cultivars, we performed co-transformations with *Helicase* and *SNAC1* and *Helicase* and *HARDY* using an *in planta* transformation protocol according to Lin *et al*. (2009) (Please see below). The genes were co-transformed into BRRIdhan-27, BRRIdhan-29, BRRIdhan-43, BRRIdhan-49, BRRIdhan-52 and BRRIdhan-55. Transgenic T_2 progenies are being assessed for their seedling salinity tolerance as described in Amin *et al*. (2012).

6 AGROBACTERIUM –MEDIATED TRANSFORMATION (TISSUE-CULTURE DEPENDENT)

Rice calli were transformed with Agrobacterium tumefaciens (strain LBA4404) containing the selected gene construct. The transformation method was carried out according to the method described by Khanna and Raina (1999) with some modifications (Rasul et al. 2005). The Bangladeshi tissue culture responsive cultivar Binnatoa, was used for transformation (Rasul et al. 1997).

7 AGROBACTERUM-MEDIATED TRANSFORMATION (TISSUE-CULTURE INDEPENDENT OR IN PLANTA)

Mature rice seeds of individual variety were sterilized with 99% ethanol, 30% chlorox, Tween 20 and kept at 37ºC. After 2 days the embryo region turned white. The embryonic apical meristem in the seed was pierced to a depth of 1-1.5 mm with a needle that had been dipped in the bacterial solution to inoculate gene construct in *Agrobacterium* into plumule where a shoot would later emerge as described in Lin et al. (2009) with the exception that 0.4% acetosyringone was added to the bacterial culture media. For co-transformation, a mixture of *Agrobacteria* solution, containing two gene constructs was used. The pierced seeds were then placed in a conical flask and soaked in *the Agrobacterium* inoculums and vacuum applied. The inoculated seeds were transferred onto petri dishes containing wet filter papers and incubated in the dark at 28°C for 6-7 days. The emerged seedlings were treated with 250mg/L carbenicillin solution, washed with ddH_20 and transferred to new petri dishes containing wet filter papers. Seedlings were then kept in light for 16 hours and in dark for 6 hours. When the seedlings turn green, they were transferred to hydroponic solution. After 2-3 days the hydroponic pots were transferred to net-house. When the seedlings were mature, they were transferred to soil. T_1 seeds only from those panicles whose flag leaf was resistant to hygromycin solution were germinated again in hygromycin. Seedlings which survived in hygromycin and were PCR-positive for the transgene were advanced to the T_2 generation and salinity tolerance tests performed.

8 SALT STRESS SCREENING FOR SELECTING TRANSGENICS WITH GOOD TOLERANCE SCORES

Transgenic plants were checked for tolerance level by seedling stage screening as described in detail in Amin *et al.* (2012). The germinated seeds of WT, transgenic lines and sensitive controls (IR29) were transferred to Hydroponics in netted, floating styrofoam in a completely randomized design, allowed to grow for 2 weeks and then salt stress up to 12 dS/m was applied gradually. (Ponnamperuma, 1977). The EC of the solution was maintained at 12 dS/m until the end of the experiment. The pH of the non-aerated Yoshida culture solution was adjusted to 5.0 every day and the culture solution was changed every 2 days. After 8–10 days, when the sensitive control IR29 in stress were dead, tolerance-related traits (Leaf Drying score, root length, shoot length) of all stressed as well as control plants were measured. Data for percent survival and total leaf area affected was recorded according to the standard evaluation system of rice at IRRI (IRRI 1996; Gregorio et al. 1997). The level of salinity tolerance was evaluated based mainly on the value of LDS, which is based on the percentage of leaf damage. The plants were scored according to the following scale: 1: highly tolerant (10%); 3: tolerant (10–30%); 5: moderately tolerant (30–50%); 7: moderately susceptible (50–70%) and 9: susceptible (70%) (Gregorio et al.1997). The chlorophyll content of the stressed and control transgenic shoots as well as WT was measured at this stage (Vernon 1969), as well as their dry weight after keeping them for 72 h at 70^{0}C in a hot-air circulating oven (Honeywell, UK model DT200).

9 INTRODUCING THE HELICASE TRANSGENE INTO FARMER-POPULAR CULTIVARS BY BACKCROSSING AND SELECTION OF THE BEST TOLERANT LINES

The *Helicase* gene was backcrossed from the Binnatoa genetic background into three farmer-popular Bangladeshi rice cultivars, BRRIdhan 28, 29 and 47. The F_1 plantlets containing the *PDH45* transgene were selected by PCR and allowed to self up to the F_5 generation. The presence of the transgene was confirmed at each generation. Seedling stage screening was carried out at both F_3 and F_4 generations. Some transgenic progenies showed better tolerance than their sensitive parent (Figure 3). Significantly tolerant plants of each variety were selected and will be screened at reproductive stage to check the grain yield under salt stress.

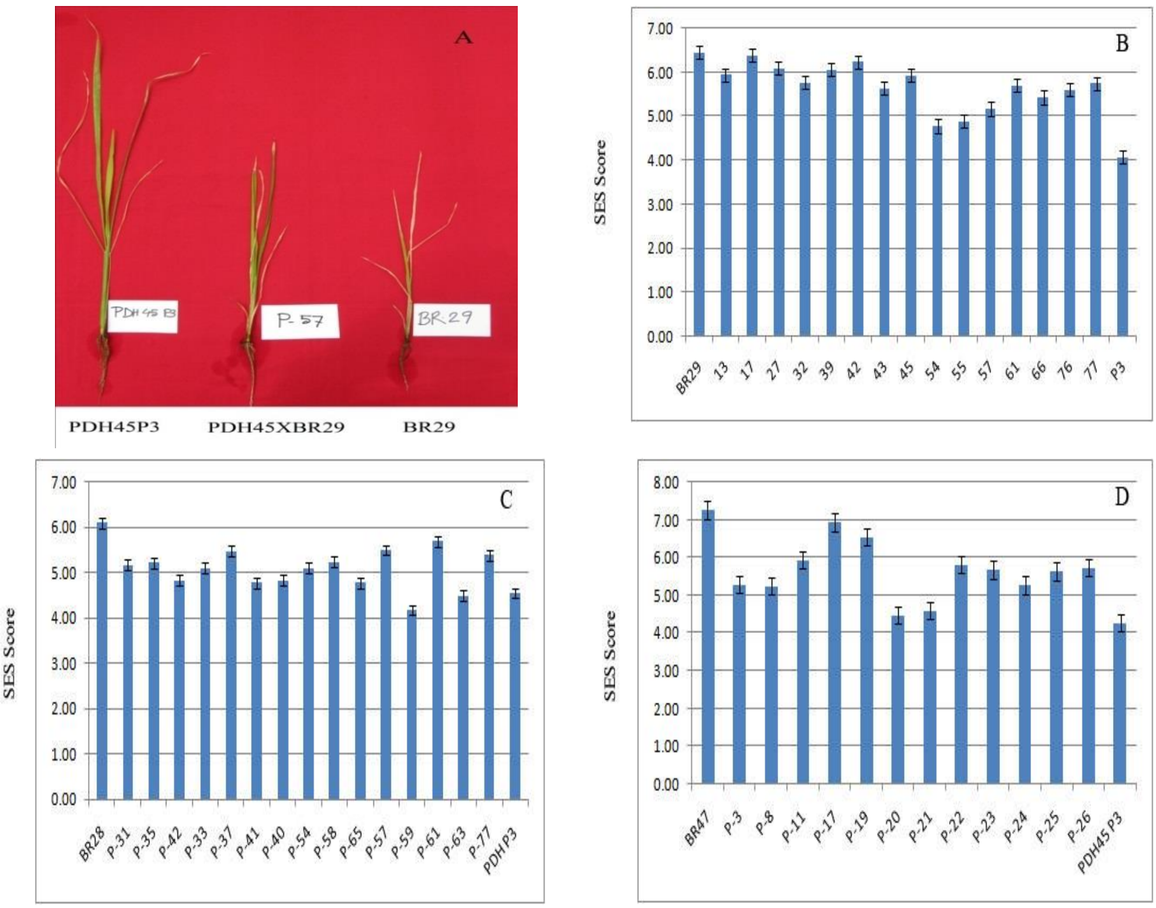

Figure 3. Transgenic rice with PDH45 performed better at physiological screening.(A) Seedlings of PDH45, PDH45×BR29 and BR29 after 12 dS/m salt stress in a hydroponic system. PDH45×BR29 seedling is more vigorus than the Wild type BR29. (B,C,D) SES Score of wild-type and transgenic rice seedlings after NaCl stress at 12 dS/m in hydroponics. Each bar represents the mean ± SE (n = 18); P<0.05.

10 SELECTION OF THE BEST-PERFORMING LINES TRANSFORMED WITH THE TRANSCRIPTION FACTORS SNAC1 AND HARDY

Six transgenic rice lines containing the SNAC1 gene were selected by PCR and advanced to the T_3 generation. The presence of the transgene was confirmed at each generation. Depending on the expression levels of the transgene by RT-PCR, four lines have been selected for physiological screening. Among these four lines, progenies of one line showed better tolerance than the wild type (Figure 4).

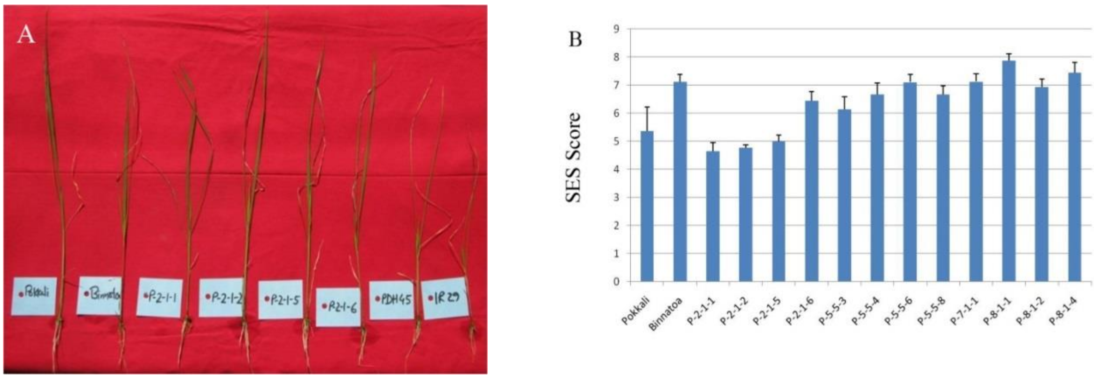

Figure 4: Transgenic rice containing SNAC1 gene showed better tolerance. (A) SNAC1 gene containing transgenic seedlings, Wild Type (Binnatoa), Sensitive control IR29 after 12 dS/m salt stress in hydroponic system. (B)) SES Score of wild-type and transgenic rice seedlings after NaCl stress at 12 dS/m in hydroponics. Each bar represents the mean ± SE (n = 18); P<0.05.

The presence of HARDY gene in the transgenic rice plants was confirmed by PCR and their expression checked by RT PCR. One of the three transgenic plants had higher expression of HARDY gene and was thus selected for further analysis. The co-transformed seedlings were screened by Hygromycin resistance assay for the presence of respective transgenes at the T_0 generation and further confirmed by PCR. T_1 seeds were collected from the hygromycin resistant PCR positive plants. The transgenic plants were further characterized by leaf disc senescence assay (Figure 5).

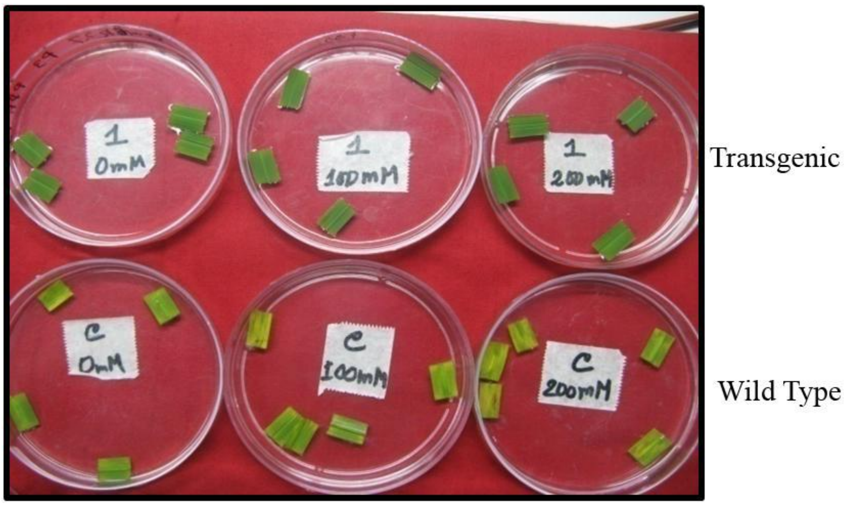

Figure 5: Leaf Senescence Assay at T_1 generation for the HARDY transformants.

11 ACKNOWLEDGEMENTS

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REFERENCES

Abdullah-Al-Emran, R. Malo, M. Amin, D. Chakraborty, A. Ferdousi and Z. I. Seraj (2010). Cloning and Transformation of the Transcription Factor *SNAC1* from Rice (*Oryza sativa* L.) Landrace Pokkali. Proceedings of the Sixth International Plant Tissue Culture and Biotechnology Conference; Dec 3-5, 2010; BAPTC&B, Dhaka, Bangladesh.
Agarwal P. K., P. S. Shukla, K. Gupta, B. Jha (2013). Bioengineering for salinity tolerance in plants: state of the art. Mol Biotechnol 54:102-23.

Alam, R., M.S. Rahman, Z. I. Seraj, M. J. Thomson, A. M. Ismail, E. Tumimbang-Raiz and G. B. Gregorio. 2011. Investigation of seedling-stage salinity tolerance QTLs using backcross lines derived from *Oryza sativa L.* Pokkali. Plant Breeding 130 (4):430-437.

Amin M., S. M. Elias, A. Hossain, A. Ferdousi, M. S. Rahman, N. Tuteja and Z. I. Seraj (2012). Over-expression of a DEAD-box helicase, PDH45, confers both seedling and reproductive stage salinity tolerance to rice (Oryza sativa L.). Mol Breeding (2012) 30:345–354

Bailey-Serres J., T. Fukao, P. Ronald, A. Ismail, S. Heuer and D. Mackill (2010). Submergence Tolerant Rice: SUB1's Journey from Landrace to Modern Cultivar. Rice 3: 138-147.

Bonilla, P.S., J. Dvorak, D. Mackill, K. Deal and G.B. Gregorio. 2002. RFLP and SSLP mapping of salinity tolerance genes in chromosome 1 of rice (*Oryza sativa* L.) using recombinant inbred lines. The Philippines Agricultural Scientist 85(1):64-74.

BRRI. 2011. *Adhunic dhaner chash (a Bengali booklet for modern rice cultivation)*. 16th Edition. BRRI, Gazipur, Bangladesh.

Ferdousi, A. 2008. Validation of DNA markers linked to salt tolerant traits in breeding populations and near isogenic lines of rice. MS thesis, Faculty of Biological Science, Department of Biochemistry and Molecular Biology, University of Dhaka, Dhaka, Bangladesh.

Fukuda A., A. Nakamura, A. Tagiri, H. Tanaka, A. Miyao, H. Hirochika and Y. Tanaka (2004). Function, Intracellular Localization and the Importance in Salt Tolerance of a Vacuolar Na^+/H^+ Antiporter from Rice. Plant Cell Physiol (2004) 45 (2):146-159.

Gamuyao R., J. H. Chin, J. Pariasca-Tanaka, P. Pesaresi, S. Catausan, C. Dalid, I. Slamet-Loedin I, E. M. Tecson-Mendoza, M. Wissuwa and S. Heuer (2012). The protein kinase Pstol1 from traditional rice confers tolerance of phosphorus deficiency. Nature 488 (7412): 535-9

Gregorio G, Senadhira D, Mendoza R (1997) Screening rice for salinity tolerance. International Rice Research Institute,Los Banos. IRRI discussion paper series no. 22

Hu, H., M. Dai, J. Yao, B. Xiao, X. Li, Q. Zhang and L. Xiong (2006). "Overexpressing a NAM, ATAF, and CUC (NAC) transcription factor enhances drought resistance and salt tolerance in rice." Proceedings of the National Academy of Sciences **103**(35): 12987-12992

Iftekharuddaula K. M., M. A. Newaz, M. A. Salam, H. U. Ahmed, M. A. A. Mahbub, E. M. Septiningsih, B. C. Y. Collard, D. L. Sanchez, A. M. Pamplona, D. J. Mackill. 2011. Rapid and high-precision marker assisted backcrossing to introgress the SUB1 QTL into BR11, the rainfed lowland rice mega variety of Bangladesh. Euphytica 178:83–97.

Islam, M.R. 2006. Validation and allelic diversity analysis of molecular markers to salinity tolerance in rice chromosome 1. Ph.D. Thesis, 2006, Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh, Bangladesh.

IRRI (1996) Standard evaluation system manual, 4th edn. International Rice Research Institute, Los Banos

Karaba, A., S. Dixit, R. Greco, A. Aharoni, K. R. Trijatmiko, N. Marsch-Martinez, A. Krishnan, K. N. Nataraja, M. Udayakumar and A. Pereira (2007). "Improvement of water use efficiency in rice by expression of HARDY, an Arabidopsis drought and salt tolerance gene." Proceedings of the National Academy of Sciences **104**(39): 15270-15275.

Khanna H. K., Raina SK (1999) Agrobacterium-mediated transformation of indica rice cultivars using binary and superbinary vectors. Aust J Plant Physiol 26:311–324

Lin, J., B. Zhou, Y. Yang, J. Mei, X. Zhao, X. Guo, X. Huang, D. Tang and X. Liu (2009). "Piercing and vacuum infiltration of the mature embryo: a simplified method for Agrobacterium-mediated transformation of indica rice." Plant cell reports **28**(7): 1065-1074.

Mackill D. J., A. M. Ismail, A. M. Pamplona, D. L. Sanchez, J. J. Carandang and E. M. Septiningsih (2010). Stress tolerant Rice varieties for adaptation to a changing climate. Crop, Environment & Bioinformatics 7:250-259

Neeraja, C.N., R. Maghirang-Rodriguez, A. Pamplona, S. Heuer, B.C.Y. Collard, E.M. Septiningsih, G. Vergara, D. Sanchez, K. Xu, A.M. Ismail, and D.J. Mackill. 2007. A marker-assisted backcross approach for developing submergence-tolerant rice cultivars. Theoretical Applied Genetics 115:767–776.

Ponnamperuma F (1977) Screening rice for tolerance to mineral stress. IRRI research paper series no. 6

Rasul N, Ali K, Islam R, Seraj ZI (1997) Transformation of anindica rice cultivar Binnatoa with
Agrobacterium tumefaciens. Plant Tissue Cult 7:71–80

Rasul N (2005) Isolation and characterization of vacuolar Oryza sativa Na?/H? antiporter and its expression in transgenic rice. PhD thesis, University of Dhaka

Sanan-Mishra N., X. H. Pham, S. K. Sopory and N. Tuteja (2005). Pea DNA helicase 45 overexpression in tobacco confers high salinity tolerance without affecting yield. Proc Natl Acad Sci USA 102(2):509–514

Septiningsih, E.M., A. M. Pamplona, D. L. Sanchez, C. N. Neeraja, G. V. Vergara, S. Heuer, A. M. Ismail and D. J. Mackill. 2009. Development of submergence-tolerant rice cultivars: the *Sub1* locus and beyond. Annals of Botany 103: 151–160.

Thomson, M.J., M. de Ocampo, J. Egdane, M.A. Rahman, A.G. Sajise, D.L. Adorada, E. Tumimbang-Raiz, E. Blumwald, Z.I. Seraj, R.K. Singh, G.B. Gregorio and A.M. Ismail. 2010. Characterizing the *Saltol* Quantitative Trait Locus for Salinity Tolerance in Rice. Rice 3:148–160.

Vernon L (1969) Spectrophotometric determination of chlorophylls and phaeophytins in plant extracts. Anal Chem 32:1144–1150

Xu K, X. Xu, T. Fukao, P. Canlas, R. Maghirang-Rodriguez, S. Heuer , A. M. Ismail, J. Bailey-Serres, P. C. Ronald, D. J. Mackill (2006). Sub1A is an ethylene-response-factor-like gene that confers submergence tolerance to rice**.** Nature 442 (7103) :705-8.

Xue Z-Y., D-Y. Zhi, G-P. Xue, H. Zhang,Y-X. Zhao and G-M. Xia (2004). Enhanced salt tolerance of transgenic wheat (*Tritivum aestivum* L.) expressing a vacuolar Na+/H+ antiporter gene with improved grain yields in saline soils in the field and a reduced level of leaf Na+. Plant Science 167 (2004) 849–859

Yoshida S, Forno DA, Cock JH, Gomez KA (1976) Laboratory manual for physiological studies of rice, 3rd edn. International Rice Research Institute, Los Banos, pp 61–66

Zhang H-X, J. N. Hodson, J. P. Williams and E. Blumwald (2001). Engineering salt-tolerant *Brassica* plants: Characterization of yield and seed oil quality in transgenic plants with increased vacuolar sodium accumulation. PNAS 98:12832-12836

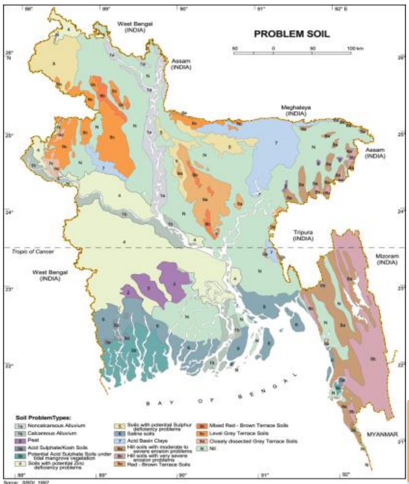
Zhang H-X. and E. Blumwald (2001). Transgenic salt-tolerant tomato plants accumulate salt in foliage but not in fruit. Nature Biotech 19:765-768

Bangladesh Agriculture at a glance

- Total area: 14.8 Mha
- Total cultivable land: 8.5 Mha
- Total irrigated land: 52%
- Cropping intensity: 191%
- Share of agriculture in the GDP: 19.29%
- Farm labour engaged in agriculture: 25.7%
- GDP growth rate: 6.66%
- Agriculture growth rate: 4.96%
- Paddy production: 33541101 ton (33.5 Mt)
- Wheat production: 972085 ton (0.9 Mt)

11/5/2017 Source: BBS/DAE 2012 2

Figure 1. Bangladesh Agriculture at a glance.



Problem soils in Bangladesh. (Source: SRDI, 1997)

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Figure 2.

Rice statistics Bangladesh

Rice areas in million hectares	
Submergence prone areas (Flash flood)	1.00
Submergence prone areas (Tidal submergence)	0.80
Drought prone areas	2.68
Saline prone areas (Coastal salinity)	1.20
Rainfed low lying areas	3.20
Upland areas	0.06
Deepwater areas	0.06
Total rice growing areas	9.00

Rice production (% share by season)	
Boro	56%
Aman	38%
Aus	6%

MV adoption (% share by season)	
Boro (HYV & Hybrid)	99%
Aman (HYV & Hybrid)	70%
Aus (HYV & Hybrid)	72%
Overall MV adoption 80.33%	

Source: Agricultural Economics Division, BRRI

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Figure 3. Rice statistics Bangladesh.

Rice varieties released in Bangladesh

There are two public sector research institute which released around 70 HYVs and hybrid varieties. But private sector seed companies and some NGOs have introduced, developed and commercialized numerous hybrid rice varieties in Bangladesh.

Public Institutes	Total variety developed, introduced and released	Inbred variety	Hybrid variety	Stress tolerant varieties developed and released
Bangladesh Rice Research Institute (BRRI)	64	60	4	Drought tol. = 4 variety Submergence tol. = 2 variety Salinity tol. = 6
Bangladesh Institute of Nuclear Agriculture (BINA)	12	12	0	Salinity tol. = 2 Submergence tol. = 2

NOTE: None of the hybrid variety is release for the stress environment.

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Figure 4. Rice varieties released in Bangladesh.

Figure 5. Submergence tolerant rice/ Submarine rice/ Scuba rice.

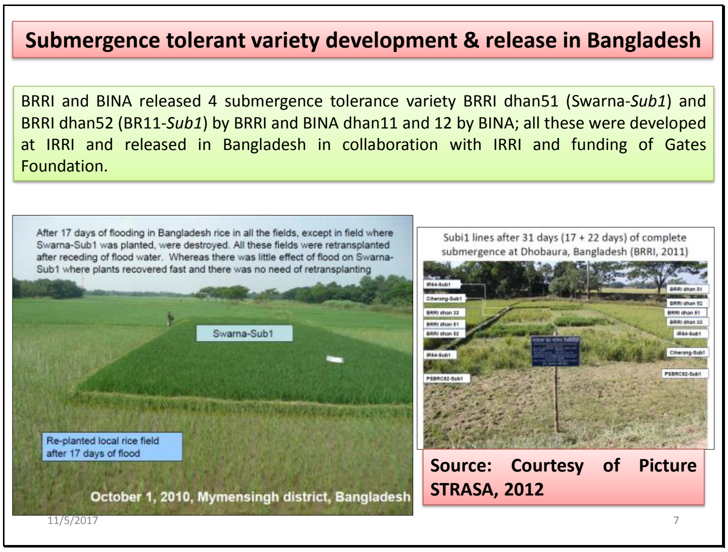

Figure 6. Submergence tolerant variety development & release in Bangladesh.

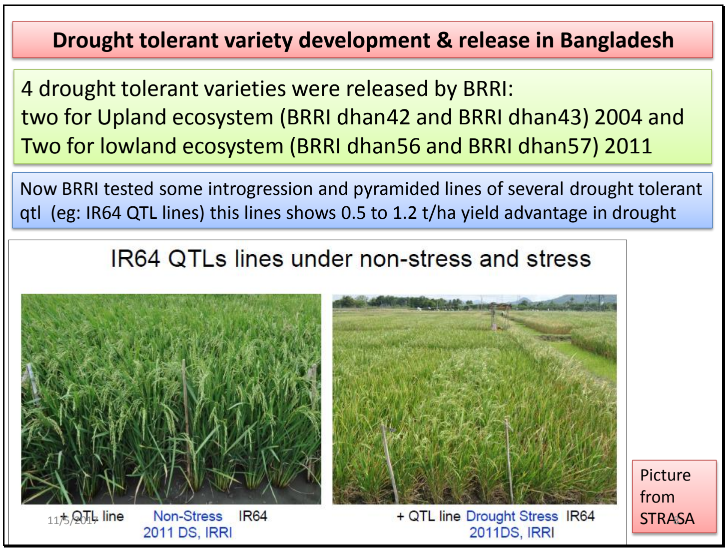

Figure 7. Drought tolerant variety development & release in Bangladesh.

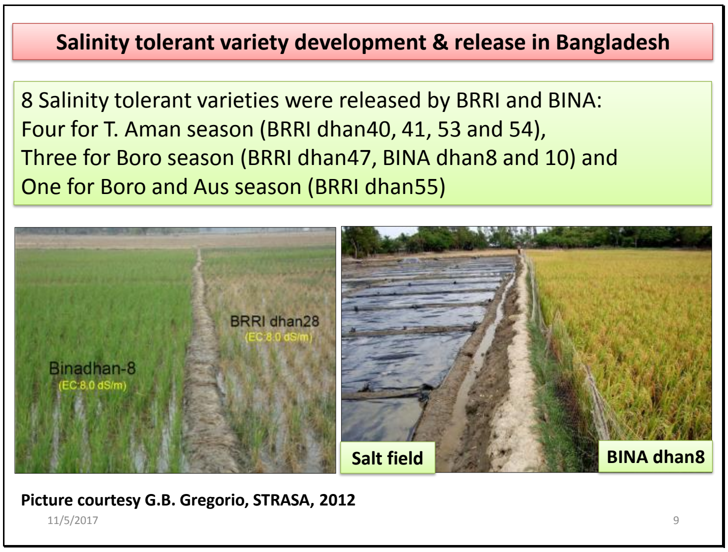

Figure 8. Salinity tolerant variety development & release in Bangladesh.

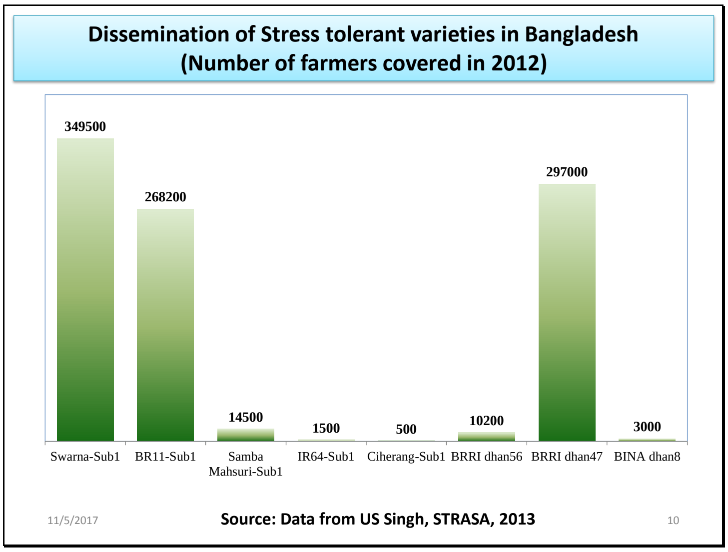

Figure 9. Dissemination of stress tolerant varieties in Bangladesh (Number of farmers covered in 2012).

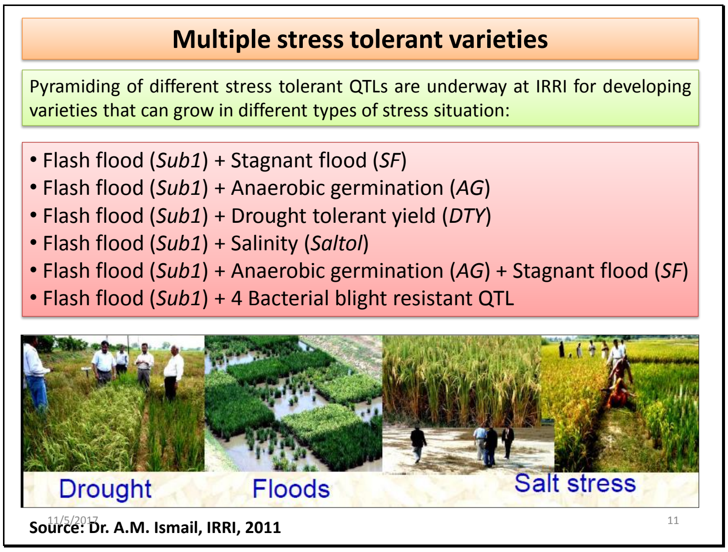

Figure 10. Multiple stress tolerant varieties.

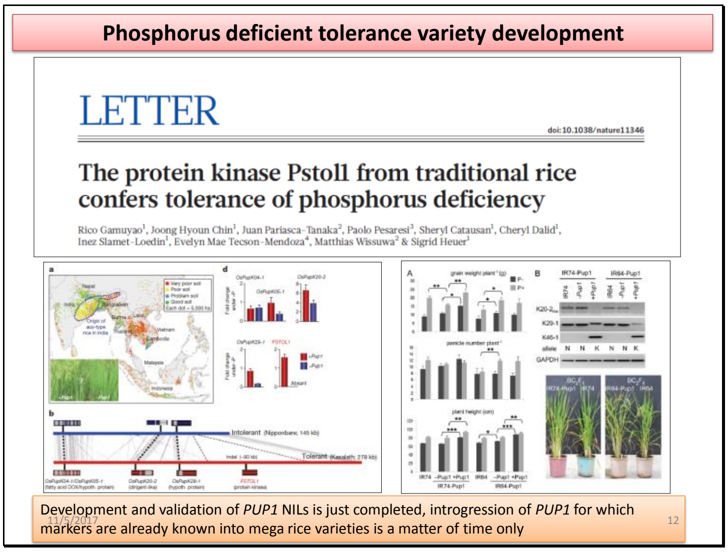

Figure 11. Phosphorous deficient to tolerate variety development.

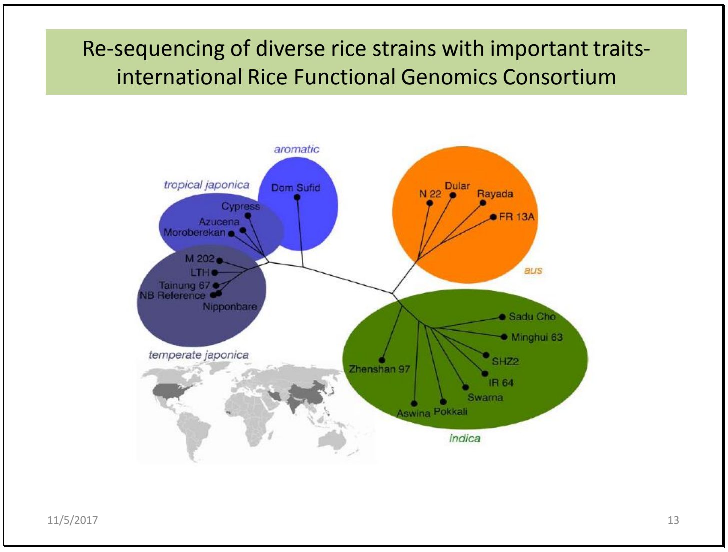

Figure 12.

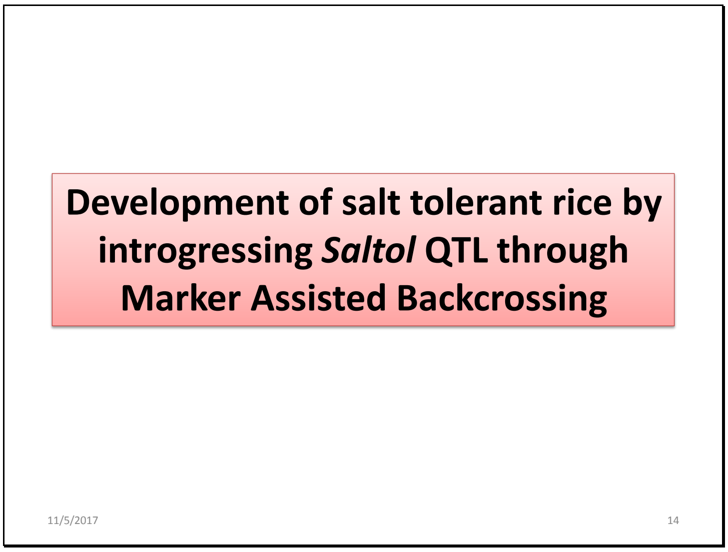

Figure 13.

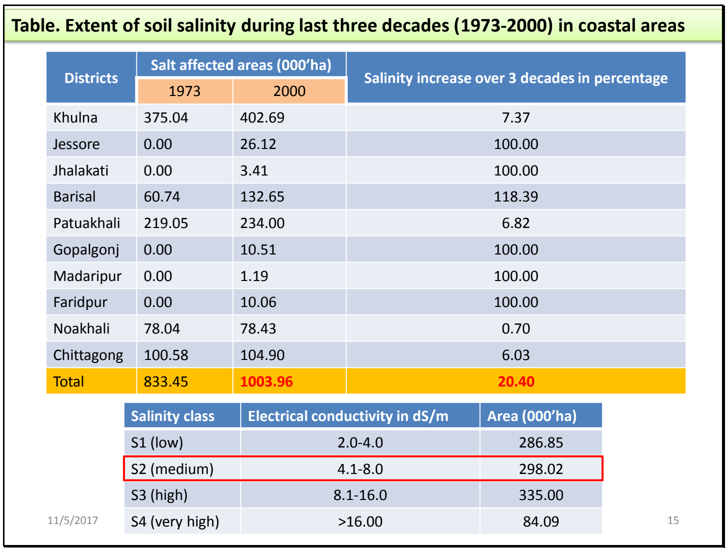
Table. Extent of soil salinity during last three decades (1973-2000) in coastal areas

Districts	Salt affected areas (000'ha)		Salinity increase over 3 decades in percentage
	1973	2000	
Khulna	375.04	402.69	7.37
Jessore	0.00	26.12	100.00
Jhalakati	0.00	3.41	100.00
Barisal	60.74	132.65	118.39
Patuakhali	219.05	234.00	6.82
Gopalgonj	0.00	10.51	100.00
Madaripur	0.00	1.19	100.00
Faridpur	0.00	10.06	100.00
Noakhali	78.04	78.43	0.70
Chittagong	100.58	104.90	6.03
Total	833.45	1003.96	20.40

Salinity class	Electrical conductivity in dS/m	Area (000'ha)
S1 (low)	2.0-4.0	286.85
S2 (medium)	4.1-8.0	298.02
S3 (high)	8.1-16.0	335.00
S4 (very high)	>16.00	84.09

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Figure 14. Table: Extent of soil salinity during last three decades (1973-2000) in coastal areas.

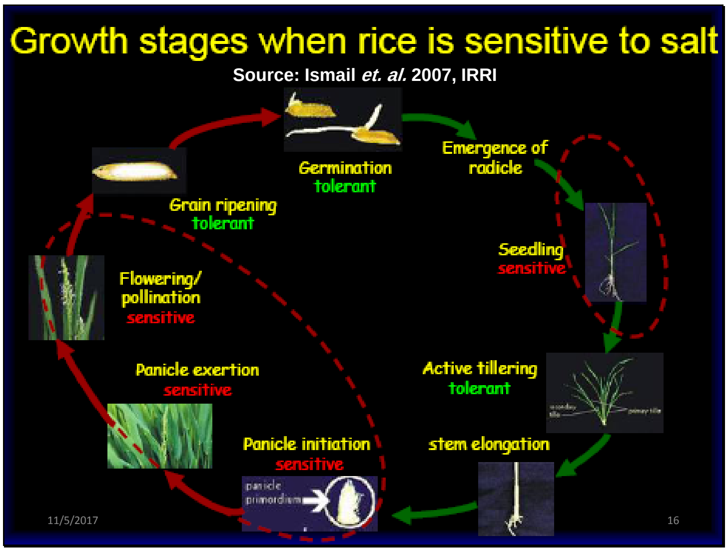

Figure 15. Growth stages when rice is sensitive to salt.

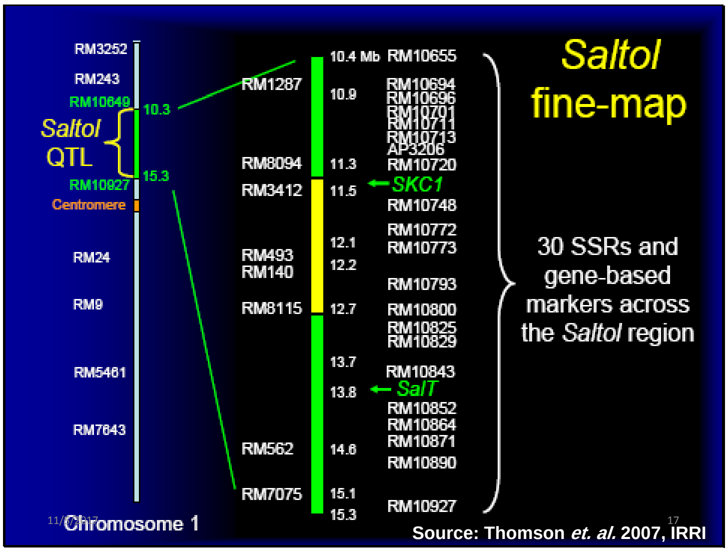

Figure 16. Saltol fine-map.

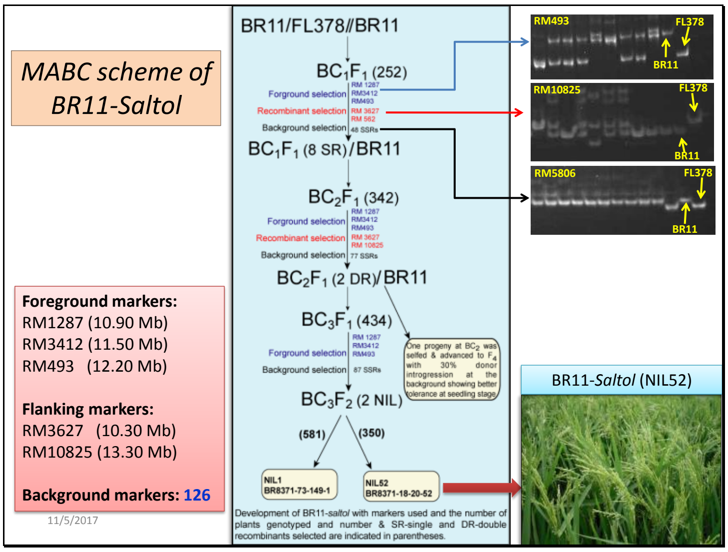

Figure 17.

Phenotypic characterization of BR11-*Saltol* lines at seedling stage

Varieties/Lines	Average SES	Average Survivability
Pokkali (Original donor)	3.97 a	100.00 a
FL378 (Donor parent)	5.03 b	90.00 ab
NIL52 (BR11-*Saltol*)	6.12 c	73.33 b
BR11 (Recipient parent)	6.73 cd	66.67 b
IR29 (Sensitive check)	7.15 d	61.67 b

Phenotyping of BR11-*Saltol* (NIL52) at seedling stage

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Figure 18. Phynotypic characterization of BR11-Saltol lines at seeding stage.

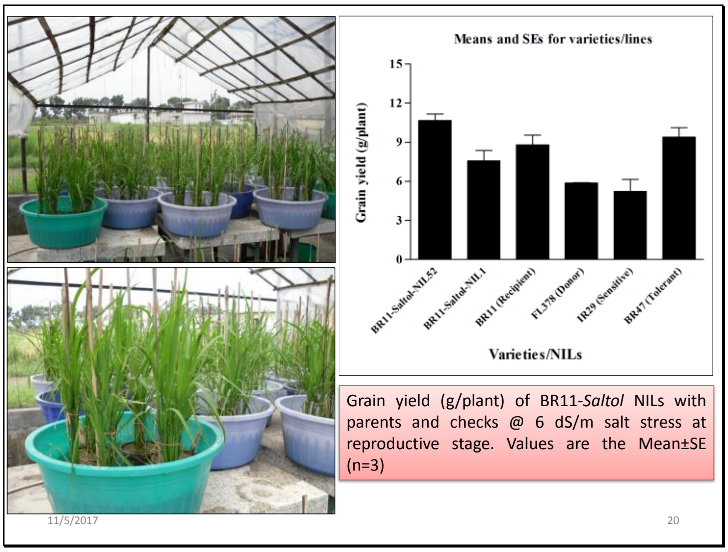


Figure 19.

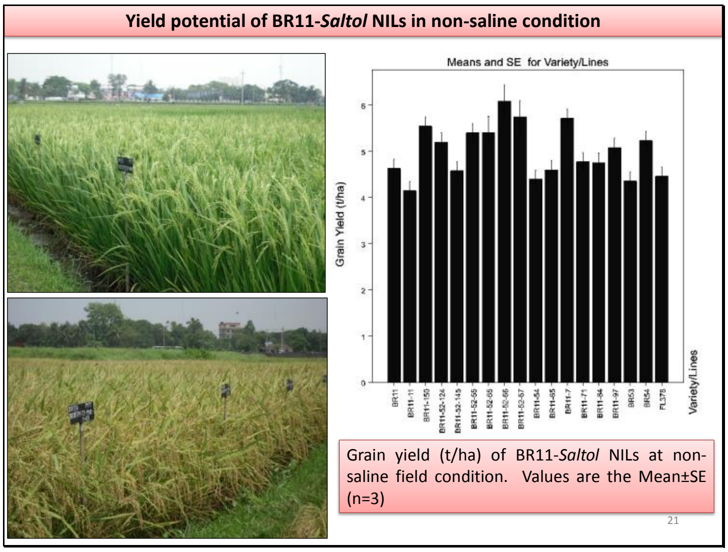
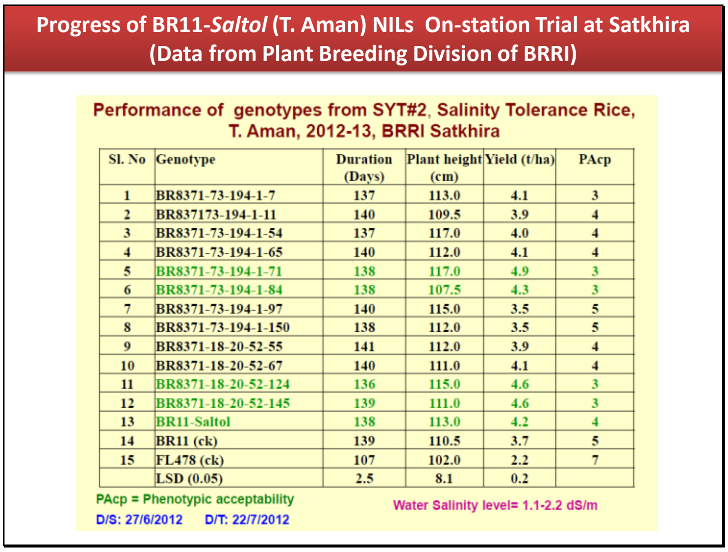


Figure 20. Yield Potential of BR11-Saltol/NILs in non-saline condition.



Progress of BR11-*Saltol* (T. Aman) NILs On-station Trial at Satkhira
(Data from Plant Breeding Division of BRRI)

Performance of genotypes from SYT#2, Salinity Tolerance Rice, T. Aman, 2012-13, BRRI Satkhira

Sl. No	Genotype	Duration (Days)	Plant height (cm)	Yield (t/ha)	PAcp
1	BR8371-73-194-1-7	137	113.0	4.1	3
2	BR837173-194-1-11	140	109.5	3.9	4
3	BR8371-73-194-1-54	137	117.0	4.0	4
4	BR8371-73-194-1-65	140	112.0	4.1	4
5	BR8371-73-194-1-71	138	117.0	4.9	3
6	BR8371-73-194-1-84	138	107.5	4.3	3
7	BR8371-73-194-1-97	140	115.0	3.5	5
8	BR8371-73-194-1-150	138	112.0	3.5	5
9	BR8371-18-20-52-55	141	112.0	3.9	4
10	BR8371-18-20-52-67	140	111.0	4.1	4
11	BR8371-18-20-52-124	136	115.0	4.6	3
12	BR8371-18-20-52-145	139	111.0	4.6	3
13	BR11-Saltol	138	113.0	4.2	4
14	BR11 (ck)	139	110.5	3.7	5
15	FL478 (ck)	107	102.0	2.2	7
	LSD (0.05)	2.5	8.1	0.2	

PAcp = Phenotypic acceptability
Water Salinity level= 1.1-2.2 dS/m
D/S: 27/6/2012 D/T: 22/7/2012

Figure 21. Progress of BR11-Saltol (T.Aman) NILs on station Trials at Satkhira (Data from Plant Breeding Division of BRRI).

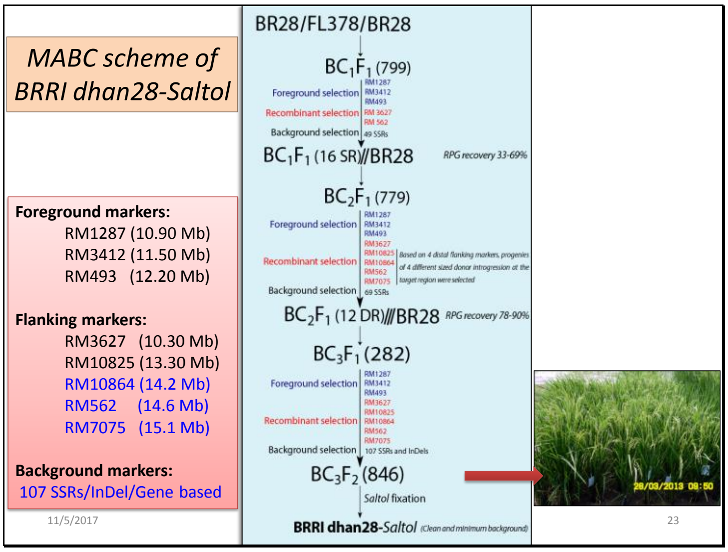


Figure 22.

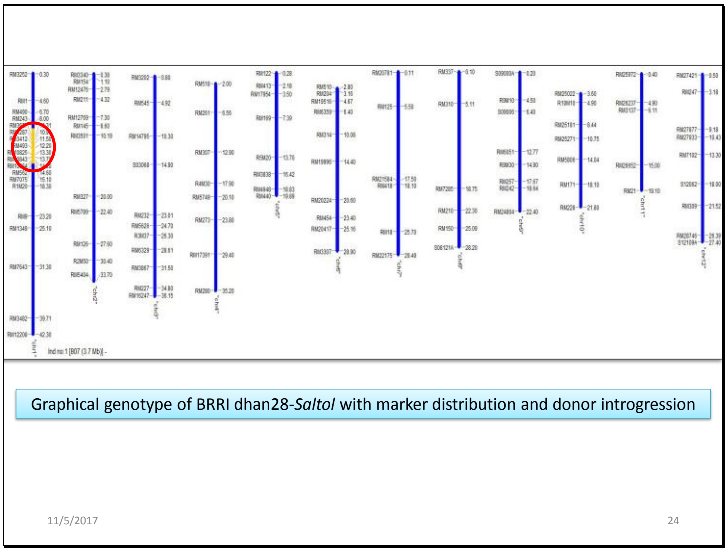


Figure 23.

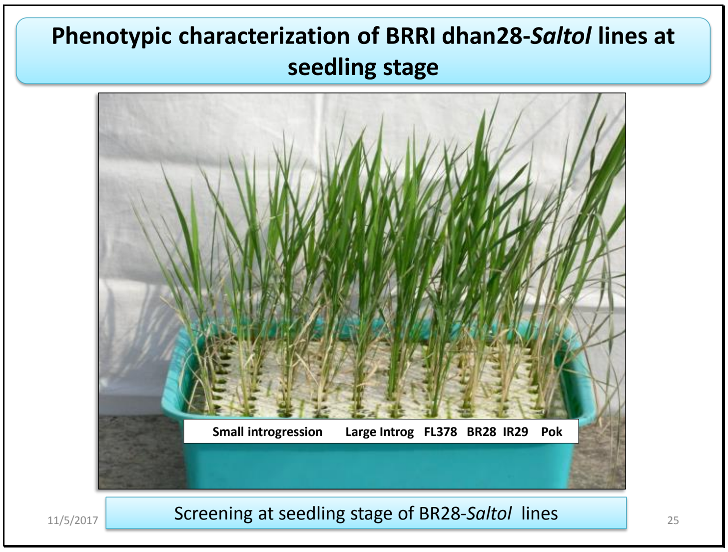


Figure 24. Phenotypic characterization of BRRI dhan28-Saltol lines at seeding stage.

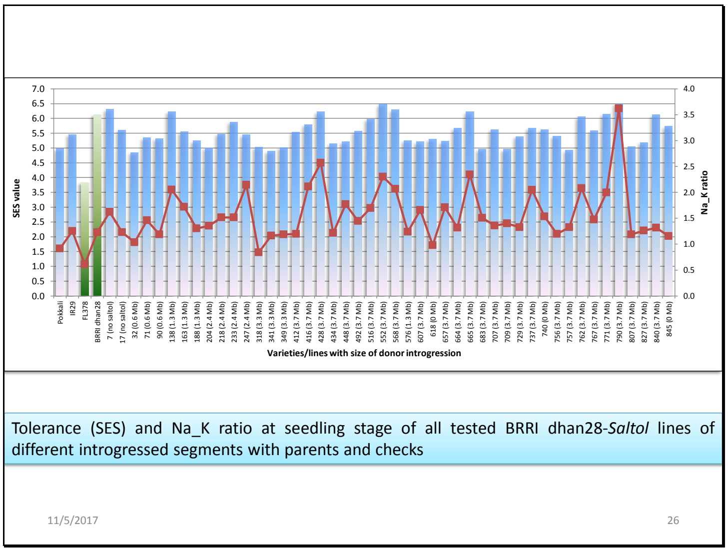


Figure 25.

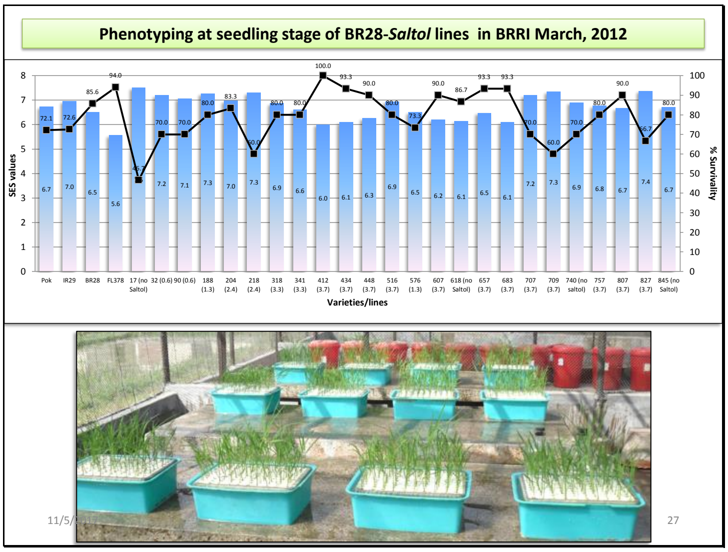


Figure 26. Phenotyping at seeding stage of BR 28-Saltol lines in BRRI March, 2012.

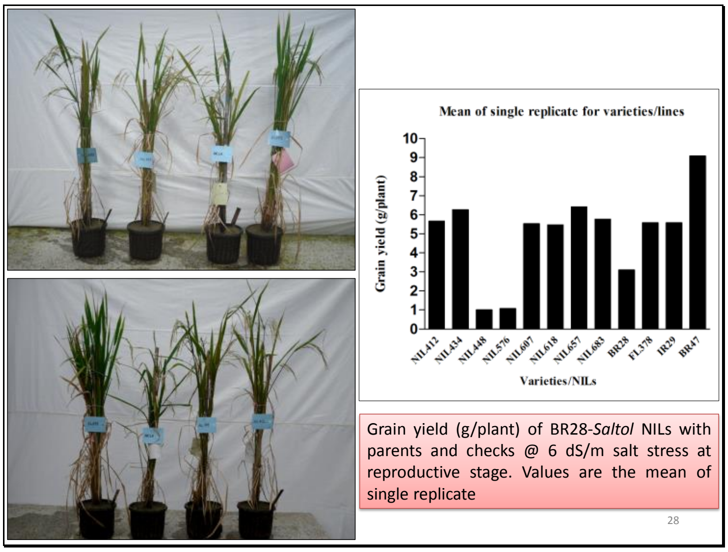


Figure 27.

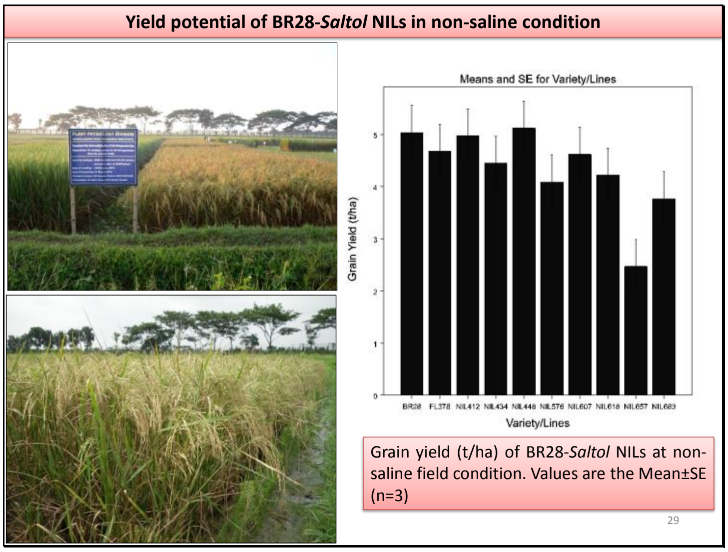


Figure 28.

Genes conferring salt tolerance

- The Na^+/H^+ antiporters
- Specific DNA/RNA helicases
- Specific transcription factors
- Detoxification systems

Figure 29. Genes conferring salt tolerance.

The vacuolar Na^+/H^+ antiporter

- The Na^+/H^+ antiporters (exchanger) catalyze the exchange of Na^+ for H^+ across membranes
- In plants, the Na^+/H^+ antiporter in vacuolar membranes transports Na^+ from the cytoplasm to vacuoles using the electrochemical H^+ gradient generated by two H^+ pumps, vacuolar H^+-inorganic pyrophosphatase and vacuolar H^+-ATPase.

Figure 30. The Vacuolar Na^+/H^+ antiporter.

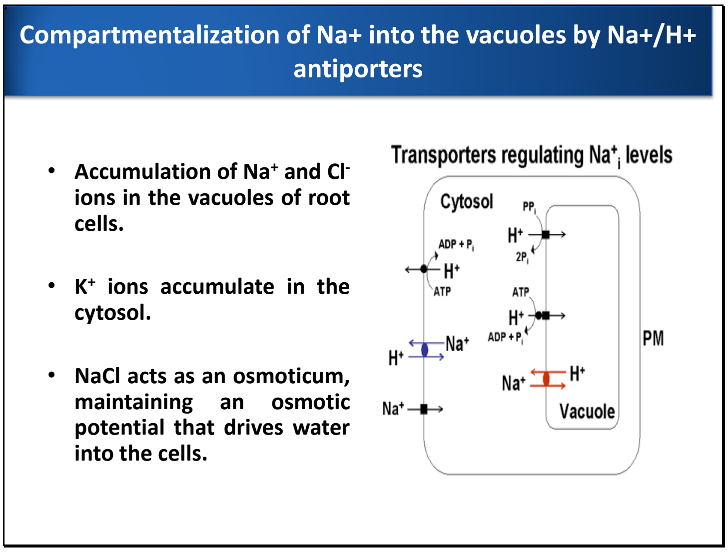


Figure 31. Compartmentalization of Na^+ into the vacuoles by NA^+/H^+ antiporters.

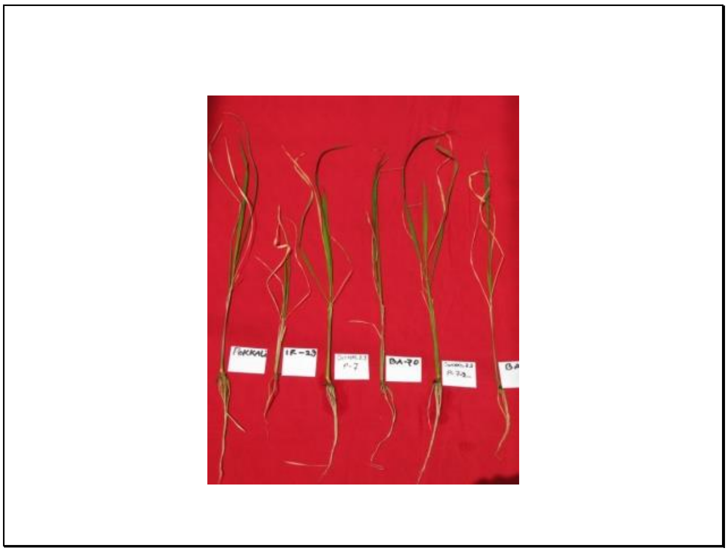


Figure 32.

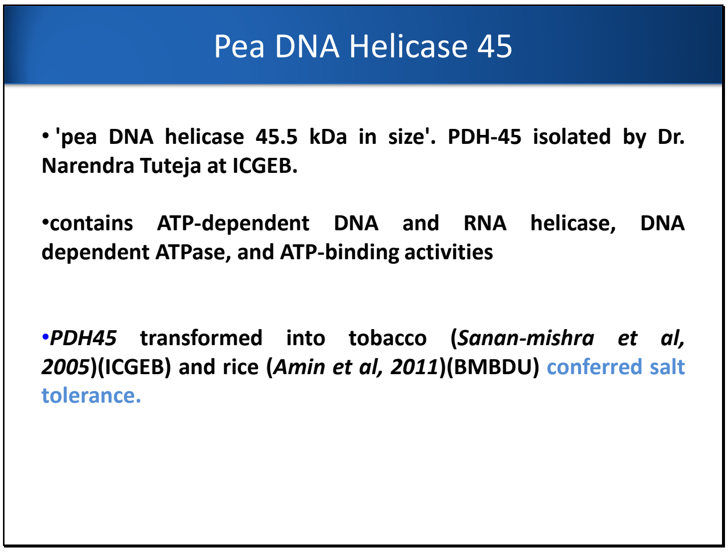


Figure 33. Pea DNA Helicase 45.

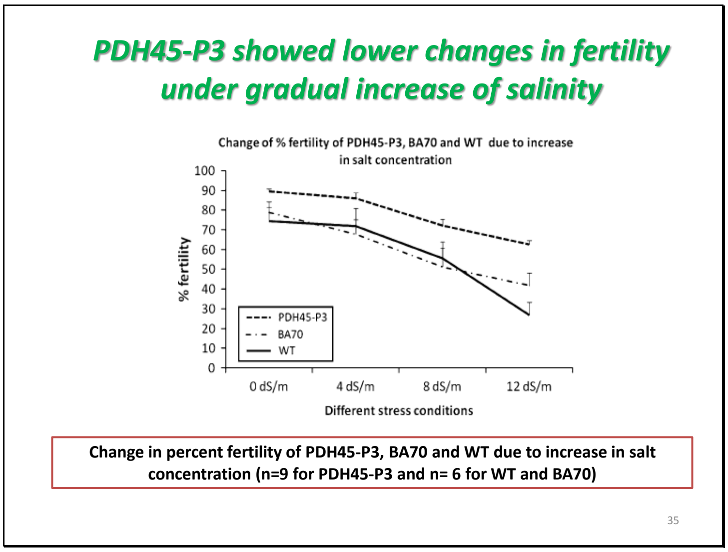


Figure 34. PDH45-P3 showed lower changes in fertility under gradual increase of salinity.

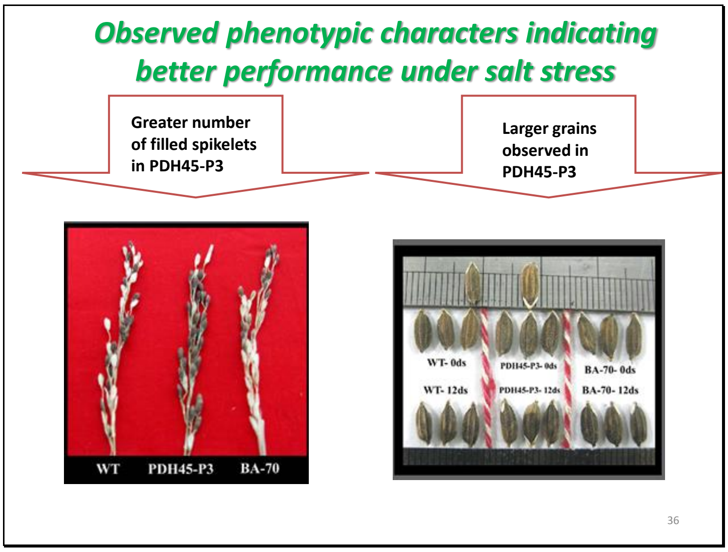


Figure 35. Observed phenotypic characters indicating better performance under salt stress.

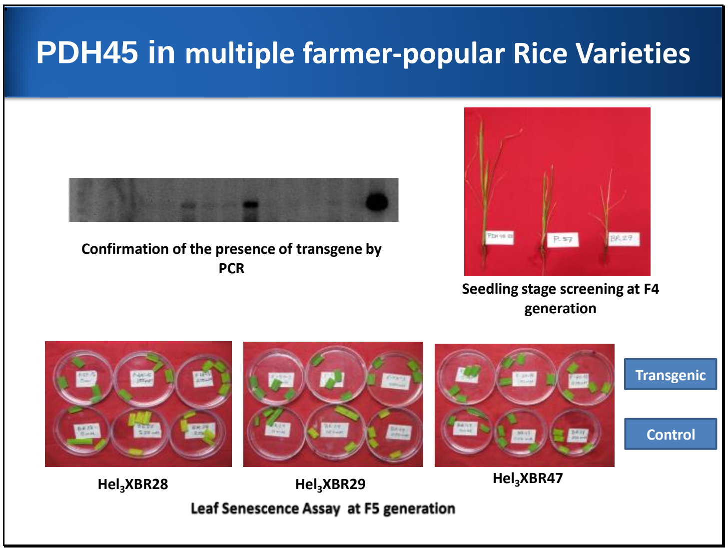


Figure 36. PDH45 in multiple farmer-popular Rice Varieties.

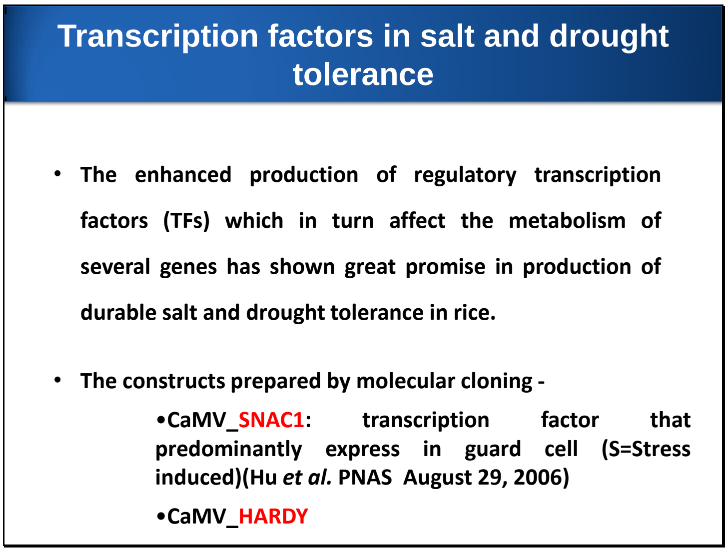


Figure 39. Transcription factors in salt and drought tolerance.

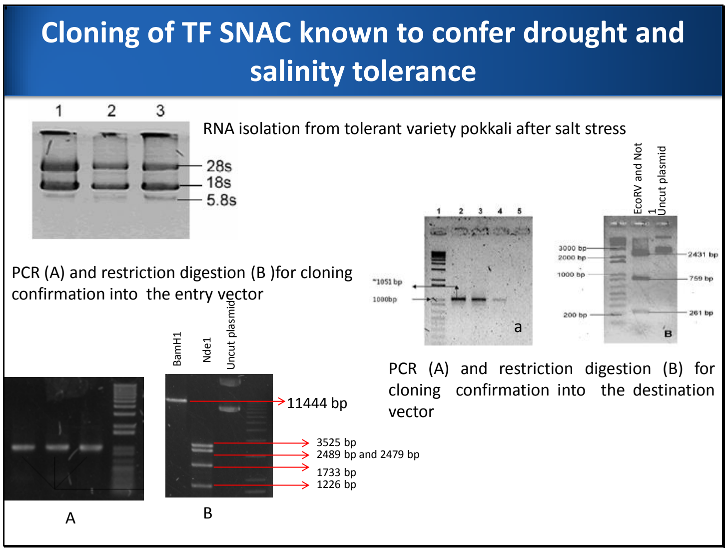


Figure 40. Cloning of TF SNAC known to confer drought and salinity tolerance.

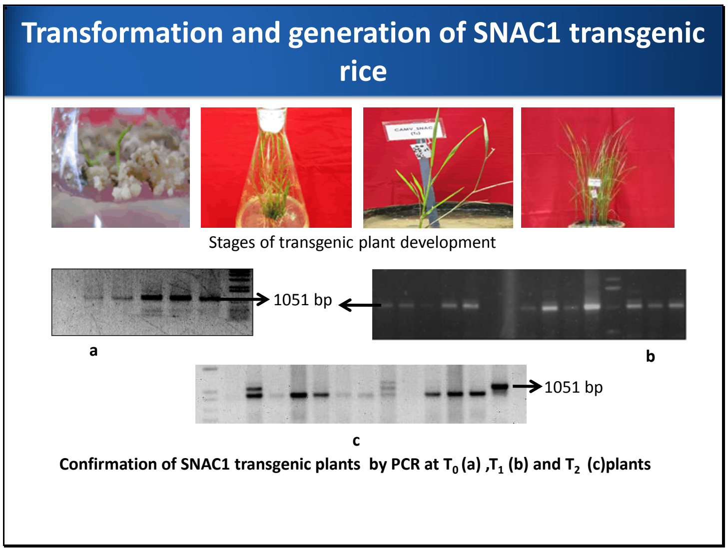


Figure 41. Transformation and generation of SNAC1 transgenic rice.

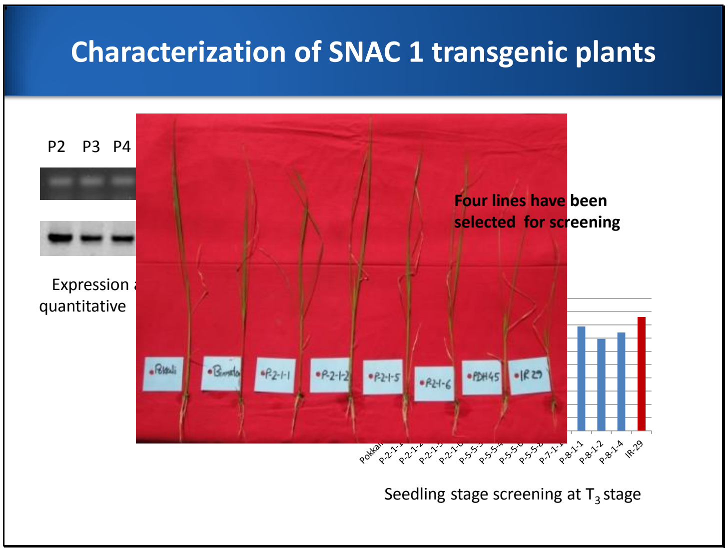


Figure 42. Characterization of SNAC1 transgenic plants.

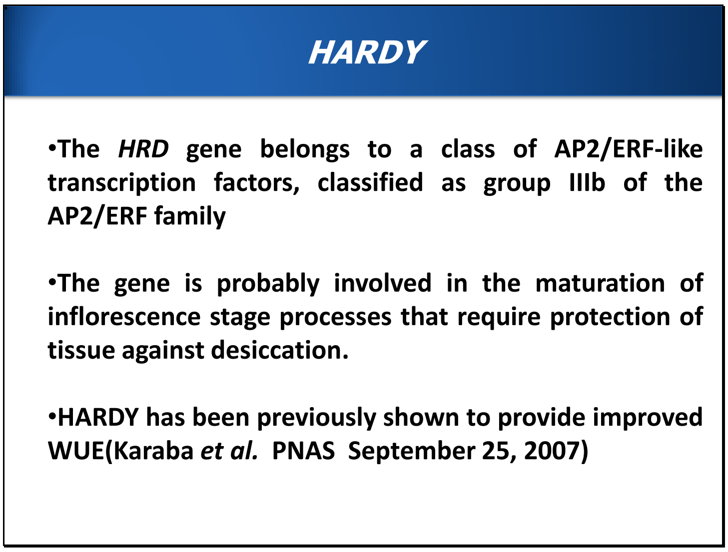


Figure 43. HARDY.

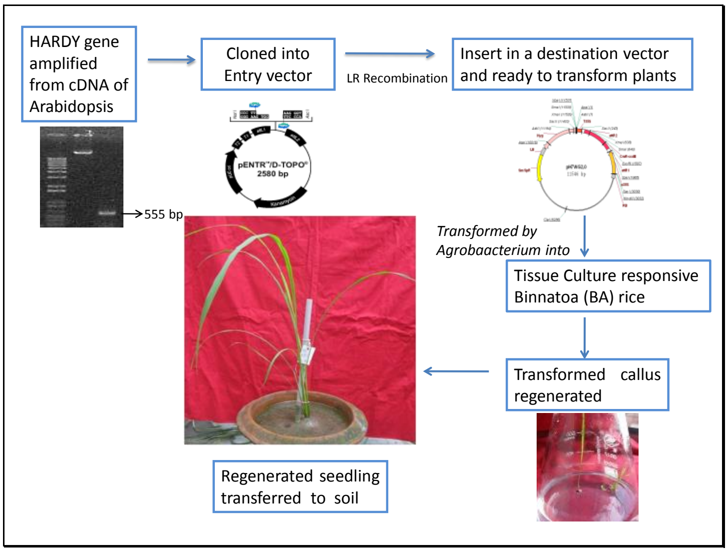


Figure 44.

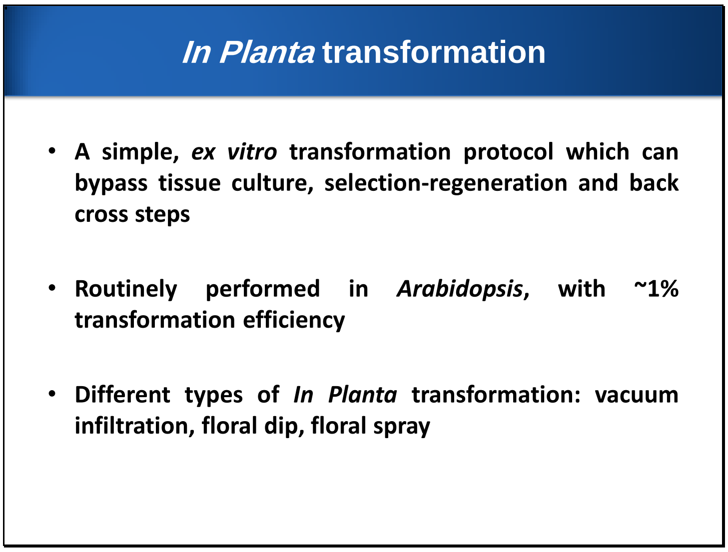


Figure 45. In Planat transformation.

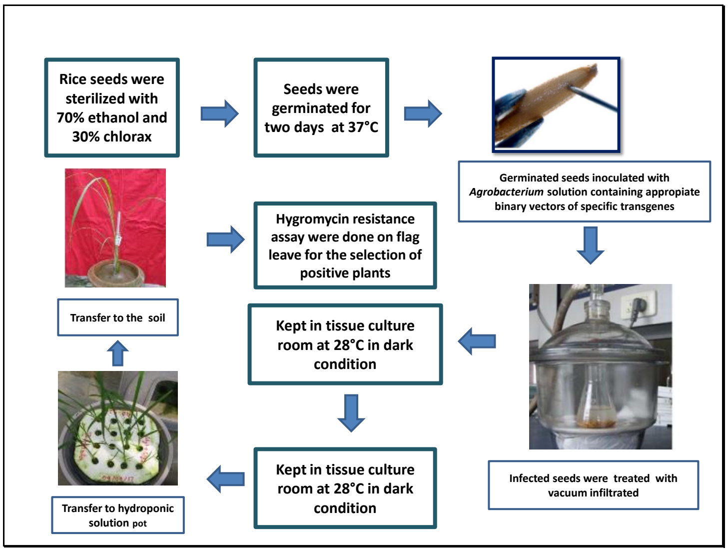


Figure 46.

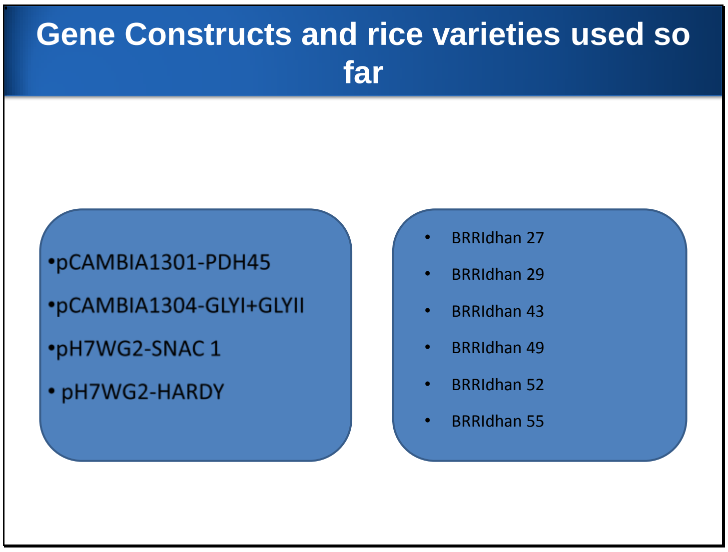


Figure 47. Gene Constructs and rice varieties used so far.

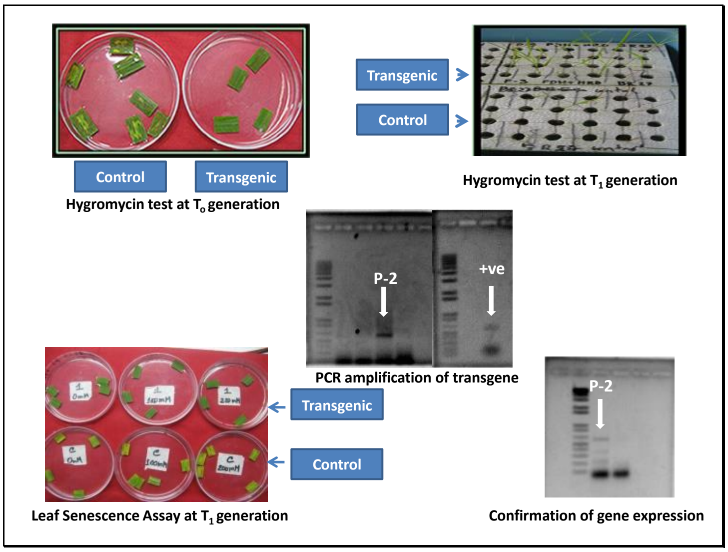


Figure 48.

From Marker to Gene: The Curious Case of a Putative vps51 Gene of Jute

HASEENA KHAN
Visiting Professor
South Asian University
India

ABSTRACT

Jute grows best in warm and humid climate. Even though Bangladesh has a subtropical monsoon climate, she cannot support the best growth of jute year long because jute does not germinate below 20^0C. Intensive physiological and biochemical investigations revealed that there are accessions in the Gene Bank of Bangladesh Jute Research Institute (BJRI) which could grow under low-temperature, short day length and low soil water potential conditions. Four such accessions were found which were short day and low temperature tolerant, able to germinate at 16^0C.

A putative vacuolar sorting protein 51 (vps51) gene was identified through a RAPD primer OPG 05, which gave a 1200 bp polymorphic band present in all low temperature tolerant jute accessions, but absent in the sensitive varieties. Linkage of this marker to the low temperature germination trait was established through the analysis of F_2 population of a cross between low temperature sensitive and tolerant parents. A 174 bp terminal exon was found within this sequence which showed strong homology with hypothesized vacuolar sorting protein 51 of Arabidopsis. We now have the complete coding sequence for the low temperature sensitive cultivar by degenerate primer based gene walking and 5' RACE. We have also deduced the intronic sequence of the gene as well. The 5'end of this putative *vps 51* gene is yet to be deduced for the low temperature tolerant accession, 2015 apparently due to sequence heterogeneity at this region between the sensitive and tolerant plants.

To study the role of vps51 gene in low temperature tolerance, quantitative, semi quantitative RT, real time PCR and dot blot analyses were carried out. Findings from these results indicate the expression of the gene to be more in the tolerant than the sensitive jute plants under low temperature and dehydration stresses and also under salt stress and diseased conditions.

The last inton of the jute vps51 gene has been found to be highly polymorphic among the different jute accessions studied. Interestingly one of the exons is hypothesized to harbor a putative miRNA gene as predicted by a number of software and also by stem-loop RT-PCR. The miRNA appears to be transcribed in the reverse orientation as that of the *vps* 51 gene. Although the target gene of this miRNA is unknown, there appears to be an inverse correlation in the expression between the *vps 51* and the miRNA gene.

❖ Jute is a bast fibre crop, ranks next to cotton as a natural fibre.
❖ Mainly cultivated in the Indian and African tropics.
❖ It is now generally agreed to have originated in Africa and migrated to India and China via Egypt and Syria.

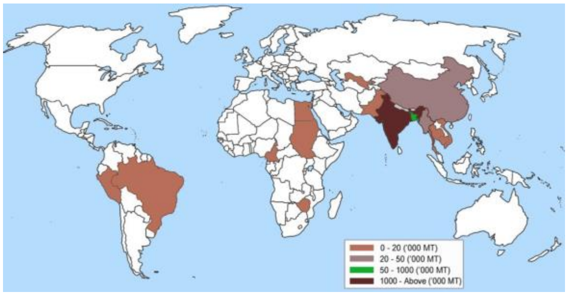


Figure 1.

Leaves of Corchorus species is used as a vegetable in Middle Eastern, East African, North African and South Asian cuisine.

A dish called *Mulukhiyyah* is rather bitter, and when boiled, the resulting liquid is a thick, highly mucilaginous broth is popular in Eygpt, Tunisia, Algeria.

Mulukhiyyah is generally eaten cooked, not raw, and is most frequently turned into a kind of soup or stew.

Figure 2.

Jute: A Symbol of National Identity

For Bangladeshis, jute is not just a plant that produces fibre; it is rather a national icon, linked to the adage: Sonar Bangla

It is also linked to our quest for economic emancipation.

In mythical golden Bengal, around which much of our national lore is constructed, we had these undulating rice fields together with fields of fibre, golden in colour.

Figure 3.

It is our principal cash crop.

It contributes to about **6% of the total export earnings.**

In Bangladesh nine million farmers/ labourers, and 45 million dependents, earn less than a dollar a day per family to grow jute in rotation with rice.

Figure 4.

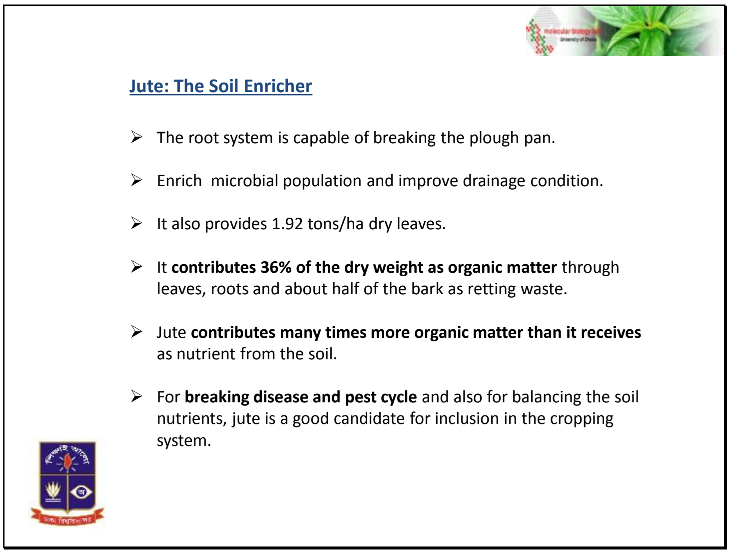


Figure 5.

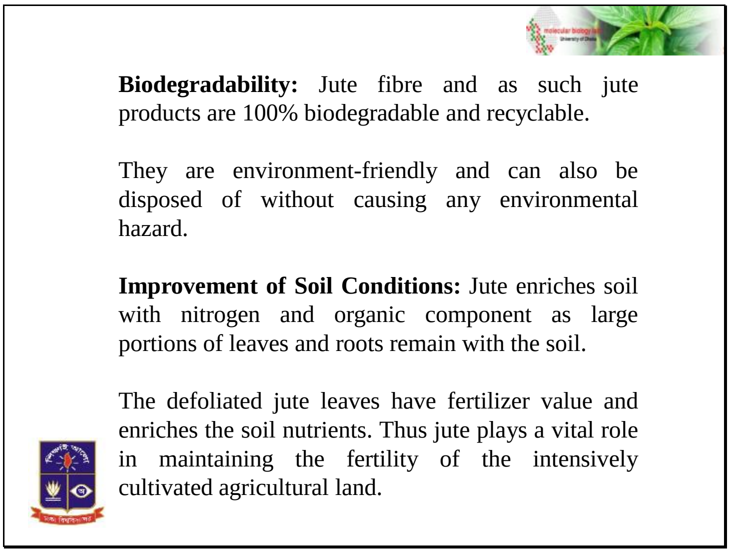


Figure 6.

Sound Agricultural Practices: Studies have found that typical jute agricultural practices are environmentally sound - they cause minimal impact to the natural environment.

Relatively modest amounts of fertilizer, herbicide, and pesticides are required for jute cultivation - especially in comparison with cotton.

The flooded fields in which jute grow support diverse fish populations, which play a critical role in the Bangladeshi diet.

That jute can be grown without reliance on pesticides is an important environmental benefit.

Figure 7.

Improvement of Other Crops: By rotating with other crops like rice and potatoes, jute acts as a barrier to pest and diseases for others crops.

Provides substantial amount of nutrients to other crops in the form of organic matter and micronutrients.

Reduce Hazards: Jute has good insulating and antistatic properties with low thermal conductivity.

Figure 8.

Figure 9.

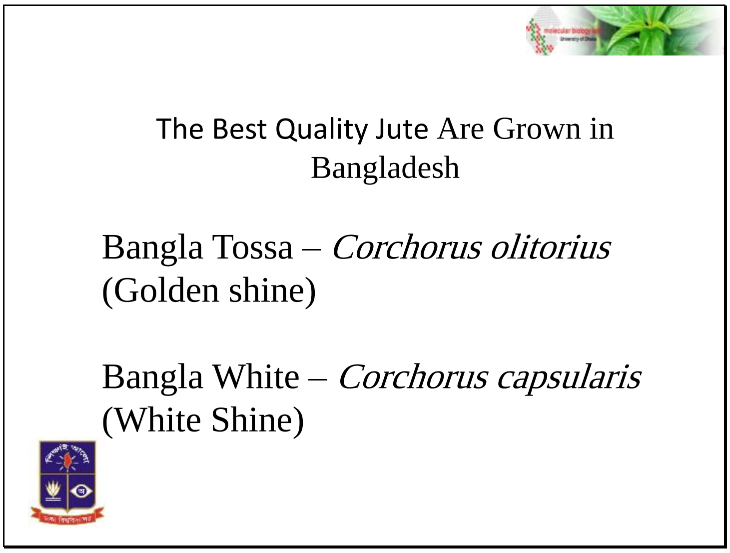


Figure 10.

White jute (*Corchorus capsularis*): ropes and twines made of white jute from ancient times for household and other uses.

Tossa jute (*Corchorus olitorius*): Tossa jute is an Afro-Arabian variety. Tossa jute fibre is softer, silkier, and stronger than white jute.

Along with white jute, tossa jute has also been cultivated in the Bengal region from the start of the 19th century.

Currently, this region (West Bengal, India, and Bangladesh) is the largest global producer of the tossa jute variety.

Figure 11.

- Jute is a diploid (2n=14) dicot annual shrub and belongs to the plant family *Malvaceae.*

- The fiber is phloem tissue obtained from the bark of two cultivated species C. *capsularis* and *C. olitorius*.

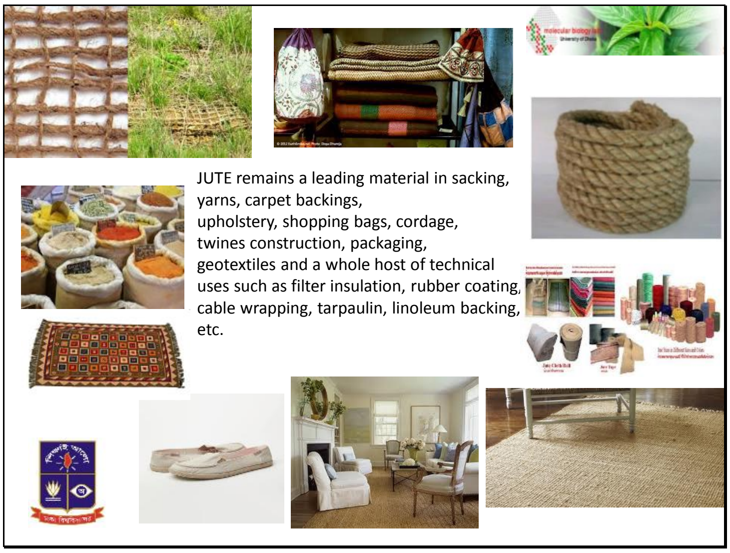
- The yield and quality of *olitorius* is better than *capsularis*.

- It is a summer season crop grown from March to July.

- Natural genetic variability is narrow due to self pollination.

Figure 12.

Figure 13.



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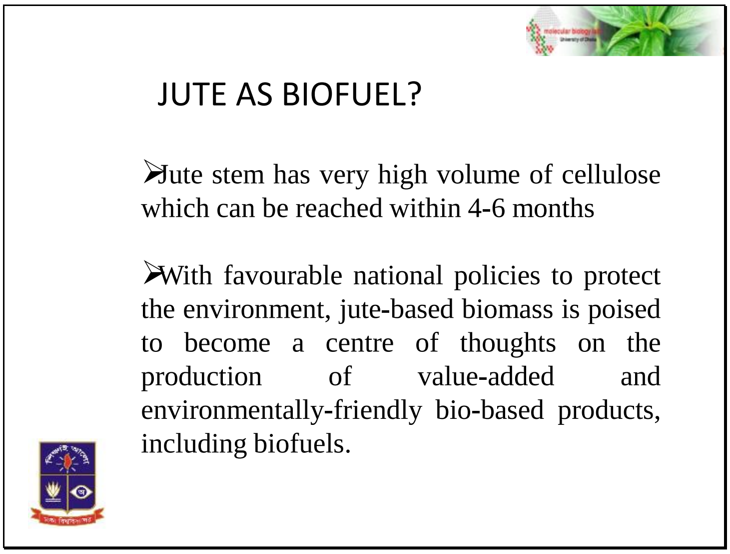

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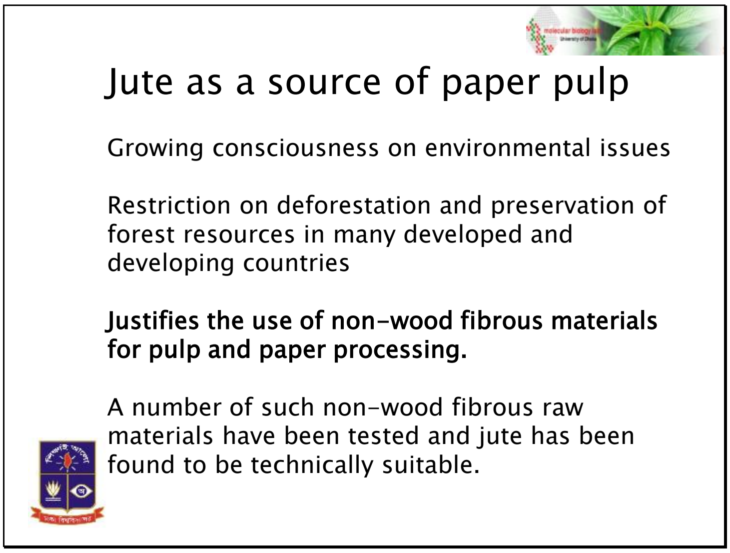


Figure 16.

Kenaf, scientifically known as *Hibiscus cannabinus*, is a jute-like plant from the hibiscus family.

Can be used as a raw material to make a multitude of products like high quality paper, biocomposites for automotive door trimmings and interior shelving, bio-plastics industry, building materials like medium-density fibre boards and even high protein animal feed.

Figure 17.

Malaysia : Kenaf to replace tobacco ?

Kenaf planting heavily promoted by the Government:

The quest for Malaysia's next golden industrial crop has been endless since the success of oil palm, rubber and to a certain extent cocoa, pepper and tobacco.

Kenaf had been the most talked about candidate so far.

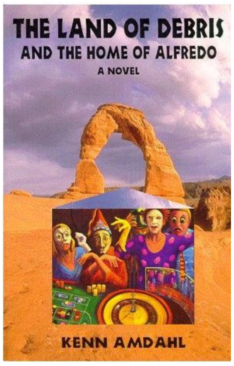
Figure 18.

The energy requirements for producing pulp from kenaf are about 20 percent less than those for wood pulp, mostly due to the lower lignin content of kenaf. Many of the facilities that now process Southern pine for paper use can be converted to accommodate kenaf.

Ford is making door material for the inner side of its vehicle, making the door 25% lighter. The first implementation of kenaf within a Ford vehicle will be in the ***2013 Ford Escape***.

Panasonic has set up a plant in Malaysia to manufacture kenaf fibre-boards for export to Japan.

Figure 19.



The first book Published using KENAF PAPER

2013 Ford Escape

Figure 20.

2013 Ford Escape Door

Figure 21.

How well do we know this wonder crop?
(at the molecular level ?)

Jute has a very narrow genetic base being a self-pollinated plant, moreover the two cultivated species are not cross-compatible and therefore can not be used in a breeding program for introducing newer/better traits.

Moreover not much attention has been paid to this fibre plant in order to know it better at the genomic level.

One will hardly find any literature on the molecular biology of jute.

Figure 22.

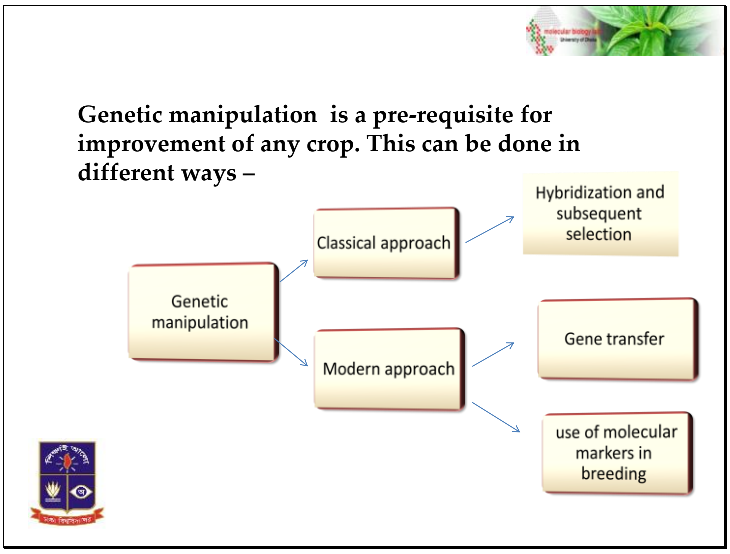


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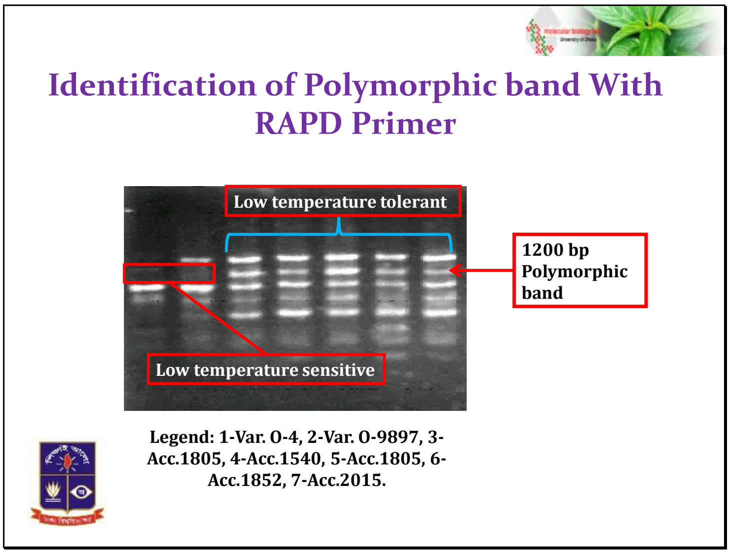
Figure 24.



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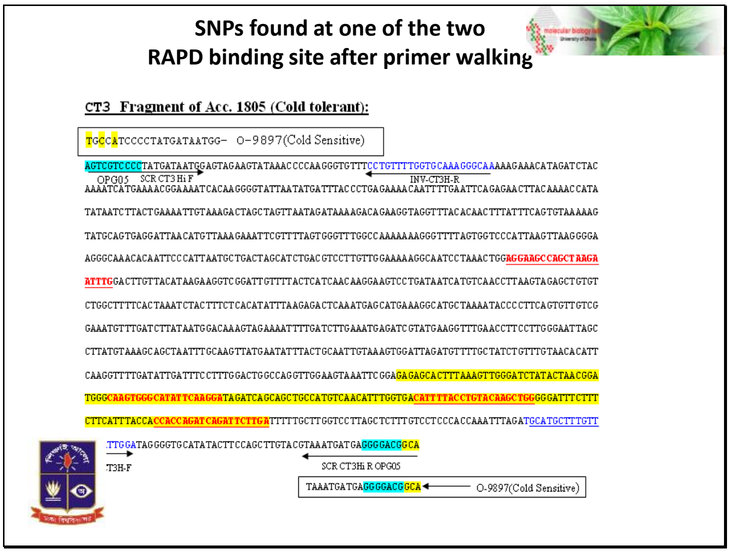

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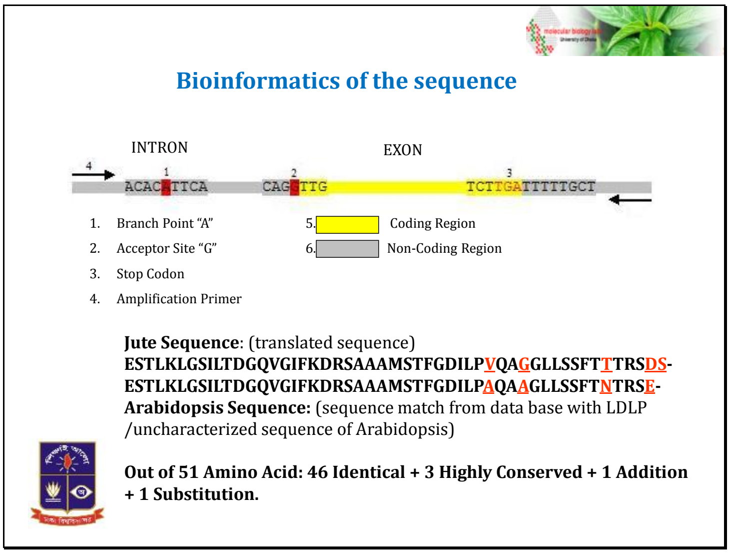

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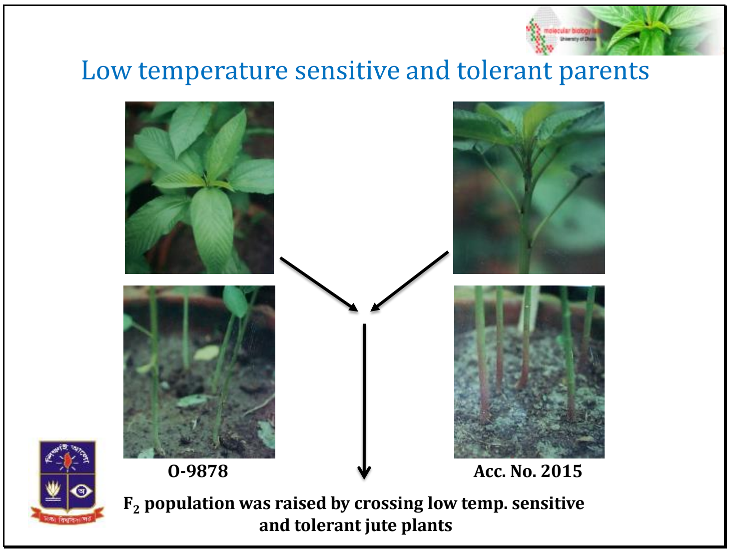

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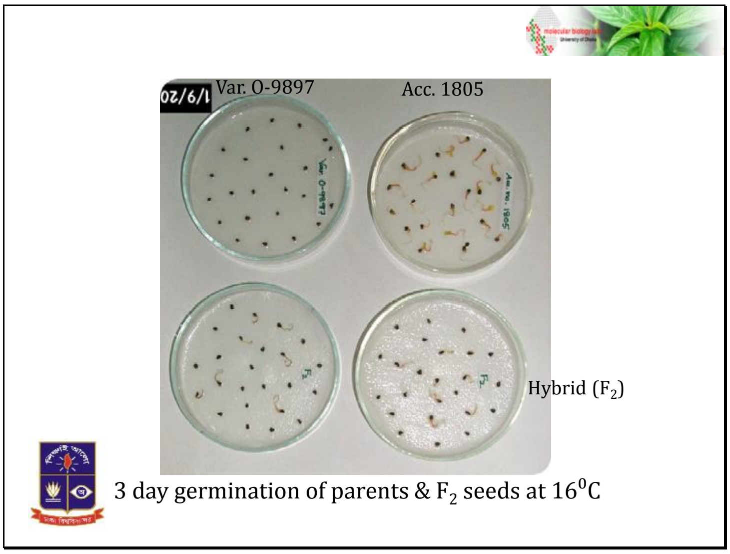

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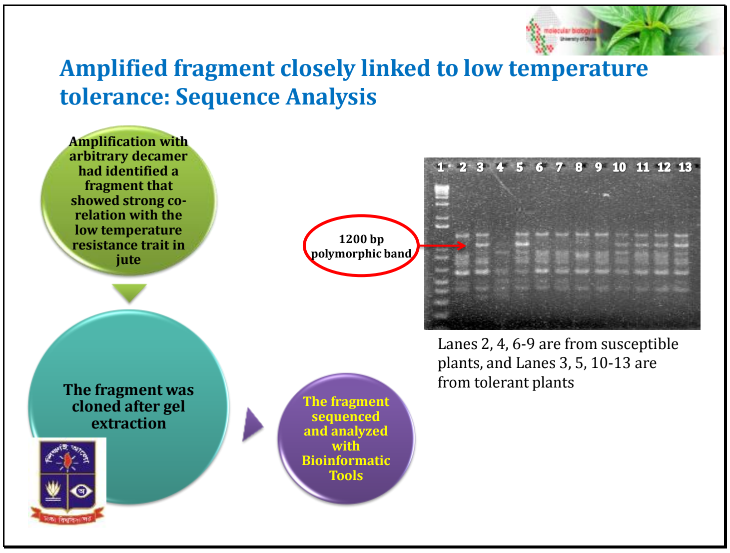

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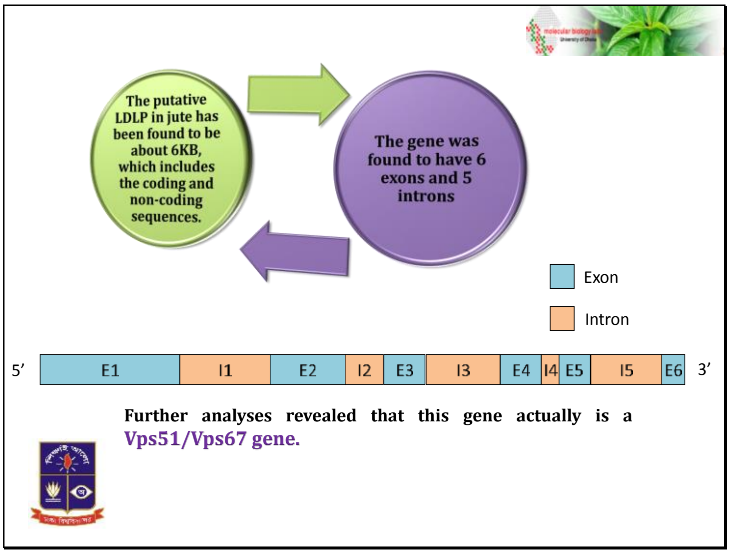

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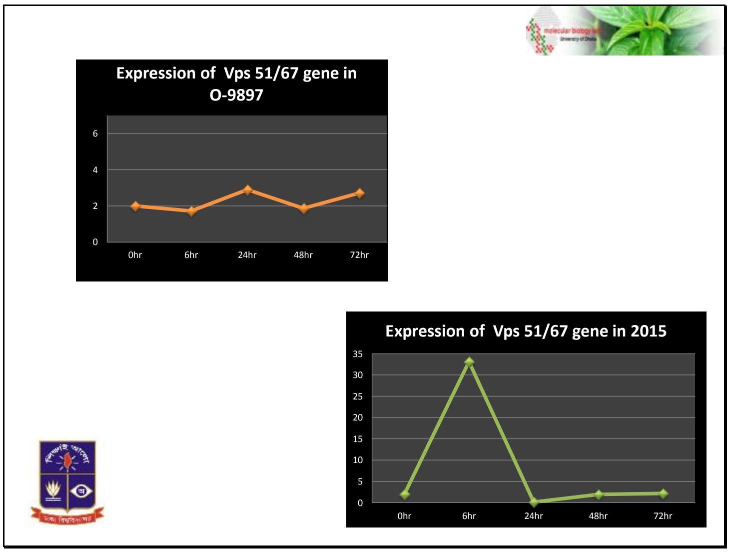

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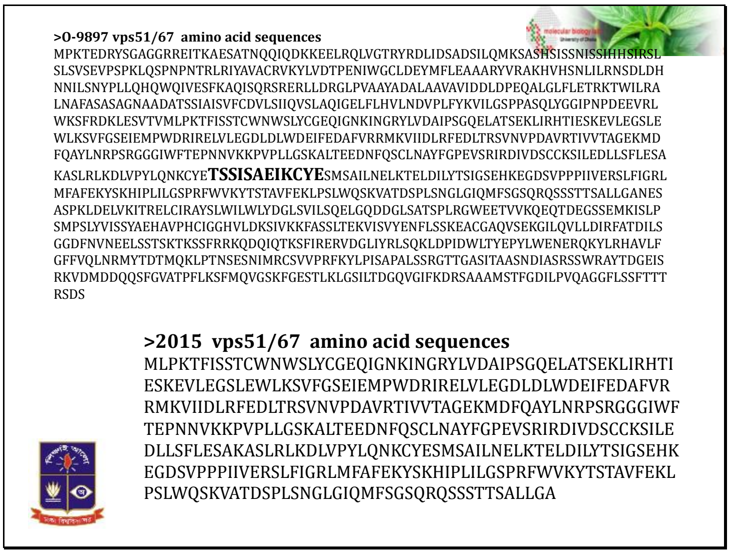

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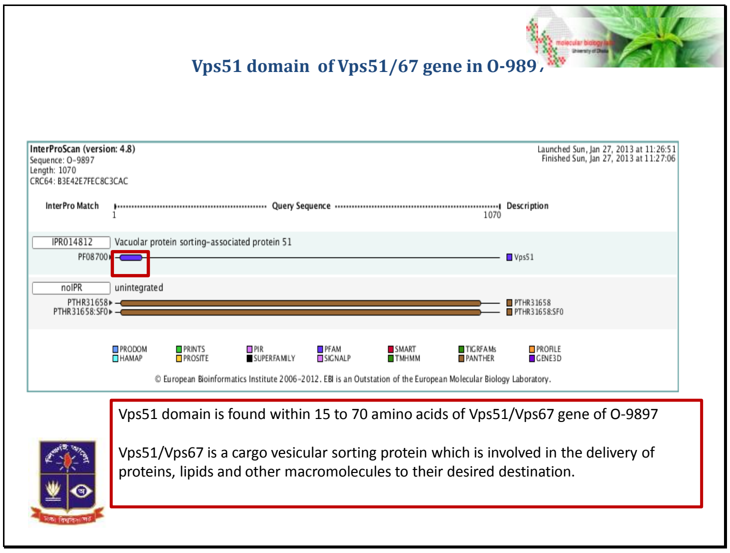


Figure 34.

Vps51/Vps67 gene

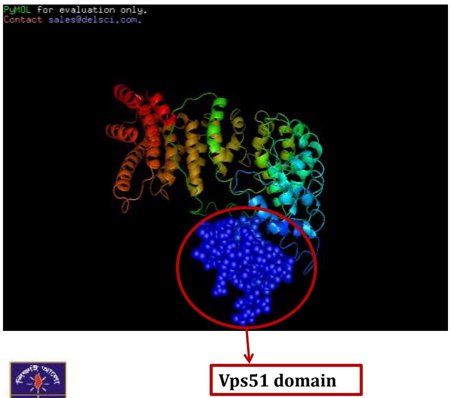
Vps51/Vps67 is a subunit of GARP (Golgi associated retrograde protein) or VFT (Vps Fifty-Three) complex.

This complex is responsible for vesicle mediated protein trafficking from endosomes to late Golgi.

This protein mediates the interaction between Vps52/53/54 and the t-SNARE Tlg1 protein, leading to the fusion between the endosomal vesicles with the late Golgi .

Figure 35.

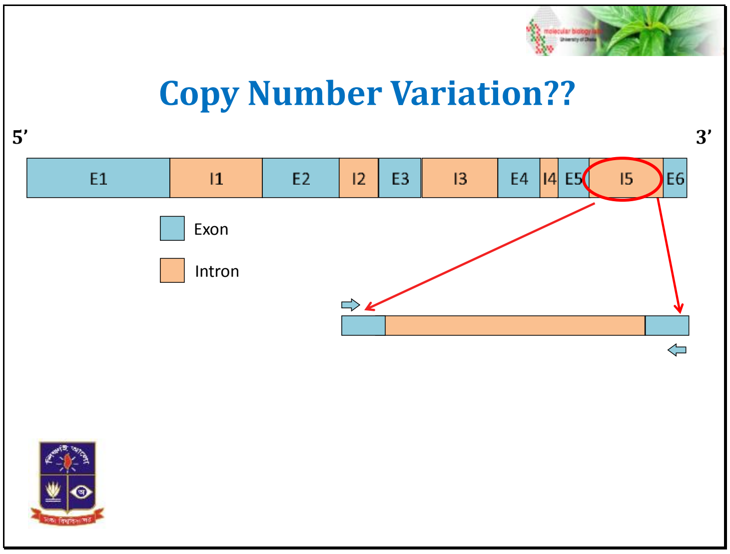
3D structure of Vps51/67 gene in O-9897



The N-terminal coiled-coil region involved in assembly with the other GARP subunits is conserved among all eukaryotes, whereas the C-terminal region is missing in fungi.

The size and coiled-coil distribution are similar to most GARP subunits, suggesting that they all have a similar overall structure.

Figure 36.



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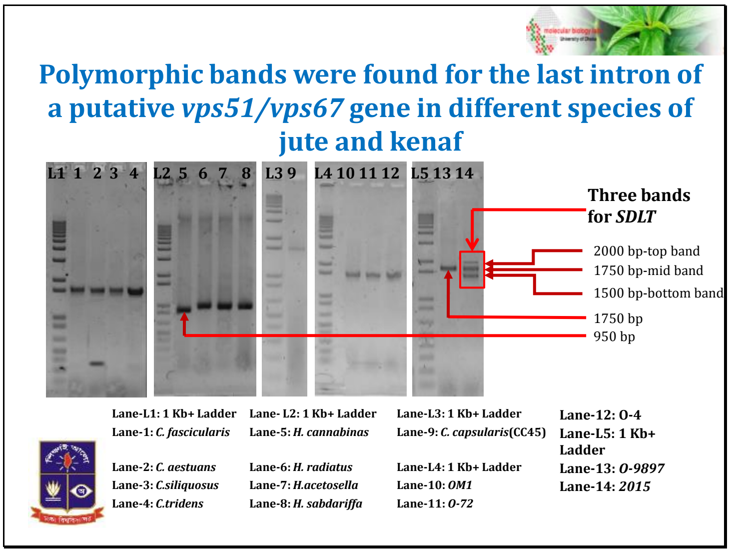

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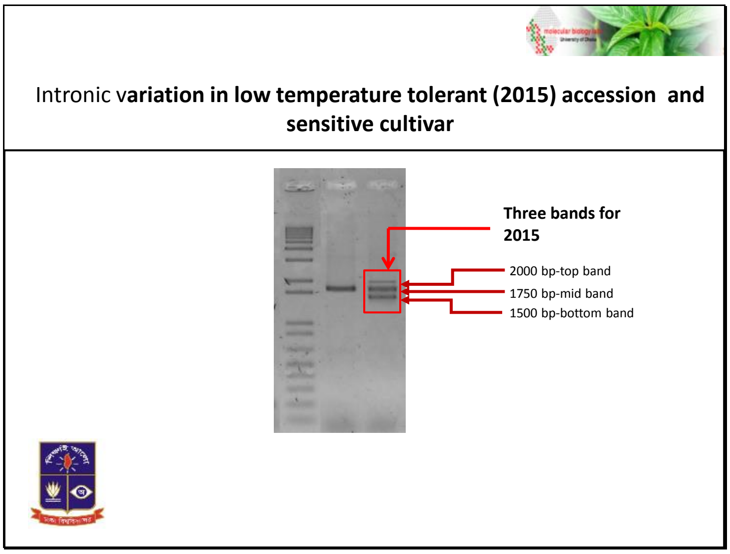

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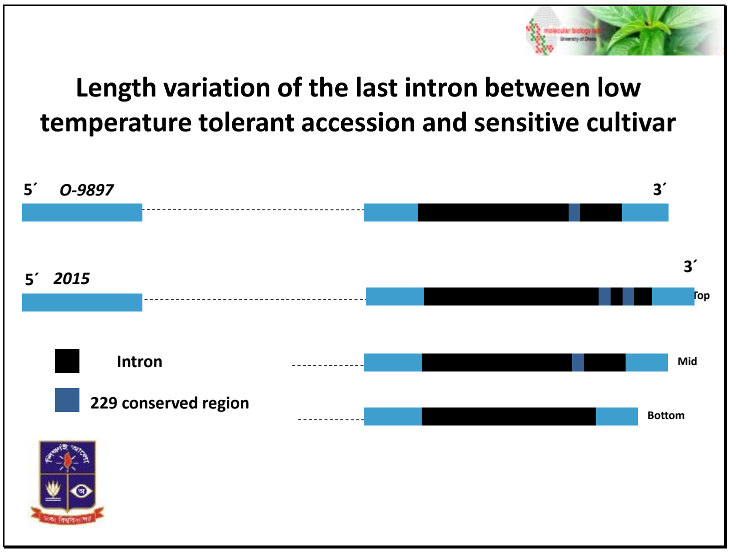

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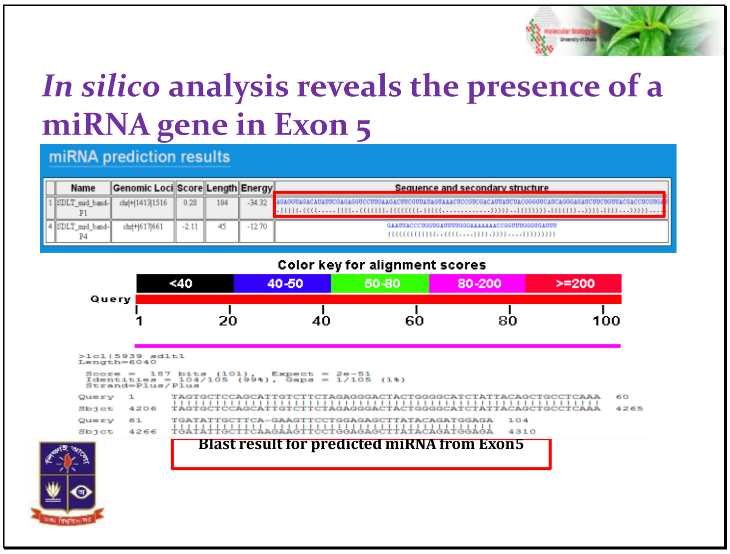

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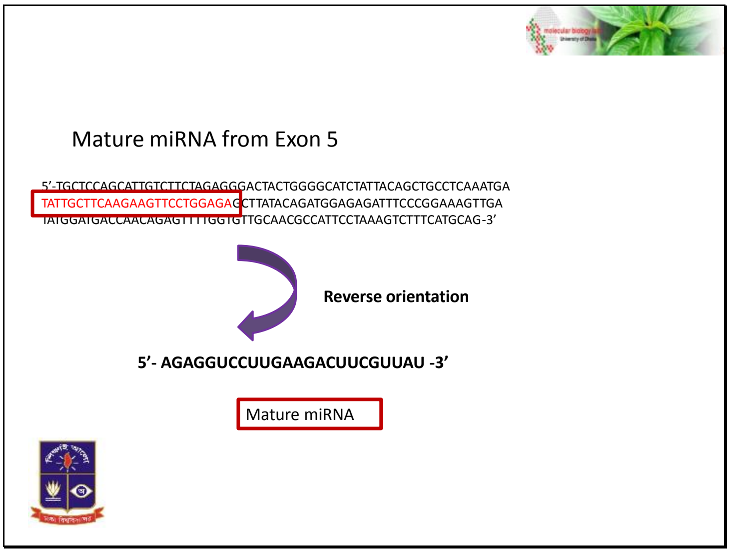

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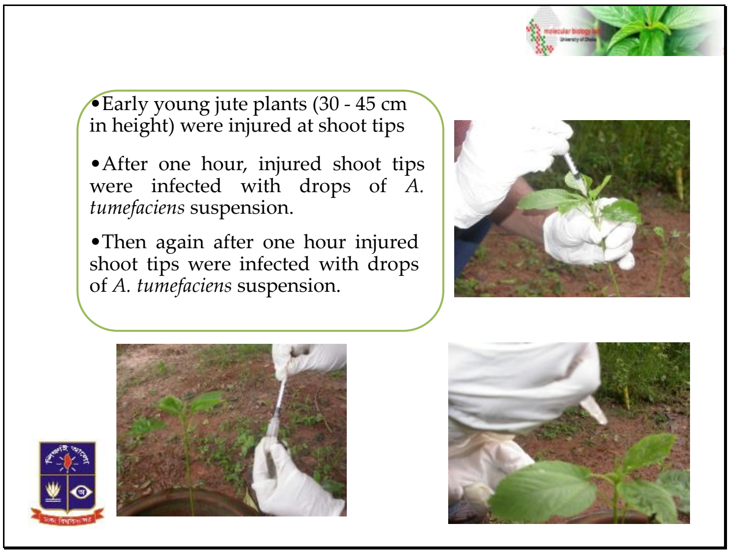


Figure 43.

Figure 44.

Gene Silencing Using RNA Interference

Uses small, double stranded RNAs to silence expression of a gene product.

Utilizes a normal host response to dsRNA and a normal cellular post-transcriptional regulatory machinery that is found in organisms ranging from yeast to mammalian species.

Figure 45.

(a) Four genes, out of the ten genes of the lignin biosynthetic pathway which do not overlap with the plant's defense machinery have been selected for gene silencing.

The genes selected for targeting are:

- C4H - Cinnamate 4 Hydroxylase
- C3H - p-Coumarate 3 Hydroxylase
- F5H - Ferulate 5 Hydroxylase
- COMT - Caffeic acid O-methyltransferase

Figure 46.

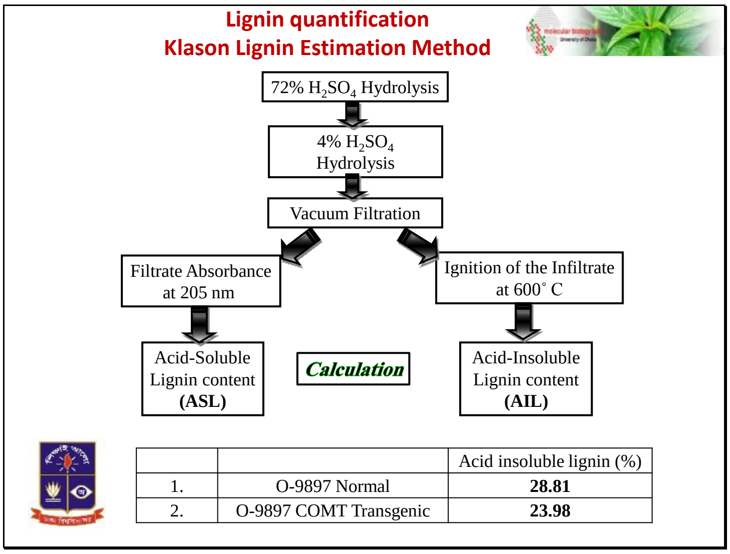


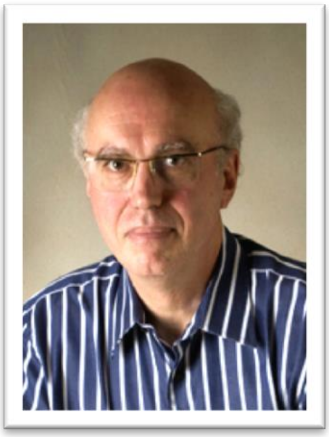
Figure 47.

Figure 48.

Rethinking Sustainable Development in Least Developed Countries: The Politics Policies Nexus.

SANDRO CALVANI[1]

ABSTRACT



The greatest expectations of humankind at the beginning of the new century are focused on the sustainability of the development model for our Planet; the poorest people on Earth are at the same time the subject of most concern and the ultimate judges of the quality of global justice and of equitable access to global public goods. The United Nations' Millennium Development Goals (MDGs) are coming to an end in 2015 and will deliver an unfinished agenda. The traditional three-fold backbone of global governance, namely socio-economic rights, civil and political rights and security rights is being shaken by concerns of declining democratic decision making processes as well as double standards in relations between nations and between different groups inside nations. At the same time climate change introduces an unprecedented sense of urgency in the adaptive changes that global politics must decide.

A new vision of eleven goals for global development, justice and peace is emerging in the international arena. New proposed goals are examined with a special reference to how the policies will require a change in politics too:

1. Inclusive growth for dignified livelihoods and adequate standards of living, where economic growth is proposed as a poverty terminator;
2. Sufficient food and water for active living, where a more comprehensive approach to food security and nutrition is proposed;
3. Appropriate education and skills for full participation in society, whereas the educational focus is expanded to secondary and tertiary education;
4. Good health for the best possible physical, mental, and social well-being, whereas correctly all health goals are seen in a unique continuum not limited to major diseases;
5. Security for ensuring freedom from violence, where the MDGs lack of attention to organized crime, violence, security and rule of law is instead properly elaborated;
6. Gender equality enabling men and women in society to participate and benefit equally in society, a fully re-invigorated approach to several aspects of gender and generational equity;
7. Resilient communities and nations through disaster risk reduction, whereas the recent lessons learned on disaster risk management are introduced;
8. Quality infrastructure for universal access to energy, transportation and communication, where the contribution of modern communication to development is recognized;
9. Empowering people to realize their civil and political rights, whereas the integration of development with human rights is proposed;
10. Sustainable management of the biosphere, enabling people and the planet to thrive together, a new environmental rights' goal which introduces the consensus derived from the Rio+20 Conference; and finally

[1] Director ASEAN Centre of Excellence on UN Millennium Development Goals, AIT, Bangkok, Thailand. www.arcmdg.ait.asia, www.sandrocalvani.it, http://en.wikipedia.org/wiki/Sandro_Calvani

11. Global governance and equitable rules for realizing human potential, a clear recognition of the inter-dependence of all previous goals and of a need of a just, transparent and smarter global governance of public goods.

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Figure 5.

Figure 6.

Figure 7.

Figure 8.

Figure 9.

Figure 10

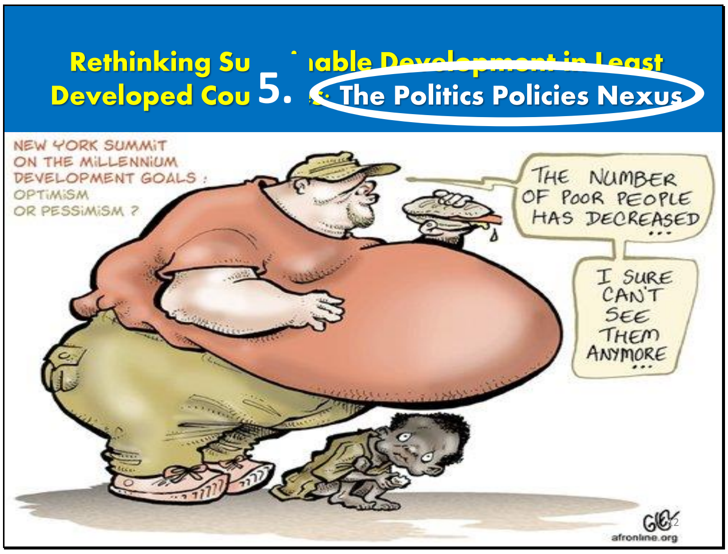


Figure 11.

Figure 12.

Figure 13.

Figure 14.

Figure 15.

Figure 16.

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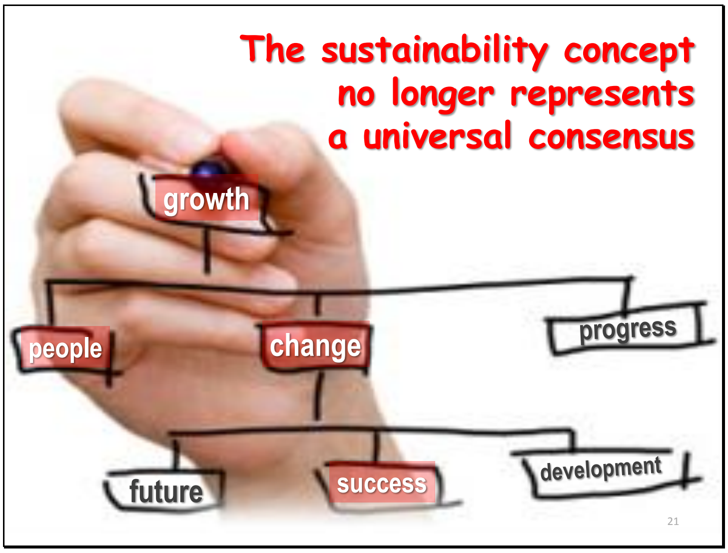
Figure 18.

Figure 19.



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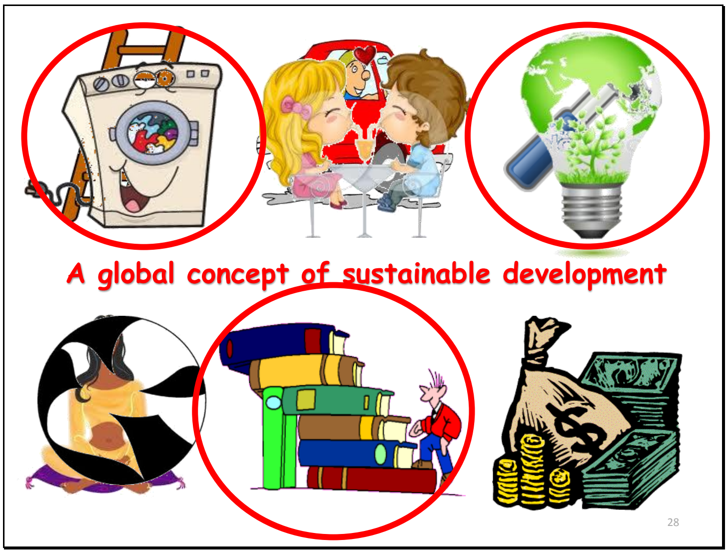

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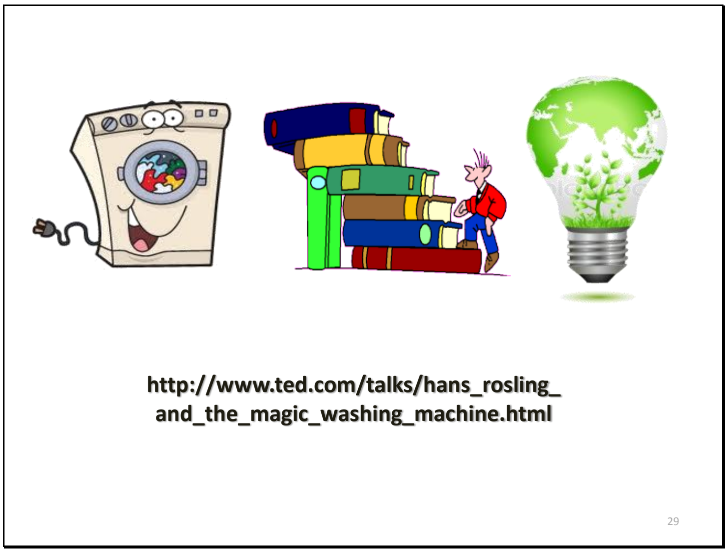

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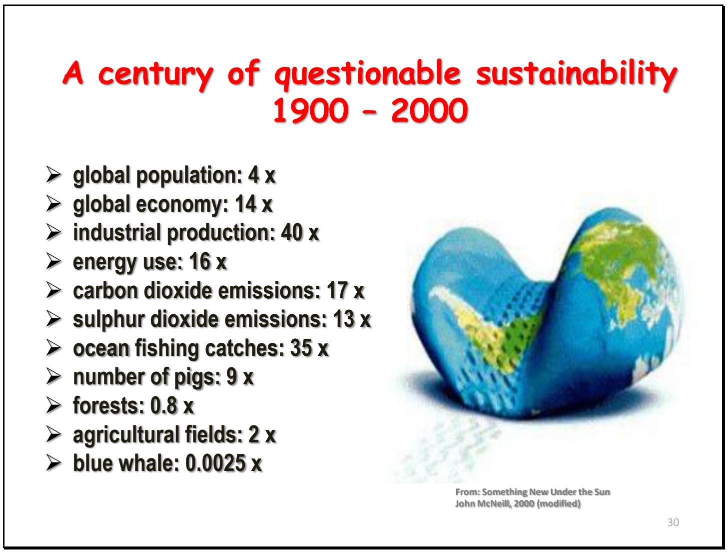

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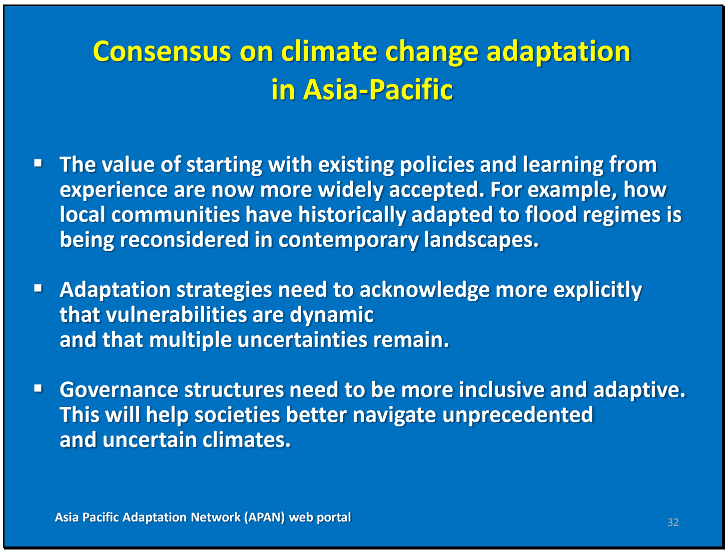

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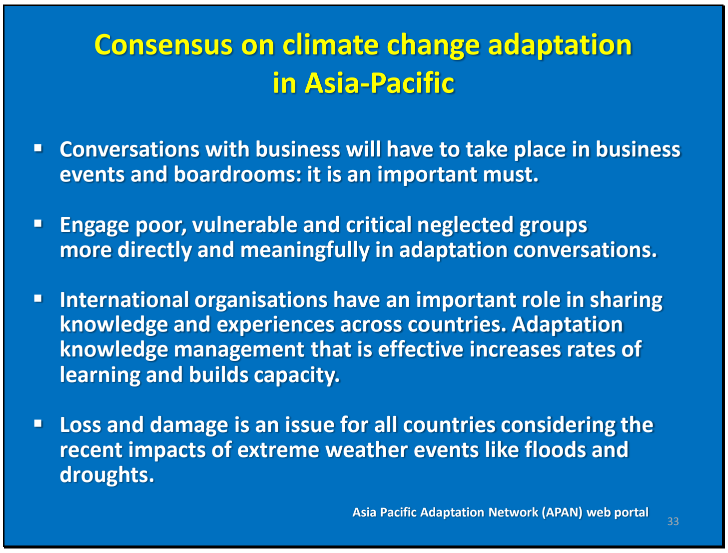

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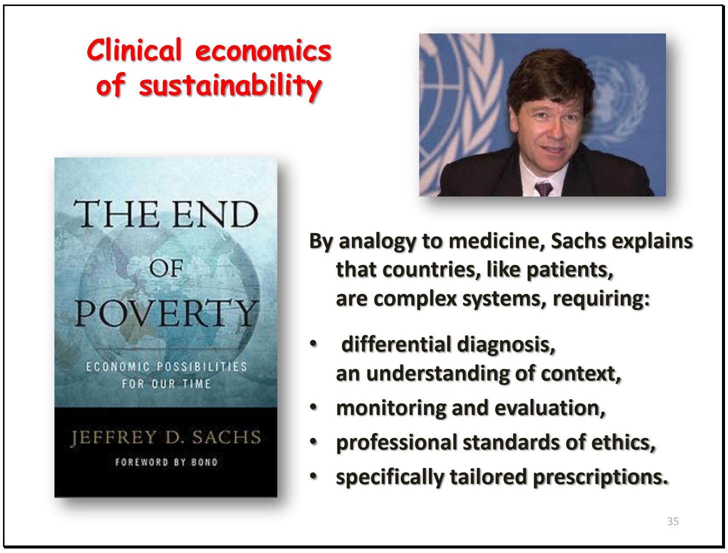

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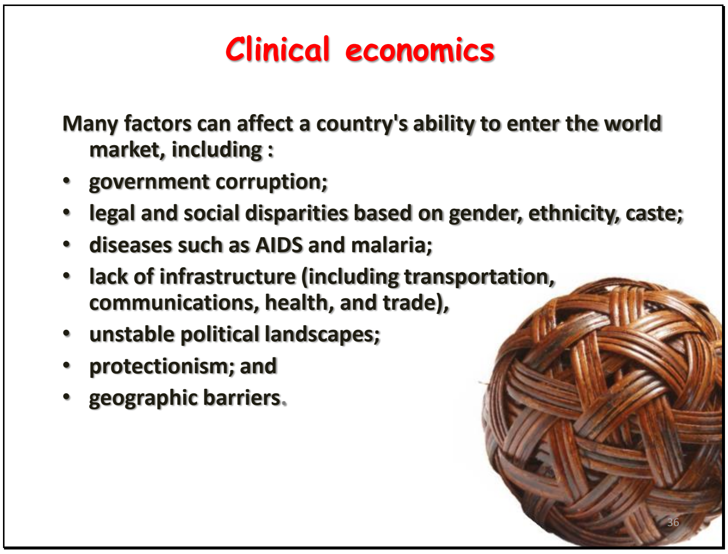

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Figure 36.

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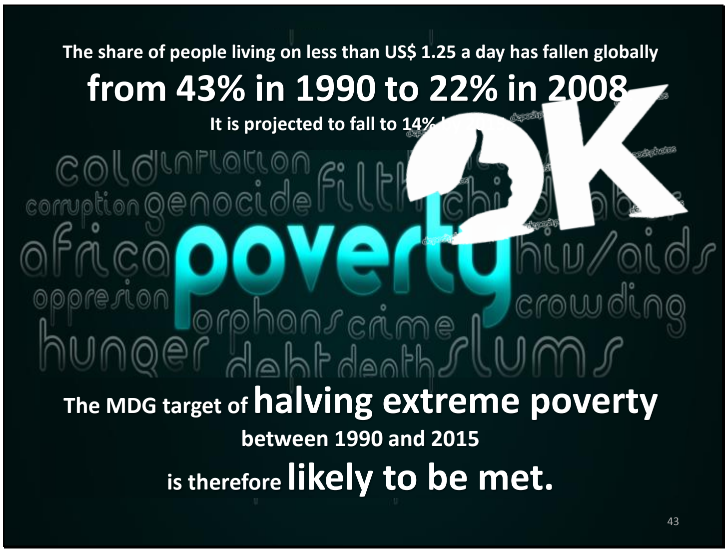

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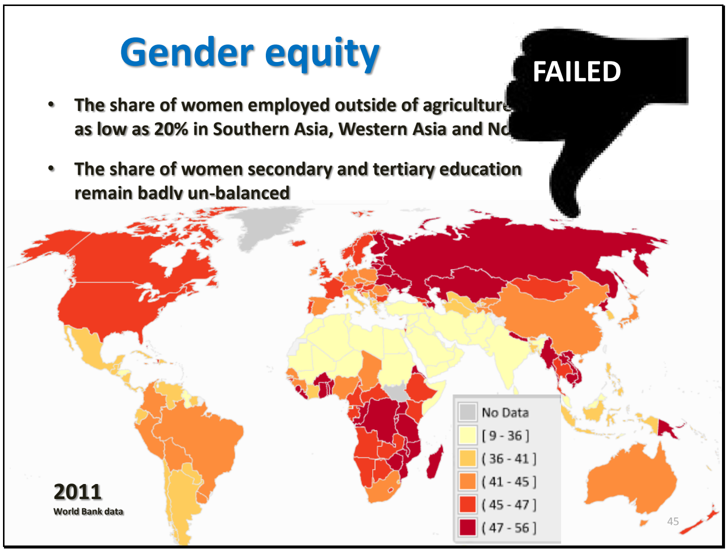

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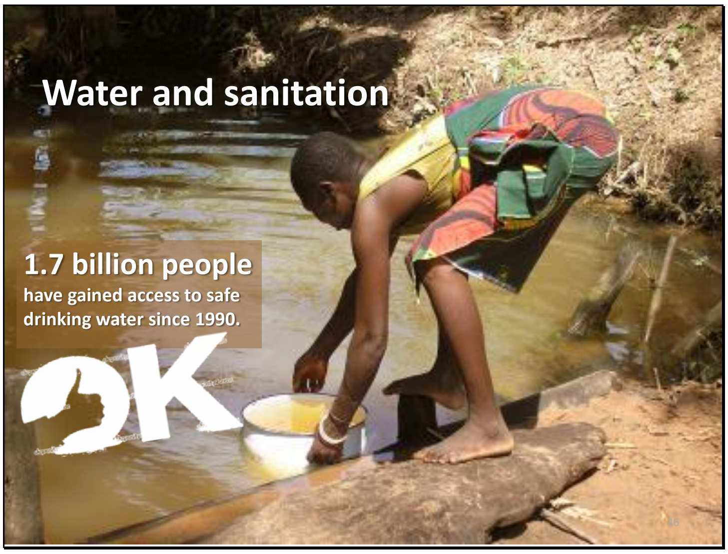

Figure 45.

Figure 46.

Global MDGs progress

MDG	Improvement Since 1990?	Distance progressed to Goal (100% = goal attained)	On Track?	Faster Progress 2003-2008 compared to 1990-2001/2?	Faster than Historical Patterns? (1970-2000 vs 2000-2009)
	(Kenny and Sumner)	*(World Bank)*	*(Kenny and Sumner)*	*(Fukuda-Parr and Greenstein)*	*(Kenny and Sumner)*
Poverty	Y	80	Y	Y	
Undernourishment	Y	77	N	N	
Primary Education	Y	90	N	Y	N
Gender Equality in Primary Education	Y	96	Y	N	N
Child Mortality	Y	69	N	Y	Y
Maternal Mortality	Y	57	N	Y	Y
Drinking Water	Y	88	Y	N	

Note: Fukuda-Parr and Greenstein took data for three points: the earliest available year, going back to 1990; a middle year from between 2000 to 2003; and the most recent year available to 2008.

Source: Kenny and Sumner (2011). Note: Empty cells indicate insufficient data to make judgment.

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Figure 47.

Country level MDGs progress

(% of developing countries making progress on each target)

MDG	Making Progress	Making Progress	On Track	On Track	Faster Progress	Outperforming Historical Pattern*
	(Leo and Barmeier)	*(ODI)*	*(Leo and Barmeier)*	*(World Bank)*	*(Fukuda-Parr and Greenstein)*	*(Kenny and Sumner)*
Poverty	63	66	49	47	51	
Undernourishment	55	57	34	25		
Primary Education	75		46	55	35	68
Gender Equality **	61		55	89/82**	46	56
Child Mortality	95	95	38	36	32	51
Maternal Mortality	83		19	30		33
Drinking Water	73	82	49	66	34	

Sources: Kenny and Sumner (2011). See also Leo and Thuotte (2011); *Represents the proportion of developing countries for which the appropriate data is available; **Gender Equality for primary and secondary education, respectively.

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Figure 48.

Top Ten MDGs achievers

Top Absolute Progress on Indicators	Top Relative Progress against MDG Targets
Benin	Ecuador
Mali	China
Ethiopia	Thailand
Gambia	Brazil
Malawi	Egypt
Viet Nam	Viet Nam
Uganda	Honduras
Nepal	Belize
India	Nicaragua
Cambodia	Armenia

Source: ODI/UNMC (2010). Note: This table and rankings are based on a simple aggregation of rankings of the annual rate of progress on selected MDG indicators. Absolute progress measures which countries have reduced the largest share of the population living in extreme poverty, for instance, or increased primary school enrolment rates by the largest number of percentage points. Relative progress measures proportionate progress against the MDG target.

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Figure 49.

Figure 50.

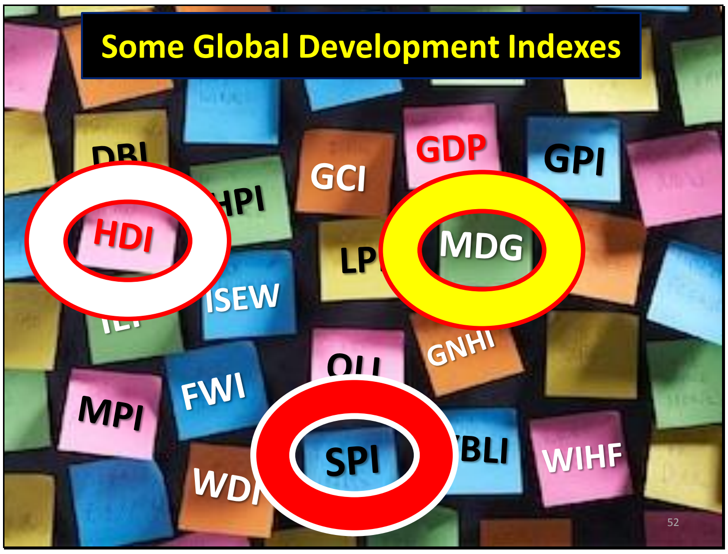

Figure 51.

Some Global Development Indexes

DBI, Doing Business Index, **World Bank**
FWI, Freedom in the World, **The Freedom House**
GCI, Global Competitiveness Index, **World Economic Forum, WEF**
GDP, Gross Domestic Product, **World Bank**
GNHI, Gross National Happiness Index**, Government of Bhutan and the Earth Institute**
GPI, Global Peace Index**, Institute for Economics and Peace, IEP**
HD, Human Development Index**, UNDP**
HPI, Happy Planet Index**, New Economics Foundation, NEF**
IEF, Index Economic Freedom**, Heritage Foundation with Wall Street Journal**
ISEW, Index of Sustainable Economic Welfare**, Friends of Earth**
LPI, Legatum Prosperity Index, **Legatum Institute**
LPI, Living Planet Index**, World Wildlife Fund, WWF**
MDGs, Millennium Development Reports**, United Nations**
MPI, Multidimensional Poverty Index**, Oxford Poverty and Human Dev. Initiative, OPHI**
QLI, Quality of Life Index**, The Economist Intelligence Unit:**
SPI, Social Progress Index, **Harvard University**
WDI, World Development Indicators**, World Bank**
WIHF Worldwide Index of Human Freedom, **Fraser Institute**
YBLI, Your Better Life Index**, Organization for Economic Cooperation and Dev., OECD**

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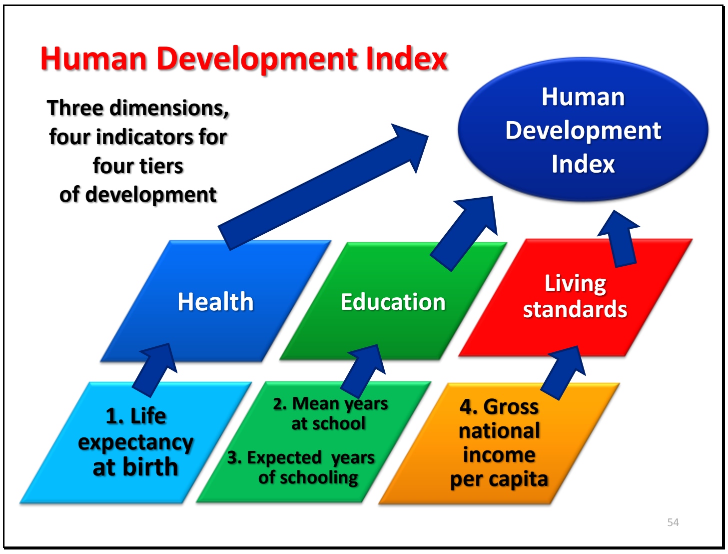

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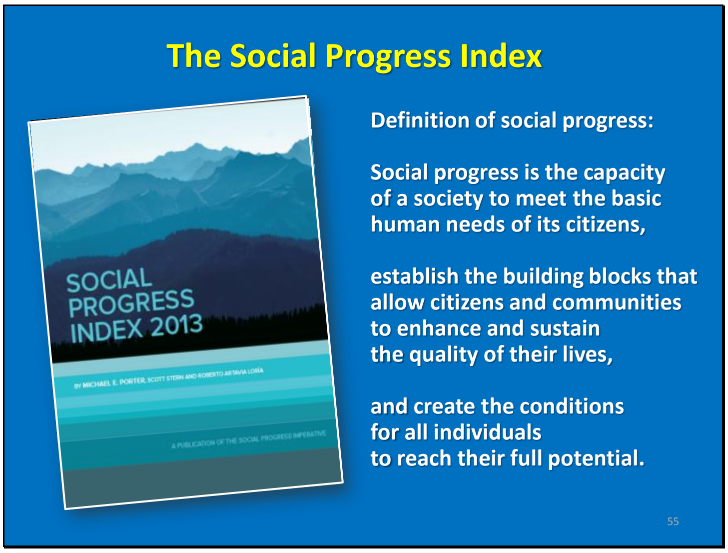

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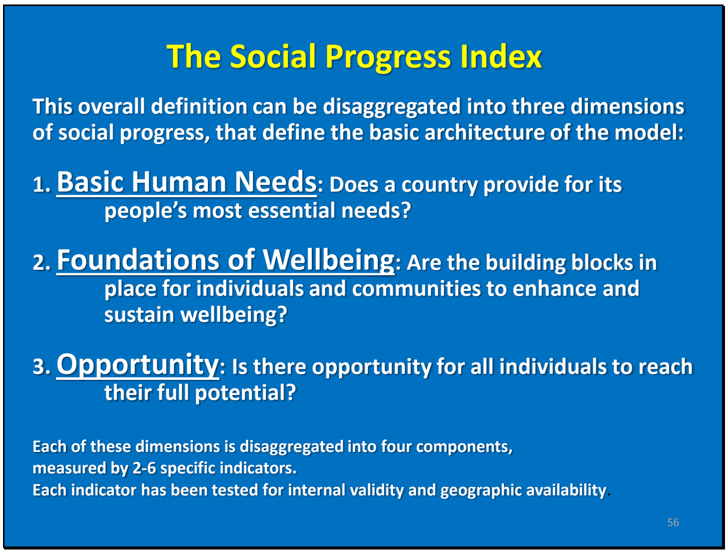

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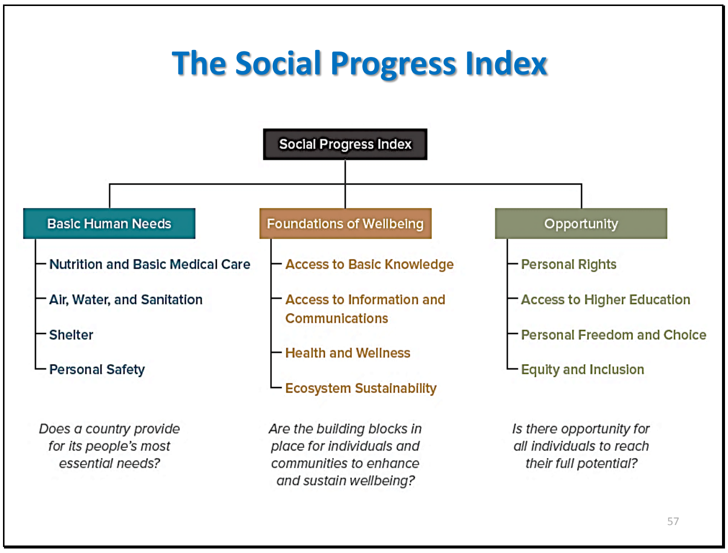

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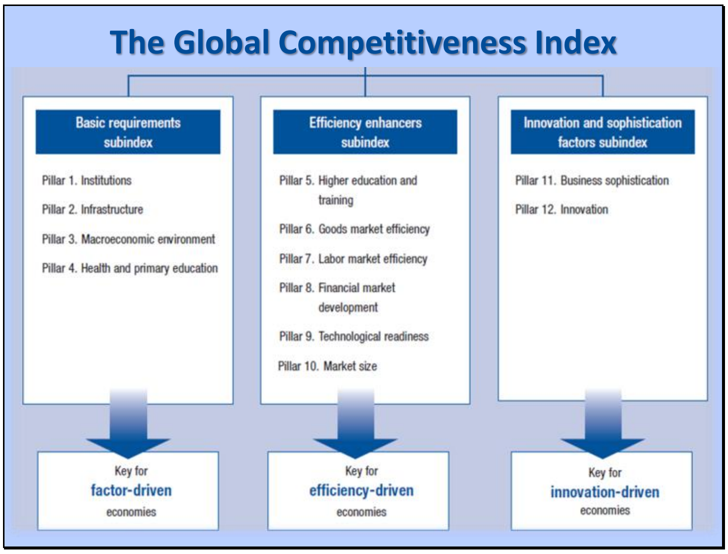

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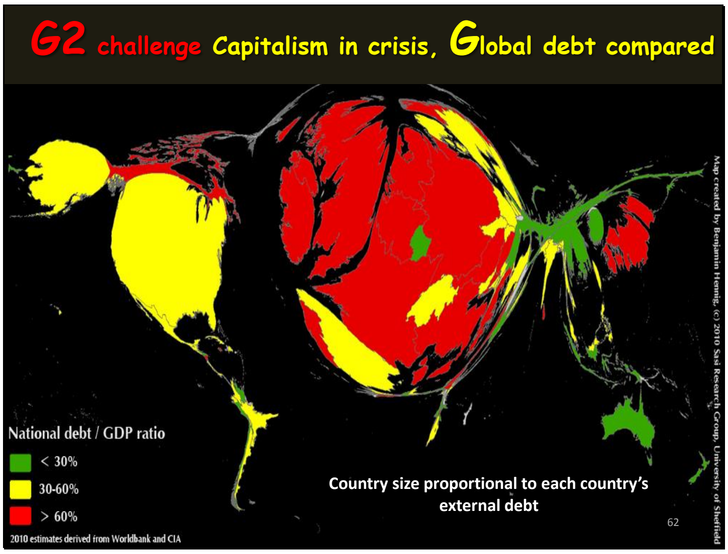

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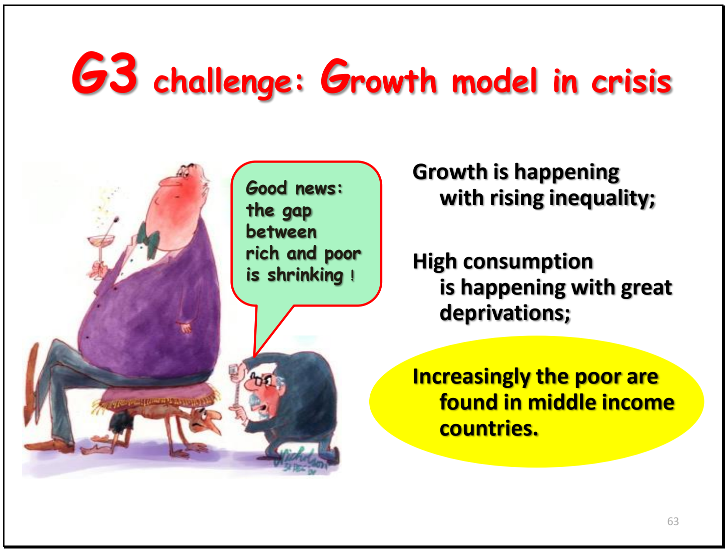

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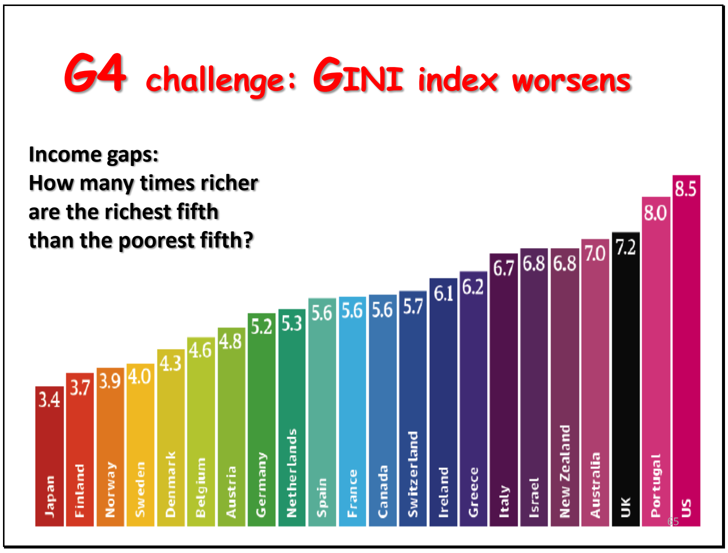

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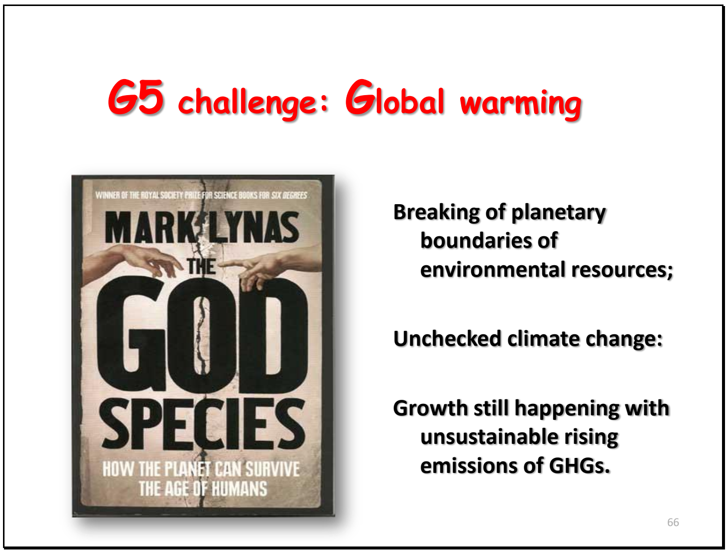

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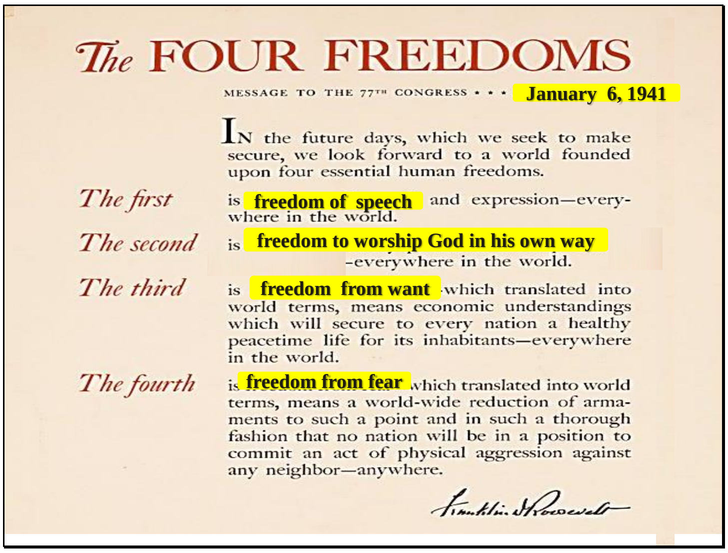

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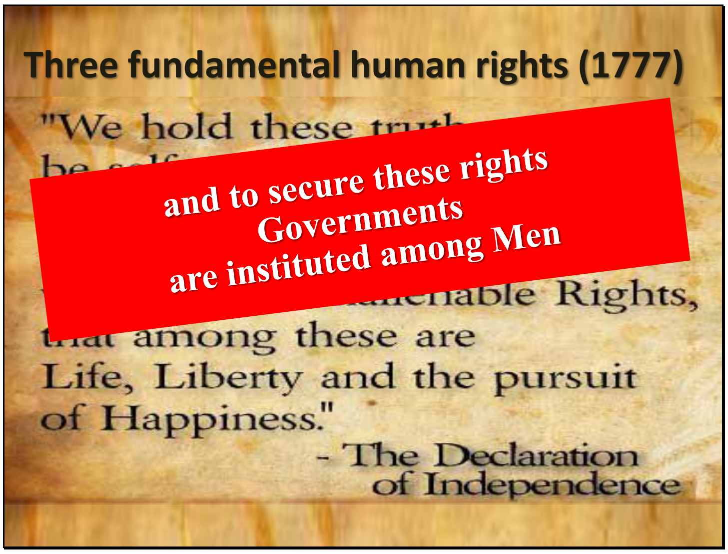

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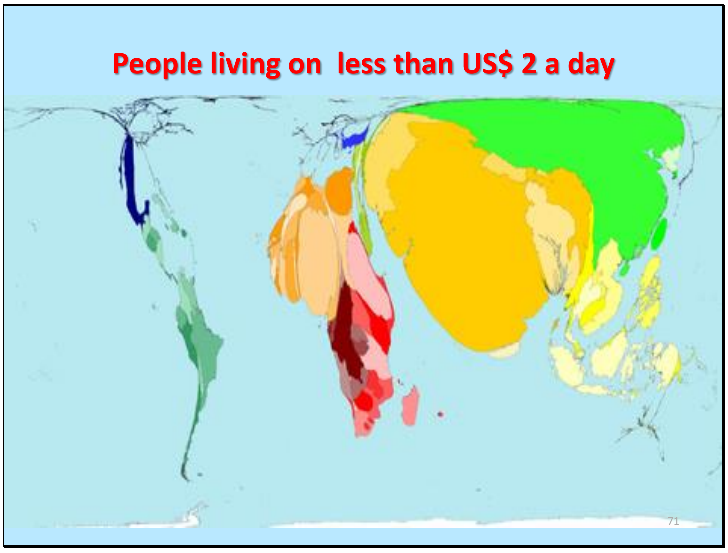

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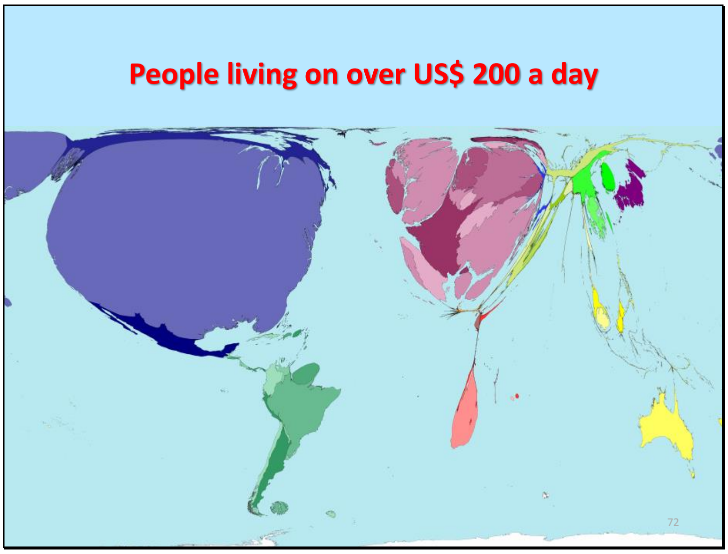

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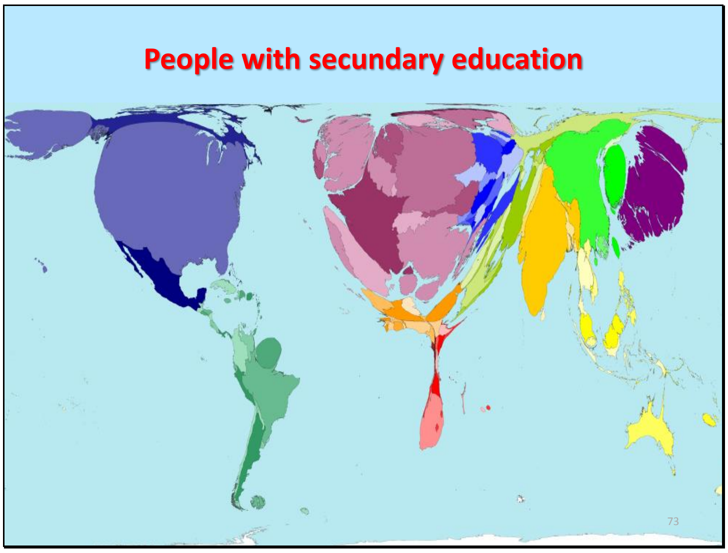

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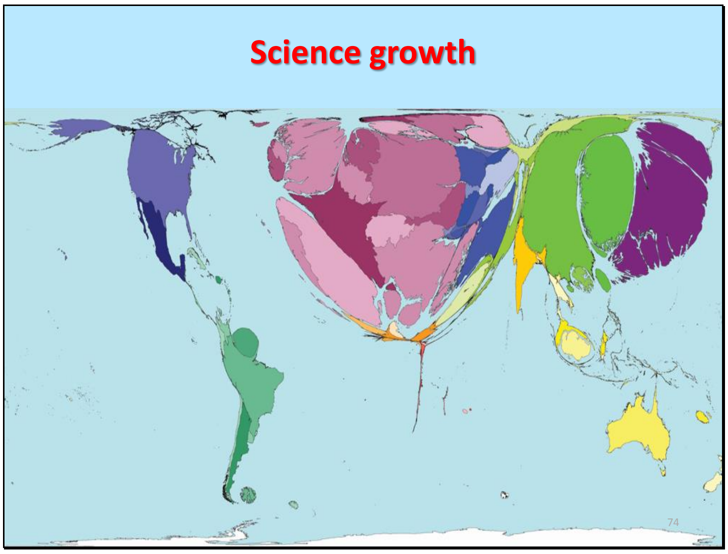

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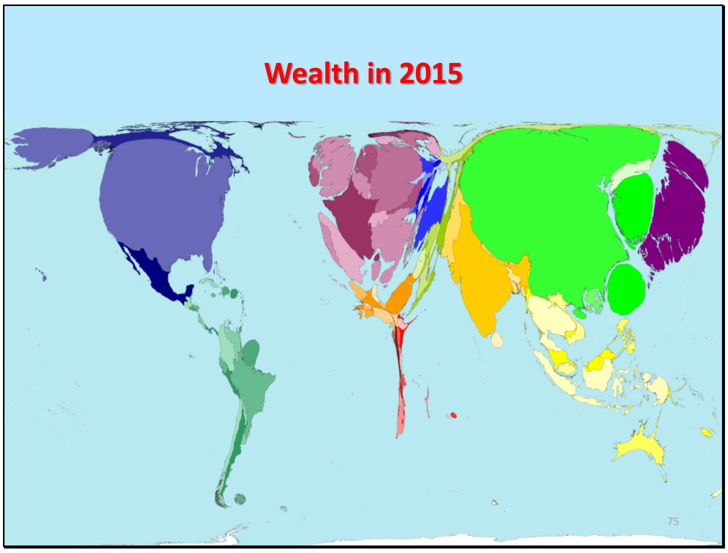

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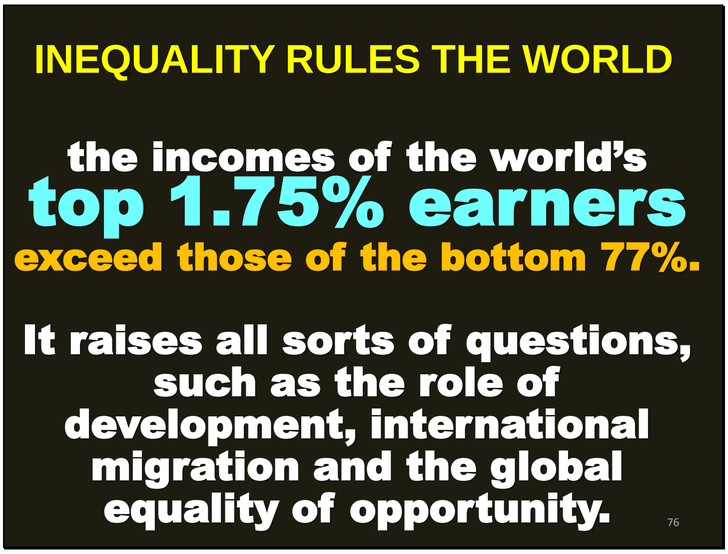

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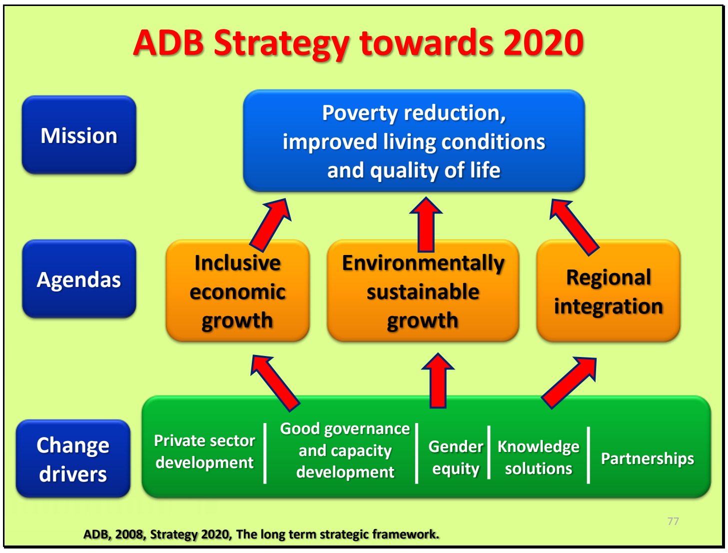

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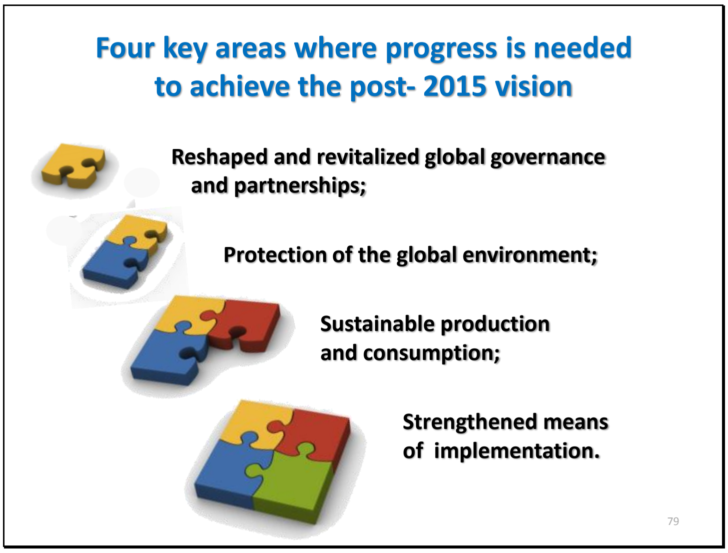

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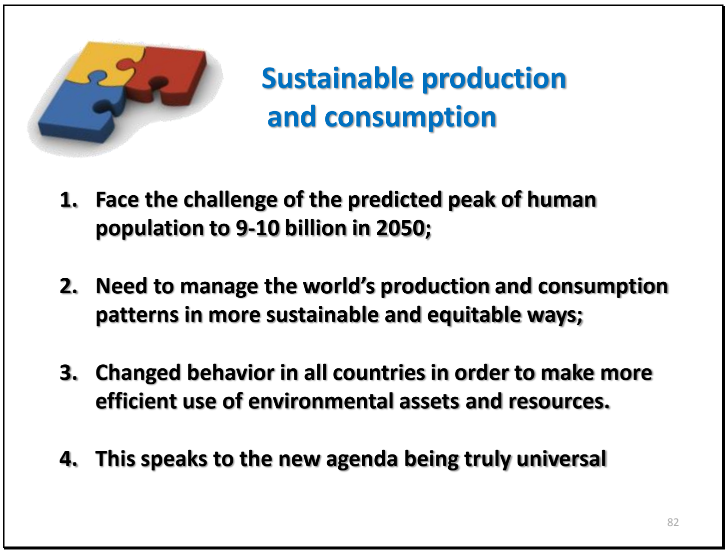

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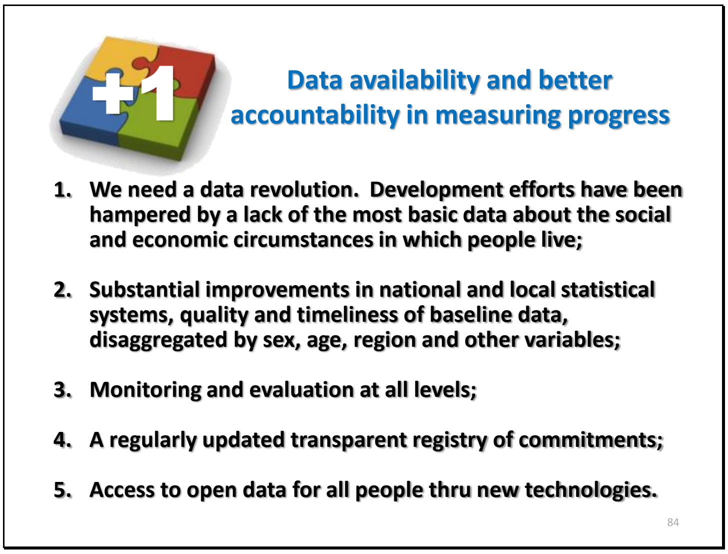

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How to make it happen?

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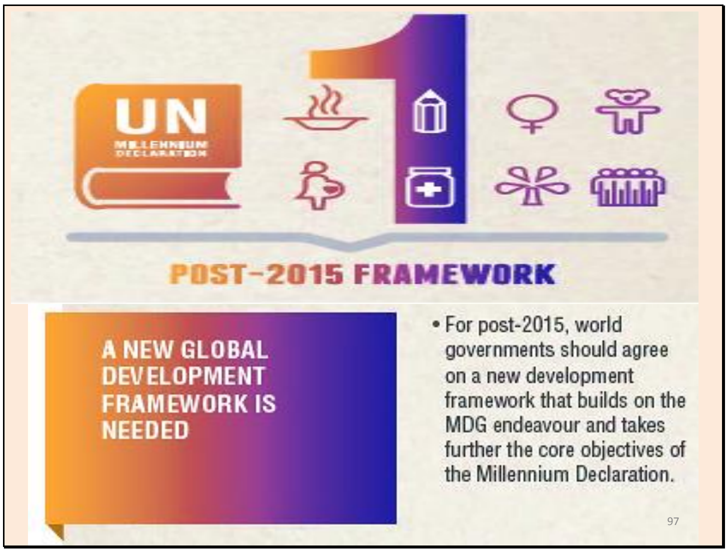
Figure 95



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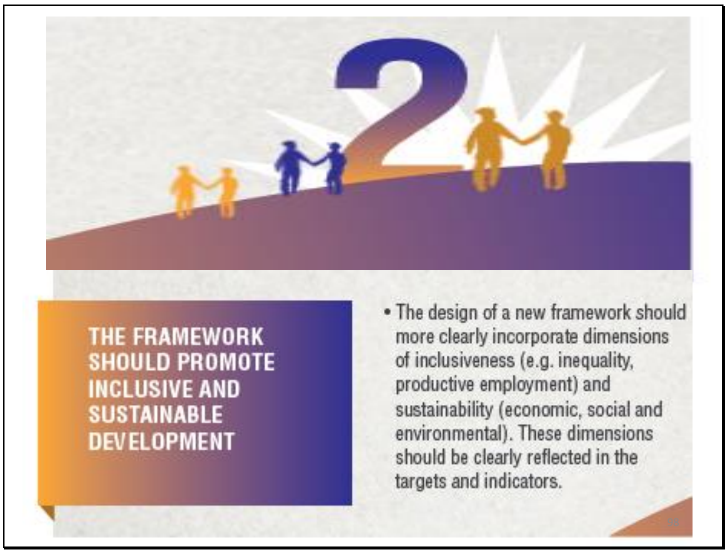

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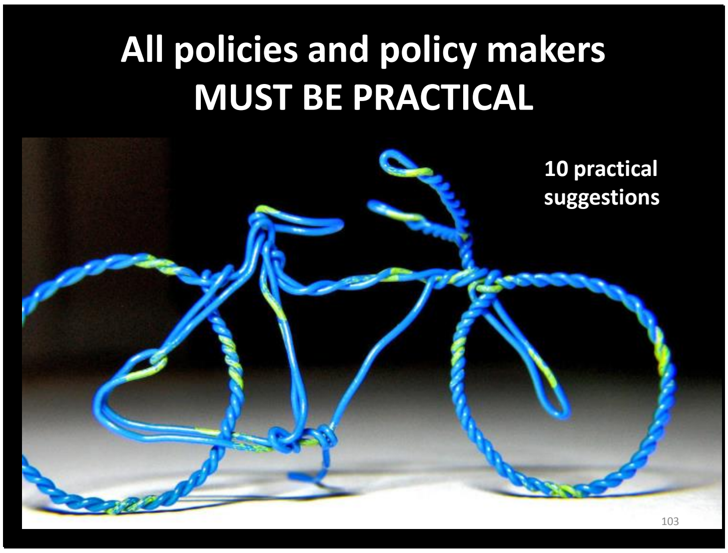

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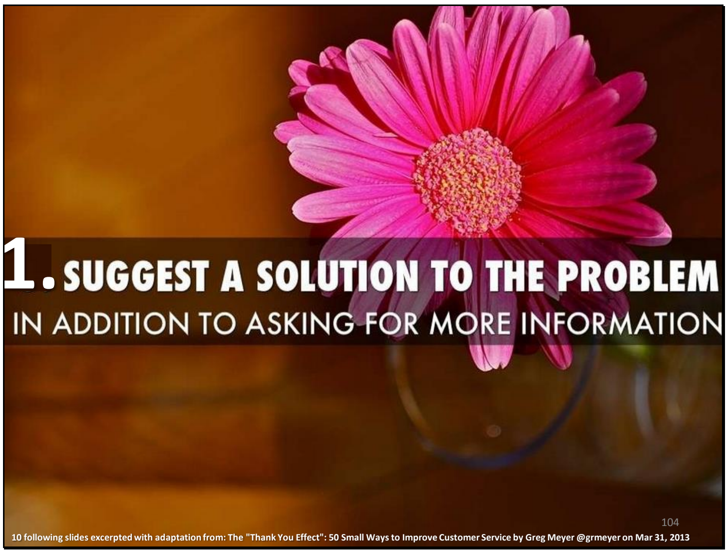

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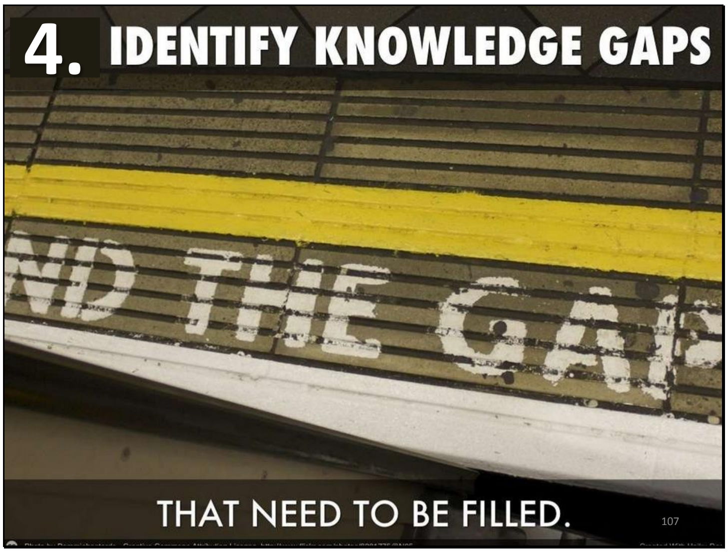

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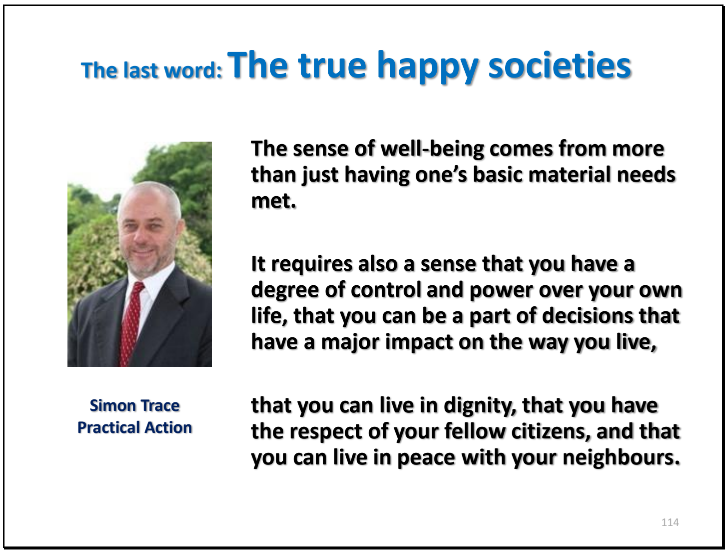

Figure 113.

Figure 114.

Thank you

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Figure 115.

Acknowledgments and sources of data

DBI, Doing Business Index, World Bank, WB: http://www.doingbusiness.org/rankings
FWI, Freedom in the World, The Freedom House: http://www.freedomhouse.org
GCI, Global Competitiveness Index, World Economic Forum, WEF:
http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2012-13.pdf
GDP, Gross Domestic Product, World Bank: http://data.worldbank.org/indicator/NY.GDP.MKTP.CD
GNHI, Gross National Happiness Index:, Government of Bhutan and the Earth Institute:
http://www.earth.columbia.edu/sitefiles/file/Sachs%20Writing/2012/World%20Happiness%20Report.pdf
GPI, Global Peace Index, Institute for Economics and Peace, IEP: http://www.visionofhumanity.org/
HDI, Human Development Index, United Nations Development Programme, UNDP: http://hdr.undp.org/en/statistics/hdi/
HPI, Happy Planet Index, New Economics Foundation, NEF: http://www.neweconomics.org/projects/happy-planet-index
IEF, Index Economic Freedom, The Heritage Foundation with Wall Street Journal: http://www.heritage.org/index/
ISEW, Index of Sustainable Economic Welfare, Friends of Earth: http://www.foe.co.uk/community/tools/isew/make-own.html
LPI, Legatum Prosperity Index, Legatum Institute: http://www.prosperity.com/Ranking.aspx
LPI, Living Planet Index: World Wildlife Fund, WWF: http://wwf.panda.org/about_our_earth/all_publications/living_planet_report/
MDGs, Millennium Development Reports, United Nations: http://www.un.org/millenniumgoals/reports.shtml
MPI, Multidimensional Poverty Index Oxford Poverty and Human Development Initiative, OPHI:
http://www.ophi.org.uk/policy/multidimensional-poverty-index/
QLI, Quality of Life Index; The Economist Intelligence Unit: http://www.economist.com/media/pdf/QUALITY_OF_LIFE.pdf
SPI, Social Progress Index, Harvard University: http://www.socialprogressimperative.org
WDI, World Development Indicators, World Bank: http://databank.worldbank.org/ddp/home.do
WIHF, Worldwide Index of Human Freedom, Fraser Institute: http://www.freetheworld.com/2012/freedomIndex/Towards-Worldwide-Index.pdf
YBLI, Your Better Life Index, Organization for Economic Cooperation and Development, OECD: http://www.oecdbetterlifeindex.org/
The "Thank You Effect": 50 Small Ways to Improve Customer Service by Greg Meyer @grmeyer on Mar 31, 2013
http://www.guardian.co.uk/global-development/poverty-matters/2011/may/24/talkpoint-measuring-development-progress
The European Development Report http://www.erd-report.eu/erd/index.html

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Figure 116.

Food Security Initiatives for the Social Well Being of the Farmers: How Science Helps

AINI IDERIS[1] FIAS, KHATIJAH YUSOFF[2] FIAS
and
ABDUL LATIF IBRAHIM[3] FIAS

ABSTRACT

Malaysia has transformed into a prosperous, urbanised and industrialized economy since early 70s due to its rapid growth and structured changes. Today less than 5% households are considered poor as compared to 50% in 1957, when the country achieved its independence. Nonetheless, although the country has been successful in lowering the national poverty rate, there are still substantial spatial individuals living in poverty especially in rural areas. As such food security remains relevant to Malaysia like many other countries. Despite various policies and efforts, Malaysia is still not able to meet its self-sufficiency level in basic food items, such as rice, meat and other livestock products (except poultry), vegetables and fruits. These deficits lead to huge import dependency with its own risks and disadvantages, both financially and strategically. The increasing trend of food prices have important implications on economic accessibility to food especially to the rural poor. Here we describe how Science has contributed towards achieving part of targeted self-sufficiency level in basic food item.

The Malaysian Third Agriculture Policy (1998-2010) emphasized on ensuring adequate supply of poultry meat and eggs, for the domestic market and to capitalize on export market. Though the self-sufficiency of poultry meat and eggs is 125%, which contributes to the 75% of the RM10 billion livestock industry in the country, the village chicken production represents only 6% of the market, and is not sustainable in the long term due to threats from diseases. Malaysia is enhancing rural development programmes to further raise the incomes of impoverised rural agricultural communities. Our research group is involved in food security initiatives through disease control. We focus on enhancing the health of poultry especially village chickens by developing efficacious vaccines which are cheaper than the imported vaccines. One of the vaccines is for Newcastle disease, which is a very important disease in poultry. The success of this vaccine which is heat-stable, has led to an increase in number of village chickens being reared by rural farmers, as poultry meat is a very important source of cheap protein. This has also expanded the village chicken industry where some farmers now rear large number of village chickens semi-intensively. The development of this vaccine has led to the establishment of the first and the only vaccine manufacturing

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company (animal health) in the country and the vaccine has also been exported to other countries. The company has grown from strength to strength and is now a certified Good Manufacturing Practice (GMP) vaccine production company. The success of this vaccine not only results in increasing number of village chickens for the rural farmers, increasing their social well-being, but also brings financial benefits to the industry. With the advancement of new technologies, we have moved from conventional vaccines to third generation vaccines which involve plasmid DNA and nanoparticles. Thus, this vaccine examplifies how Science has a direct impact on the poor rural farmers and on the economy of a fast-developing nation.

Figure 1. Food Security: The Big Picture.

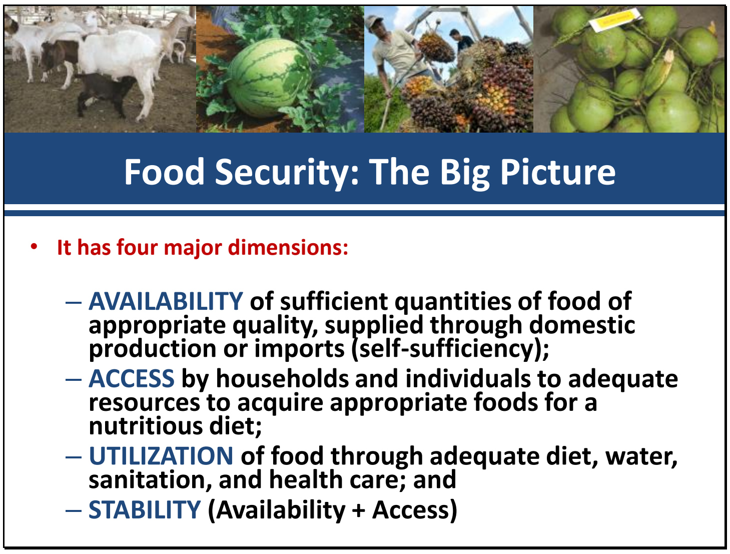

Figure 2. Food Security: The Big Picture.

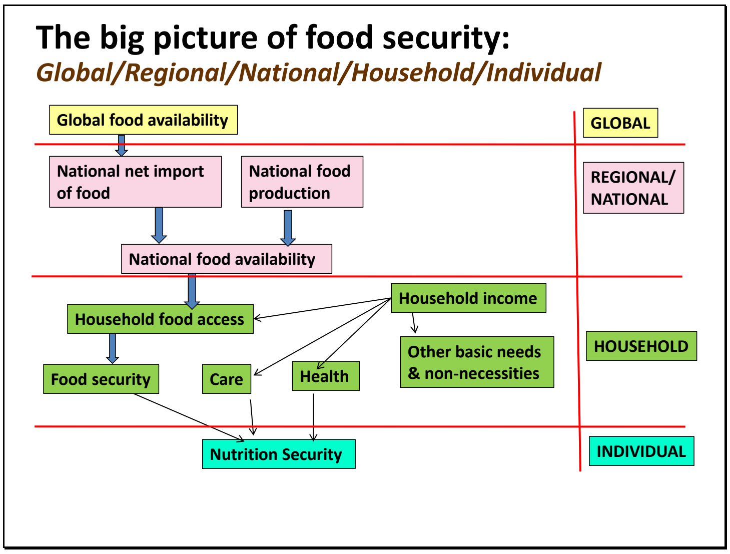

Figure 3. The big picture of food security.

Figure 4. Malaysia's Food Security Situation.

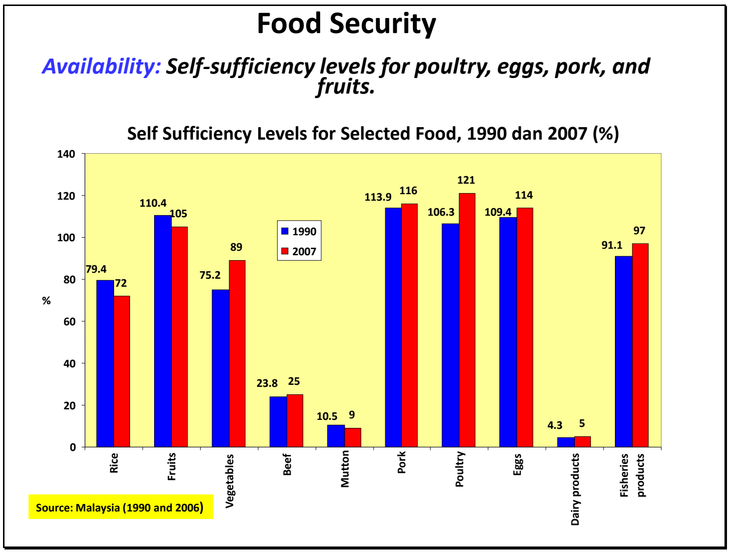

Figure 5. Food Security.

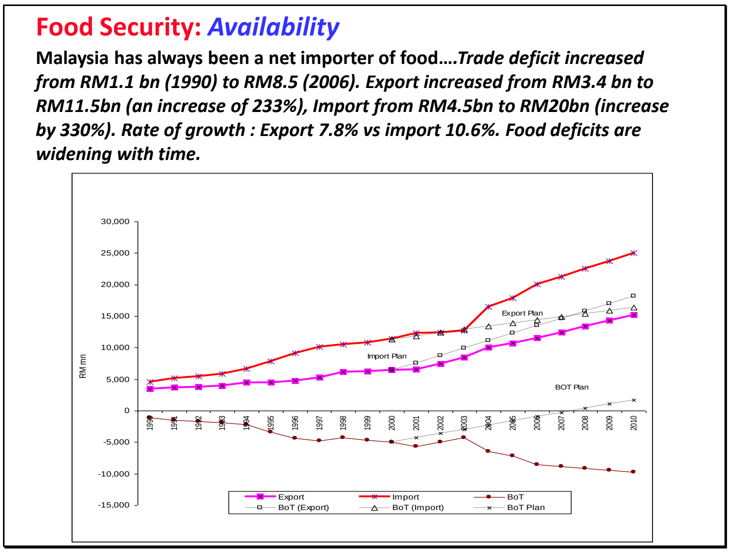

Figure 6. Food Security: Availability.

Figure 7. Malaysia Strategies to Address Food Security.

Emphasis of the National Agricultural Policies

NAP I (1984 - 1992)	▪ To address the imbalance growth agric vs non-agric sector ▪ To develop agro-based industries ▪ Increase production of food
NAP II (1992 – 98)	▪ Maximisation of income through optimal utilisation of resources ▪ To correct imbalance growth agric vs non-agric sector ▪ To enhance productivity, efficiency and competitiveness
NAP III (1998 – 2010)	▪ Maximisation of income through optimal utilisation of resources ▪ To increase competitiveness in global trade ▪ To increase the production of food
9MP **(2006 – 10)**	▪ Agriculture as the 3rd engine of growth ▪ Biotechnology ▪ New source of growth, halal, HRD, role of GLCs, private investment

Figure 8. Emphasis of the National Agricultural Policies.

Figure 9. Food Security Plan.

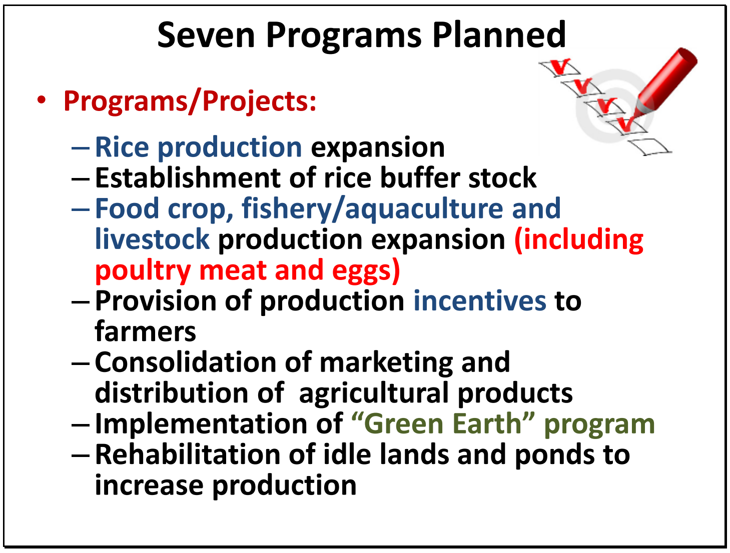

Figure 10. Seven Programs Planned.

Figure 11. Universities/ Research Institutes Roles.

Figure 12. Our Research Team.

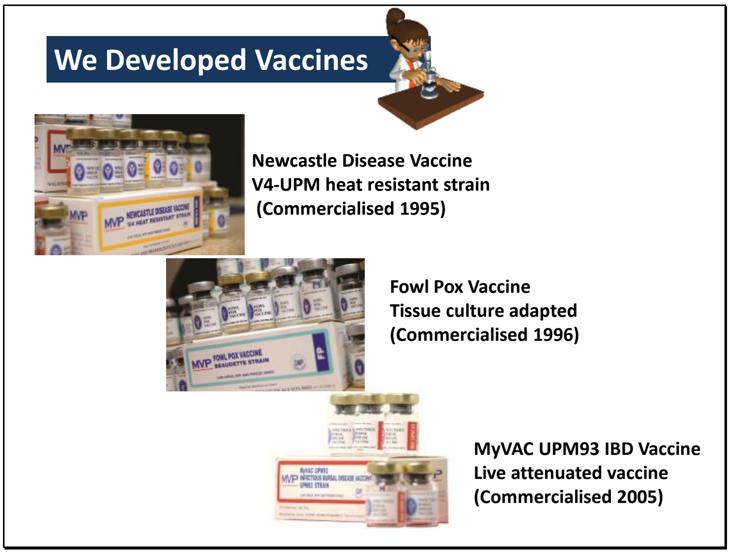

Figure 13. We developed vaccines.

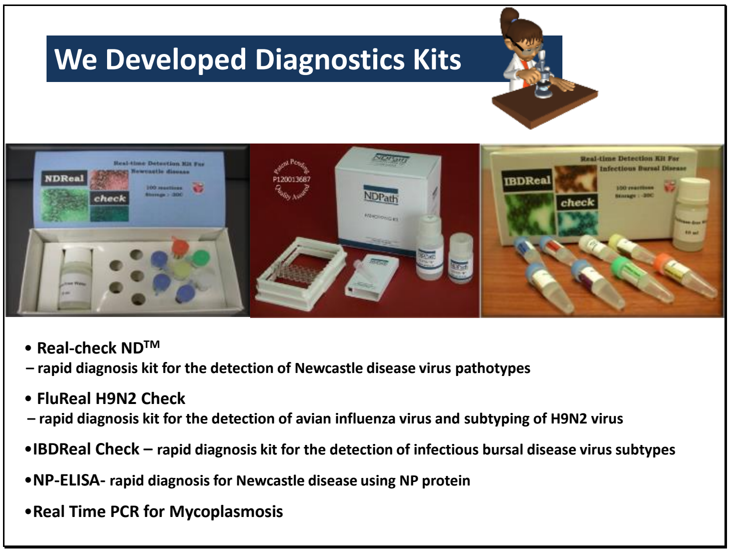

Figure 14. We Developed Diagnostics Kits.

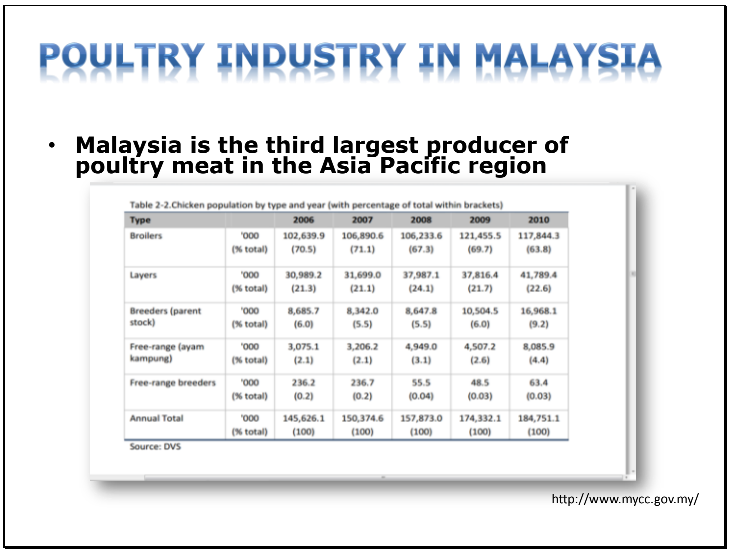

Table 2-2.Chicken population by type and year (with percentage of total within brackets)

Type		2006	2007	2008	2009	2010
Broilers	'000 (% total)	102,639.9 (70.5)	106,890.6 (71.1)	106,233.6 (67.3)	121,455.5 (69.7)	117,844.3 (63.8)
Layers	'000 (% total)	30,989.2 (21.3)	31,699.0 (21.1)	37,987.1 (24.1)	37,816.4 (21.7)	41,789.4 (22.6)
Breeders (parent stock)	'000 (% total)	8,685.7 (6.0)	8,342.0 (5.5)	8,647.8 (5.5)	10,504.5 (6.0)	16,968.1 (9.2)
Free-range (ayam kampung)	'000 (% total)	3,075.1 (2.1)	3,206.2 (2.1)	4,949.0 (3.1)	4,507.2 (2.6)	8,085.9 (4.4)
Free-range breeders	'000 (% total)	236.2 (0.2)	236.7 (0.2)	55.5 (0.04)	48.5 (0.03)	63.4 (0.03)
Annual Total	'000 (% total)	145,626.1 (100)	150,374.6 (100)	157,873.0 (100)	174,332.1 (100)	184,751.1 (100)

Source: DVS

Figure 15. Poultry Industry in Malaysia.

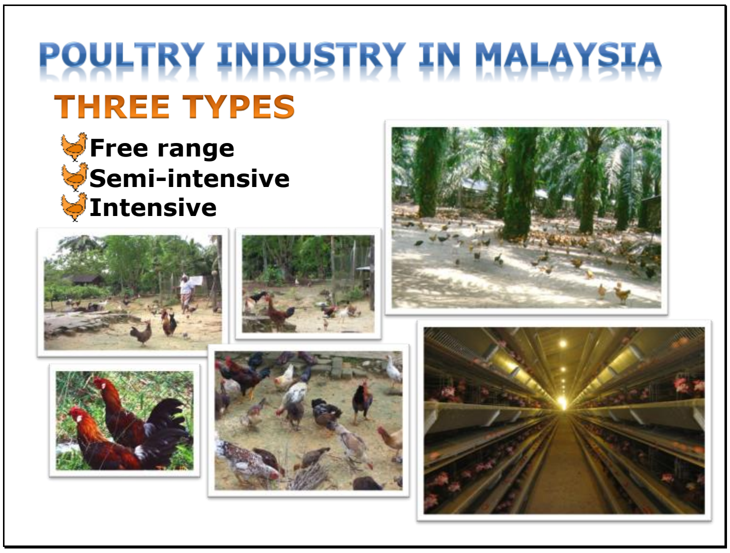

Figure 16. Poultry Industry in Malaysia.

Figure 17. Broiler Farms.

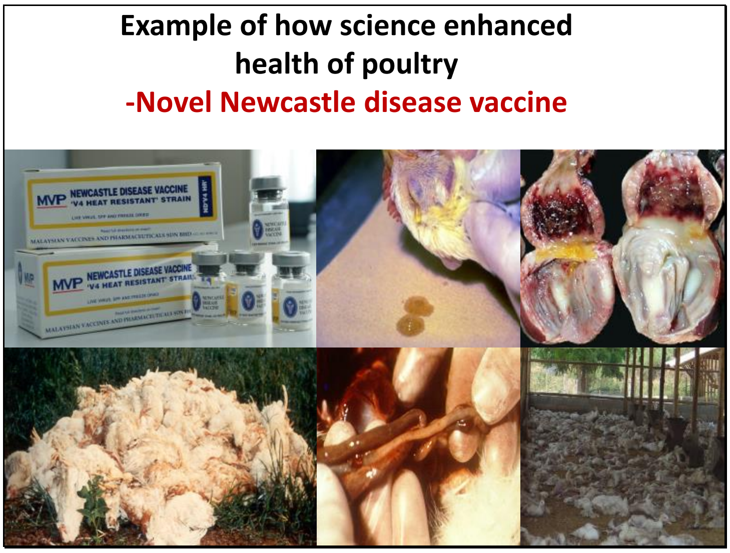

Figure 18. Examples of how science enhanced health of poultry.

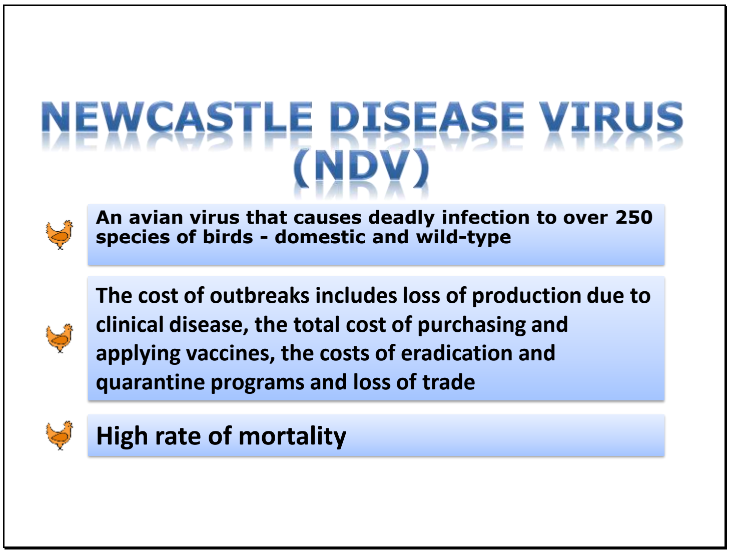

Figure 19. Newcastle Disease Virus (NDV).

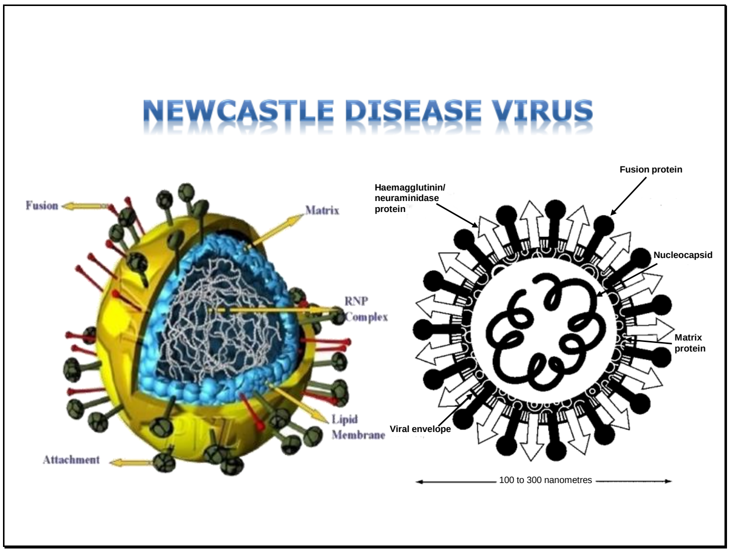

Figure 20. Newcastle Disease Virus.

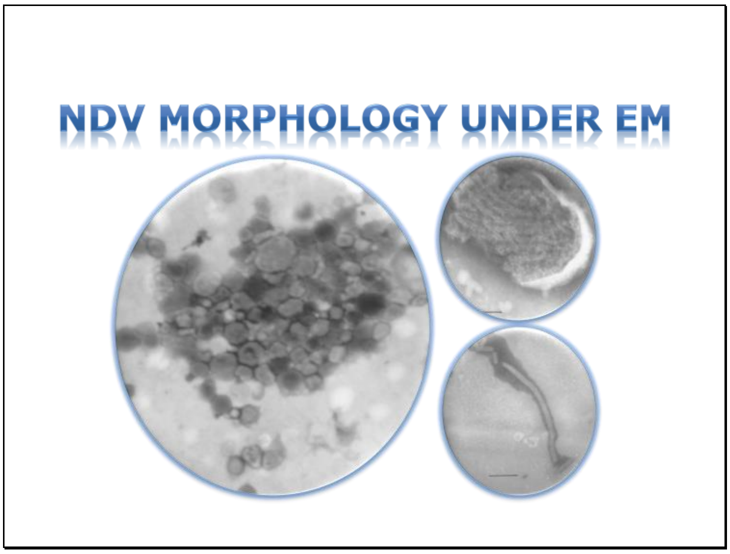

Figure 21. NDV Morphology Under EM.

Figure 22. Newcastle Disease.

Figure 23. Control of Newcastle Disease.

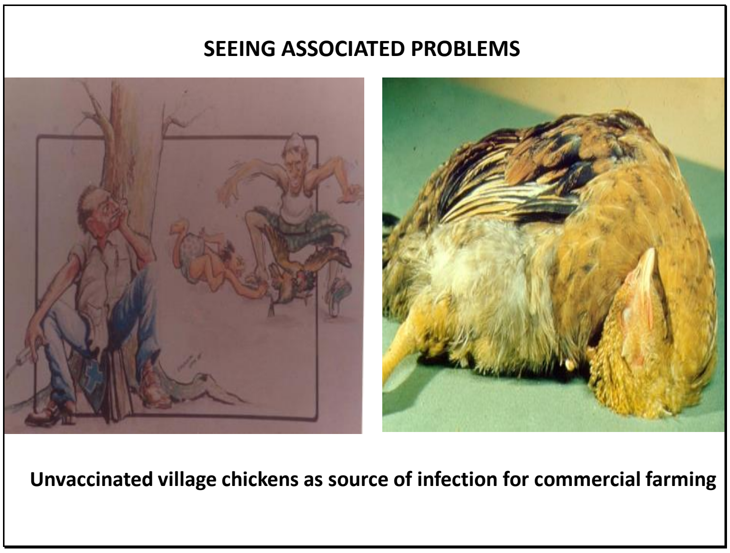

Figure 24. Seeing Associated Problems.

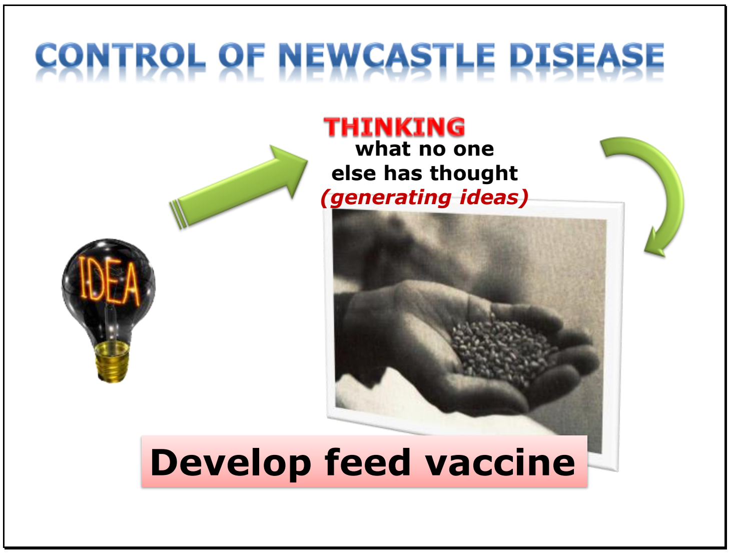

Figure 25. Control of Newcastle Disease.

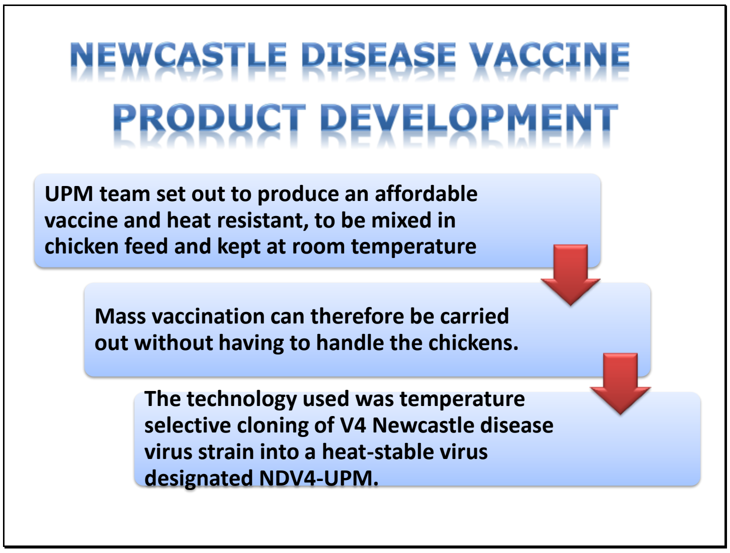

Figure 26. Newcastle Disease Vaccine Product Development.

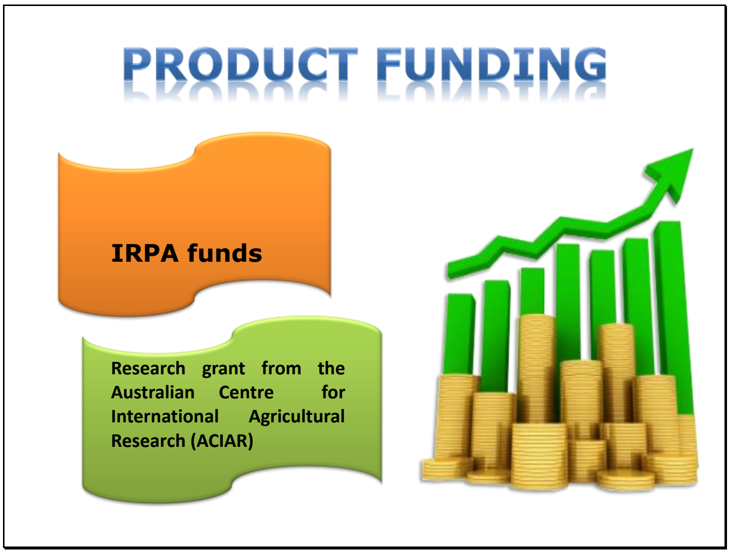

Figure 27. Product Funding.

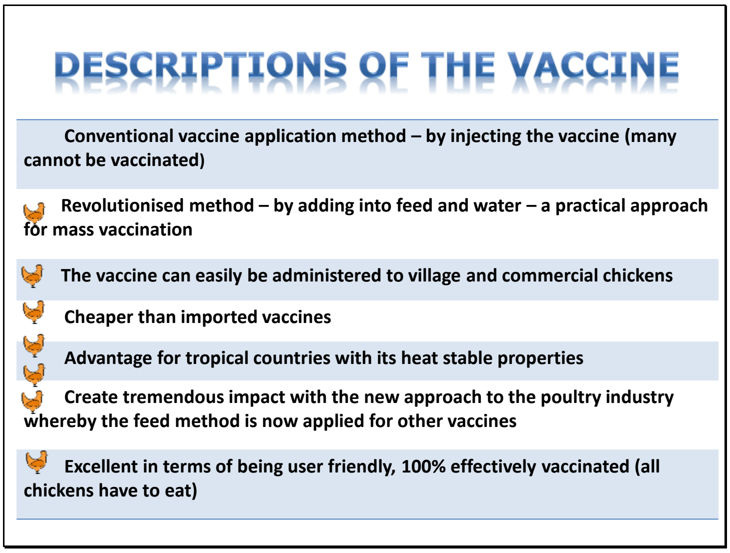

Figure 28. Descriptions of the Vaccine.

Figure 29. Freeze Dried Vaccine.

Figure 30. Feed Vaccine.

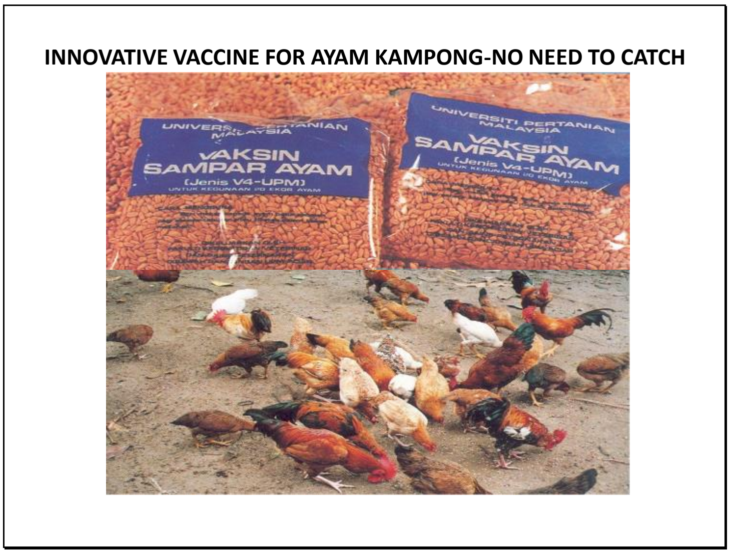

Figure 31. Innovative Vaccine for Ayam Kampong-No Feed to Catch.

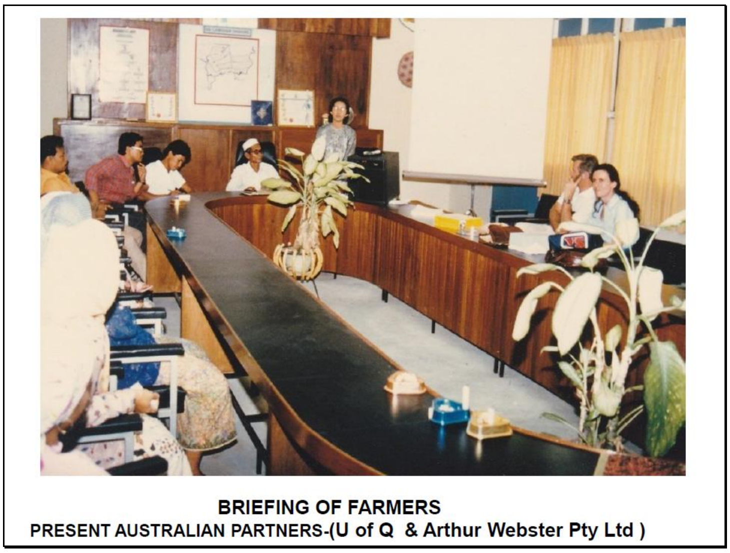

Figure 32. Briefing of Farmers.

DEMONSTRATION ON THE APPLICATION OF VACCINE

Figure 33. Demonstration of the Applications of the Vaccine.

ROAD SHOW

Figure 34. Road show.

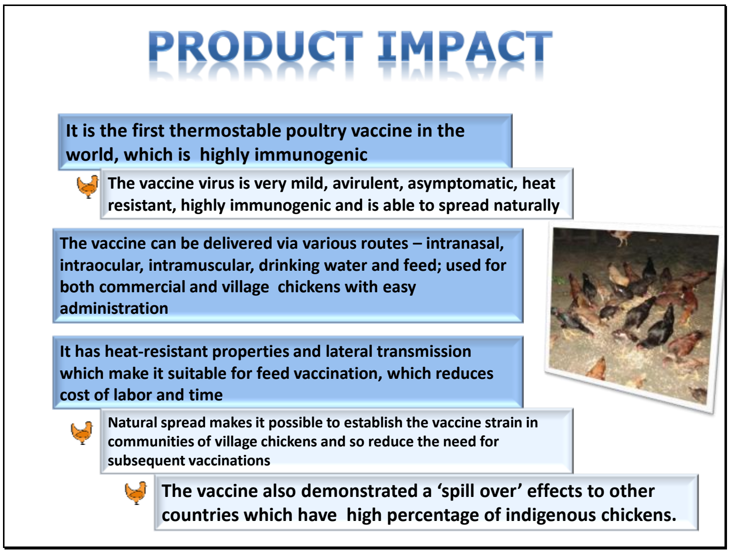

Figure 35. Product Impact.

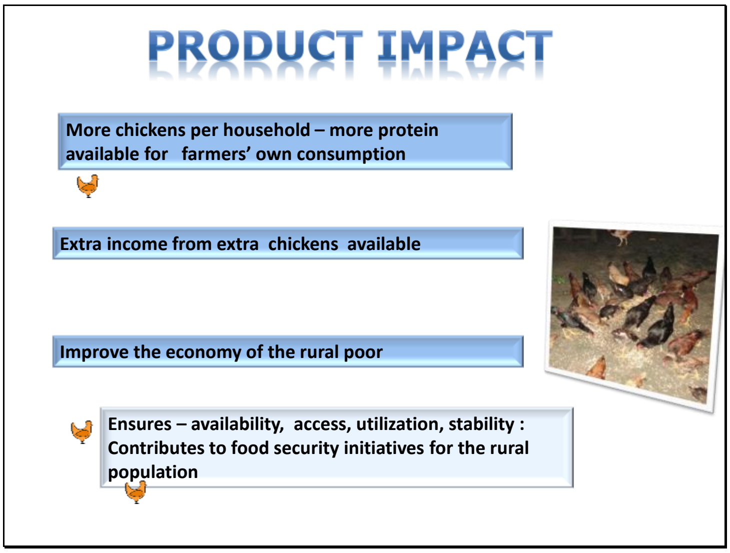

Figure 36. Product Impact.

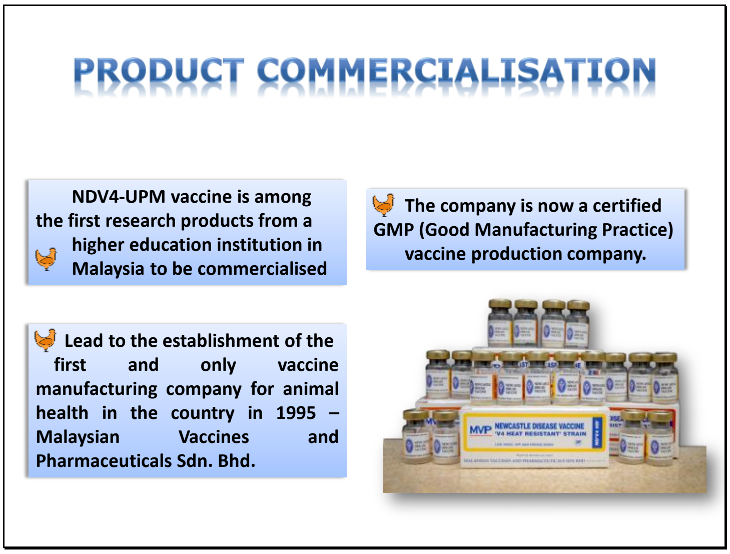

Figure 37. Product Commercialisation.

Figure 38. Malaysian Vaccines and Pharmaceuticals SDN. BHD.

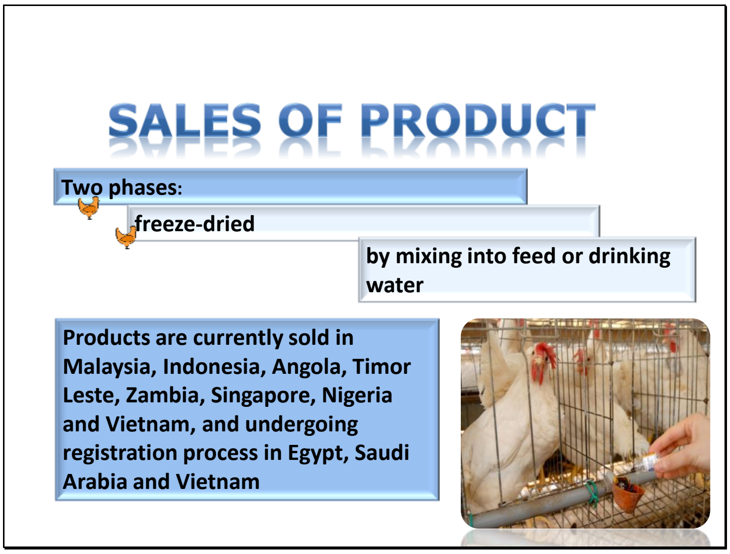

Figure 39. Sales of Product.

Figure 40. Where Do We Go From Here?

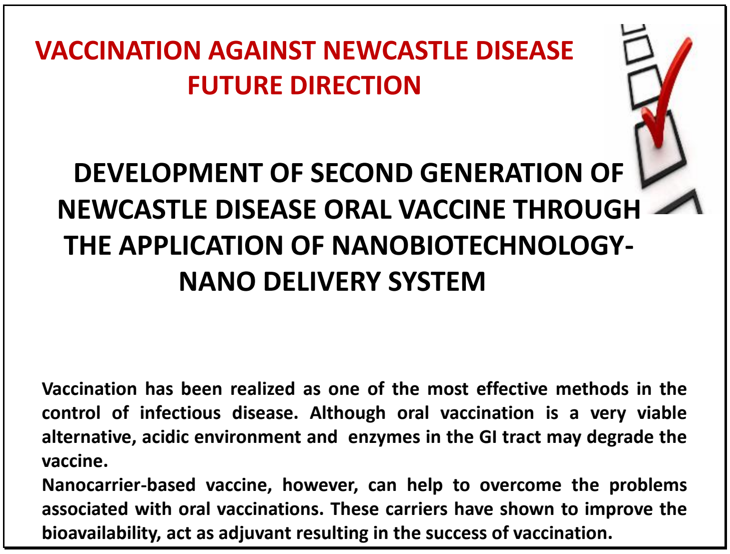

Figure 41. Vaccination Against Newcastle Disease Future Direction.

Radionuclide Research and Development Studies under Bangladesh-German Cooperation

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Germany

1 ABSTRACT

There is a long history of cooperation, starting 1975, between the Institute of Nuclear Chemistry (INC) of the Forschungszentrum Juelich (FZJ), Germany, and the Institute of Nuclear Science and Technology (INST) of the Bangladesh Atomic Energy Commission (BAEC) at Savar, Bangladesh. The major interest has been in physical and chemical aspects of radionuclide research for peaceful applications. From 1995 onwards, the Department of Applied Chemistry and Chemical Engineering (DACCE) of the Rajshahi University in Bangladesh also became a cooperating partner. The chronological development in cooperation and the related experience are briefly described. The research and development work pursued has been broad-based, covering both fundamental investigations and application-oriented studies. Regarding the former, formation probabilities of radioactive products were experimentally measured, and nuclear model calculations were performed to understand the reaction mechanisms. The application-oriented work, on the other hand, involved characterization of neutron spectra, measurement of nuclear data for applications, and development of radiochemical and technological methodologies to produce a few desired radionuclides in a highly pure form, especially for medical applications. Experimental studies were carried out using both mono-energetic and spectral neutrons as well as charged-particle beams from cyclotrons. The salient results of the cooperation (reported in 24 international publications) are outlined. Most of the reported work was done by Bangladeshi scientists together with a few German colleagues at Juelich, but a respectable amount of work has also been carried out in Bangladesh, especially in recent years. An appraisal of the cooperative effort is presented and future prospects are considered.

2 INTRODUCTION

The research and development work related to radionuclides is of considerable fundamental significance and it is also very useful for practical applications. From the fundamental point of view, the formation probability of a radioactive product (i.e. the nuclear reaction cross section), if accurately determined via experiment, can serve as a useful parameter for testing a nuclear model calculation, thereby throwing some light on the reaction mechanism. Since the sensitivity of detection of radioactivity is very high, especially if the radioactive product is chemically separated, the cross section of even a rare reaction can be determined. This interdisciplinary technique, called the *activation technique*, demands relatively modest facilities, so that work can be done also in developing laboratories. The major aim of radionuclide research, however, is directed towards applications. The data obtained and the knowledge gained are useful in reactor technology, materials analysis and preparation of radiotracers for applications in medicine, industry and environmental research.

Radionuclide research work had been going on in full swing at the Institute of Nuclear Chemistry of the Forschungszentrum Juelich (FZJ), Germany, when Bangladesh Atomic

Energy Commission (BAEC) decided in mid 1970s to start this type of research. This article briefly reviews the development of cooperation between the two institutions and its later extension to include Rajshahi University. The salient results achieved are summarized and an appraisal of the cooperative effort is presented.

3 CHRONOLOGY OF DEVELOPMENT OF COOPERATION

The development programme of BAEC included, among other things, establishment of a few facilities to produce neutrons and to make use of them in activation studies mentioned above. The first facility to be commissioned was a 14 MeV neutron generator, involving acceleration of deuterons to an energy of a few hundred keV which would impinge on a Ti(T) target and deliver fast neutrons. The second larger facility to be installed was a TRIGA Mark II reactor for interdisciplinary use. The FZJ was approached by the International Atomic Energy Agency (IAEA) in 1975 with the request to accept a few Bangladeshi scholars for research training in the field of radionuclide research. The German Government was very sympathetic to all developing countries; so the FZJ responded positively and between 1975 and 1985 three Bangladeshi scholars got extensive research education at Juelich in the use of neutrons produced at a generator as well as at two cyclotrons. On their return to Bangladesh they developed very interesting research programmes around the above mentioned two facilities which were installed in the Institute of Nuclear Science and Technology (INST) at Savar (Dhaka) by the end of 1980s.

After completion of the training programme, exchanges of more experienced scientists, funded by external agencies like European Union (EU), German Academic Exchange Service (DAAD) and IAEA, started at a higher research level, so that from early 1990s onwards a real cooperation in research was established. From 1995 onwards, the cooperation was extended to include the Department of Applied Chemistry and Chemical Engineering (DACCE) of the Rajshahi University in Bangladesh where some experience in radiochemistry existed.

In the year 2001, the FZJ donated an Am/Be neutron source to Rajshahi University. This modest facility is well-suited for teaching and research activities at the university level. Shortly later, impetus was given to both educational and research activities at Rajshahi through the appointment of this author as a Research Professor by the Academy of Sciences for the Developing World (TWAS) for the period 2006 to 2011. During three extended visits to Rajshahi, a meaningful research programme around the newly installed facility was established.

A new wave of active cooperation between the BAEC and FZJ came though the award of an Alexander von Humboldt Fellowship to a young scientist (M.S. Uddin) from BAEC to do research at Juelich. Based on his productive performance at the host institute in Germany, that Foundation granted him a home-return stipend for one year to extend the cooperative research between the two institutions. Thus the strong bond established between the FZ Juelich on one side and the BAEC and Rajshahi University on the other, has been very fruitful for both sides and the cooperation is continuing further.

4 MAJOR RESEARCH RESULTS UNDER COOPERATION

The research results obtained over the years are documented in scientific publications [1 – 24] listed at the end of this article. Most of the reported work was done by Bangladeshi scientists together with a few German colleagues at Juelich, but a respectable amount of work has also been carried out in Bangladesh, especially in recent years. All publications deal with radioactive products. As mentioned in the Introduction, both fundamental and application-oriented studies were performed. Some of the salient results in the two areas are summarized below.

4.1 Fundamental Investigations

Cross sections for the formation of a large number of activation products in the interactions of 14 MeV neutrons with light, medium and heavy mass target nuclei were experimentally determined and the systematic trends observed [2] in the cross sections of the three major reactions, namely (n,p), (n,α) and (n,2n), as fractions of the total non-elastic cross section (σ_{Rx}/σ_{ne}) are shown in Fig. 1. Evidently in the target mass region around 50 (asymmetry parameter ~ 0.07) the three reactions compete with each other. With the increasing target mass, however, the neutron emission process becomes increasingly dominant whereas the emission of charged particles becomes weaker and weaker. Extension of those studies to lower [5, 6, 8, 11] and higher [3, 4, 9, 12] neutron energies and inclusion of nuclear model calculations [2, 4, 6, 8, 11, 12] revealed that the products formed via emission of nucleons (neutrons and protons) are described well by statistical processes, including some contributions from precompound effects. The products formed via the emission of light complex particles, especially tritons and α-particles [4, 6, 12], on the other hand, entail considerable contributions of direct and precompound effects.

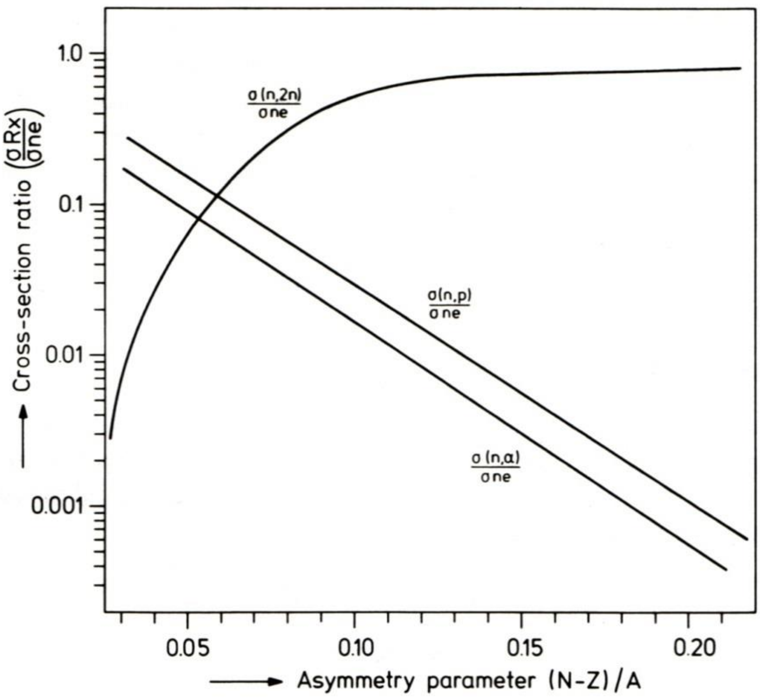
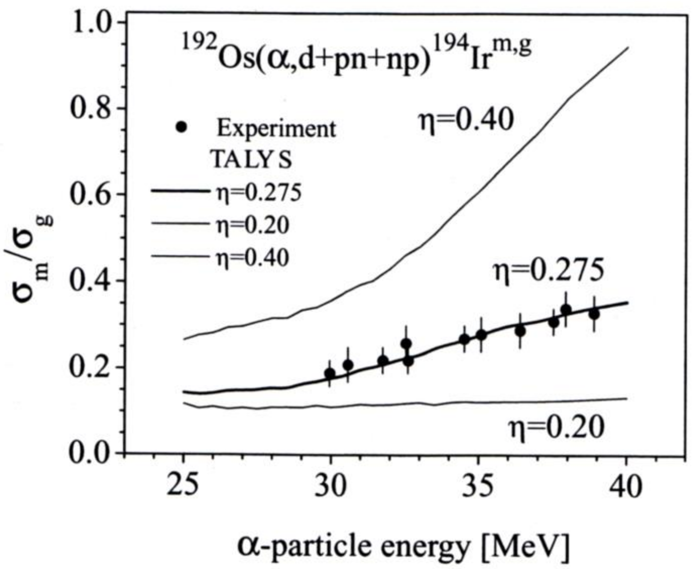


Figure 1. Trends describing the relative contributions of (n,p), (n, α) and (n,2n) reaction cross sections to the nonelastic cross section of the target nucleus at 14.5 MeV as a function of (N-Z)/A. The (n,p), (n,α) and (n,2n) cross section data were obtained experimentally; σ_{ne} was derived from the optical model; smooth curves were drawn through the points.

(taken from Molla and Qaim, 1977, Ref. [2]).

Another area of fundamental investigation dealt with the formation of low-lying isomeric states of activation products in both neutron [2, 8] and charged particle [16, 18, 21, 22] induced reactions. Those studies demanded characterization of the soft radiation emitted in the deexcitation of the isomeric state, often after radiochemical separation of the desired activation product. The isomer distribution ratio was found to depend on several factors, such as the nuclear spins of the two states concerned, the reaction channel involved and the energy of the projectile used. As an example, the isomeric cross section ratio of the pair $^{194m,g}Ir$ [18], is shown in Fig. 2 (A) and (B) for two reactions, namely $^{192}Os(\alpha,d)$ and $^{194}Pt(n,p)$. A dramatic difference of an order of magnitude is observed if the (n,p) reaction is substituted by the (α,d) reaction. As far as nuclear model calculations are concerned, the results are strongly dependent on the input parameters, especially the description of discrete levels [8], the level density parameter used [8] and the spin distribution of the level density assumed [18].

(A)



(B)

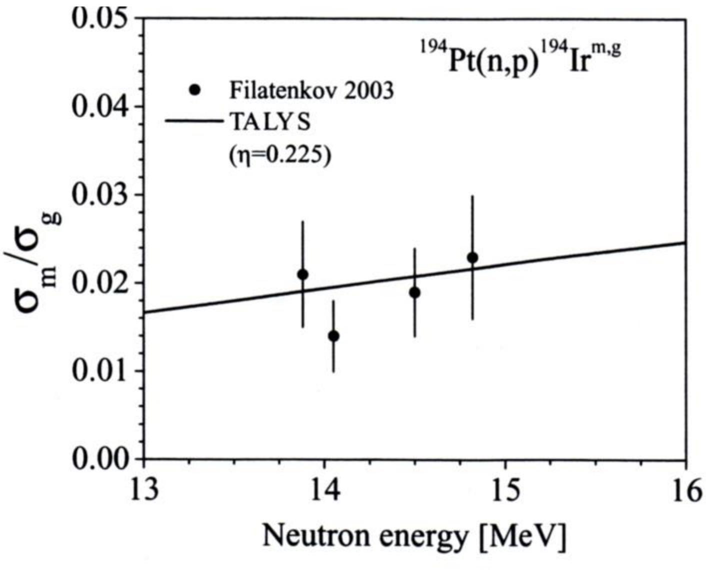


Figure 2 Isomeric cross section ratio (σ_m/σ_g) of the pair $^{194m,g}Ir$ formed in (α,d) and (n,p) reactions. The ratio in the former reaction (A) is by an order of magnitude higher than in the latter reaction (B). The curves give results of nuclear model calculations with different η values, i.e. different spin distributions of the level density.
(taken from Uddin et al, 2011, Ref. [18]).

4.2 Application Oriented Studies

The application oriented work has been pursued in four directions: they are briefly mentioned below.

4.2.1 Characterization of neutron spectra

The characterization of spectral shapes of fast neutrons is of considerable importance because of their use in many areas. Several sophisticated techniques like time of flight, chopper selection, etc. are advantageously used for this purpose but they are rather expensive. A comparatively simple method is to perform activation of a set of foils of different metals, thereby inducing nuclear reactions with different thresholds, and to use an iterative code to unfold the neutron spectrum. This technique was employed to characterize two types of neutron fields generated at the Juelich cyclotrons, namely the quasi-monoenergetic neutrons [5] produced through the dd reaction in a deuterium gas target and the d(Be) breakup neutrons [4]. The same technique in an improved form, involving activation of about 10 metal foils and unfolding the neutron spectrum using the modern code SULSA, was utilized in Bangladesh to characterize the shapes of the fast neutrons emitted from the Am/Be source at the Rajshahi University [23] as well as of the fast neutrons available in the core of the nuclear reactor TRIGA Mark II at Savar [19]. The results are shown in Fig. 3 (A) and (B). The spectral shape of the Am/Be neutrons is consistent with the existing knowledge. The TRIGA reactor neutron spectrum has a shape similar to the fission neutron spectrum in the energy range above 1.5 MeV. In the lower energy region, however, the TRIGA spectrum is harder than the pure ^{235}U-fission spectrum. There could be several reasons, e.g. difference in fuel cladding, presence of $ZrH_{1.6}$, lower enrichment of U-235 in TRIGA (i.e. higher concentration of U-238), presence of thick graphite in the vicinity of the core, etc.

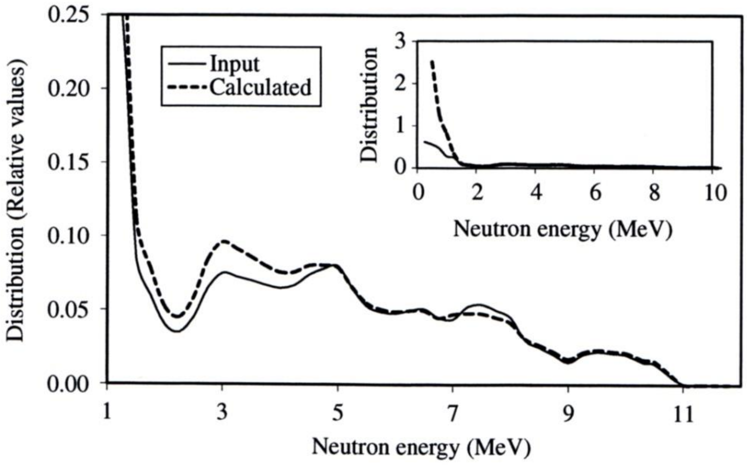
The characterization of the two types of neutron sources available in Bangladesh has placed the neutron data and the radionuclide development work (described below) on a more firm footing.

4.2.2 Neutron data for applications

Besides the fundamental studies described in section 4.1, extensive collaborative work on activation cross section measurement of neutron threshold reactions has been done at Juelich using mono-energetic neutrons [1, 2, 5 – 12] as well as d(Be) spectral neutrons [1, 3, 4, 7, 10]. The aim of all those studies was to gain data on hydrogen, helium and tritium formation through (n,xp), (n,xα) and (n,xt) reactions, especially for fast reactor materials Al, Ti, Cr, Ni, Nb and Mo. The data are important for estimating activation products, nuclear heat and radiation damage in materials through hydrogen and helium gas accumulation.

In Bangladesh collaborative efforts have concentrated on measurement of (n,p) reaction cross sections with 14 MeV neutrons on Sc and Y [13] and with spectral neutrons on Mg, Al, Ti, Fe, Co, Ni and Mo [19, 23, 24]. There have been two motivations behind those measurements: (i) to estimate the formation of some purely β^- emitting radionuclides of potential use in medicine (e.g. ^{89}Sr), (ii) to test evaluated excitation functions of a few reactions given in data files and data libraries. The emphasis was more on data testing since the use of both Am/Be neutron spectrum and the TRIGA neutron spectrum in such studies is novel. The results of integral measurements on a few selected reactions [19, 23, 24] are given in Table 1, together with the integrated data, calculated by averaging the evaluated excitation functions of those reactions (given in data files) for the neutron spectrum under consideration. Furthermore, the ratios of calculated to measured integral cross sections (calc/meas) are also shown in Table 1. In most cases this ratio varies between 0.92 and 1.08, depicting that the integrated cross section agrees well with the integral measurement. From this observation it is concluded that the neutron spectra associated with the Am/Be source and the TRIGA reactor can be regarded as suitable neutron fields for testing data files.

(A)



(B)

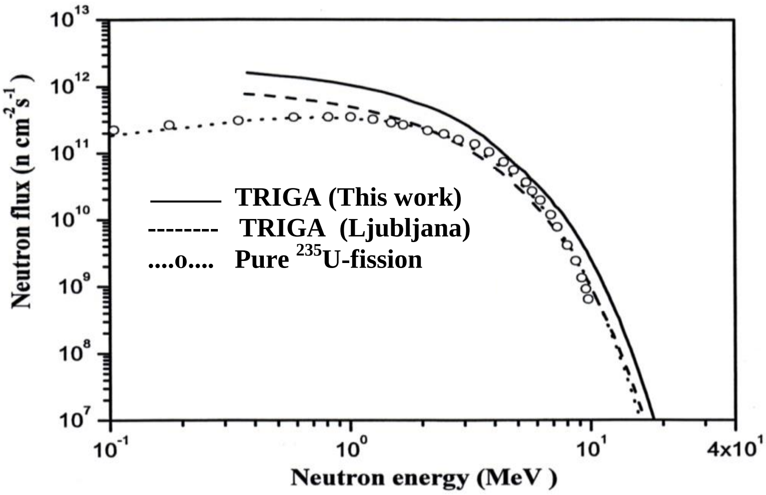


Figure 3. Unfolded fast neutron spectrum; (A) Am/Be source at Rajshahi (taken from Uddin et al, 2010, Ref. [23]); (B) Core of the TRIGA Mark II reactor at Savar.
(taken from Uddin et al, 2013, Ref. [19]).

Table 1. Measured and calculated* neutron-spectrum averaged cross sections
[19, 23, 24]

Reaction	Am/Be neutron source			TRIGA reactor neutron field		
	$<\sigma>_{meas}$ (mb)	$<\sigma>_{calc}$ (mb)	$\frac{<\sigma> calc}{<\sigma> meas}$	$<\sigma>_{meas}$ (mb)	$<\sigma>_{calc}$ (mb)	$\frac{<\sigma> calc}{<\sigma> meas}$
^{24}Mg(n,p)^{24}Na	26 ± 3	24.6	0.94			
^{27}Al(n,α)^{24}Na	9.7 ± 1.2	10.2	1.05	0.67 ± 0.06	0.71	1.07
^{46}Ti(n,p)^{46}Sc				11.6 ± 0.9	11.2	0.97
^{54}Fe(n,p)^{54}Mn	311 ± 26	314	1.01	72.5 ± 6	66.6	0.92
^{59}Co(n,p)^{59}Fe	9.3 ± 1.0	9.8	1.05			
^{92}Mo(n,p)^{92m}Nb	45 ± 4.6	48	1.06	6.6 ± 0.5	7.1	1.08

** All calculated values are based on data given in ENDF-B/VII, except for the ^{92}Mo(n,p)^{92m}Nb reaction which were taken from IAEA-Activation Library.*

4.2.3 Charged particle data for applications

Considerable amount of work with charged particles (extracted from cyclotrons) has been carried out at Juelich in collaboration with Bangladeshi scientists [15-17, 20, 21]. The main motivation behind that work was the development of suitable production methods for three medically important radionuclides, namely Co-55 ($T_{½}$ = 17.6 h), I-124 ($T_{½}$ = 4.2 d) and Pt-193m ($T_{½}$ = 4.3 d). The first two are positron emitters and are of interest in Positron Emission Tomography (PET), a very modern imaging technique used in diagnostic nuclear medicine. Although in routine PET investigations mainly short-lived positron emitters like F-18 ($T_{½}$ = 110 min) and Ga-68 ($T_{½}$ = 67 min) are used, the development of longer lived non-standard positron emitters, like Co-55 and I-124 mentioned above, is opening up new vistas in investigations on slow biological processes. The third radionuclide, namely Pt-193m, is of therapeutic interest. Since in its decay about 33 secondary electrons are emitted, it could be a very useful radionuclide in internal radionuclide therapy with low-energy electrons, termed as Auger therapy.

For production of the radionuclide Co-55 several methods had been suggested. In a careful study on highly enriched Fe-54 as target material, however, it was demonstrated that the $^{54}Fe(d,n)^{55}Co$ reaction [20, 21] leads to the purest form of Co-55. The measured excitation function is shown in Fig. 4. The optimum energy range for production of Co-55 is between 5.0 and 12.5 MeV. The calculated yield of Co-55 amounts to 43 MBq/μAh and the level of the Co-56,57 impurities is < 0.1 %.

For I-124 production, out of several reported reactions, the $^{124}Te(p,n)^{124}I$ process is the best and it is commonly used since it provides I-124 of the highest radionuclidic purity. Yet there was a need to investigate the $^{123}Sb(\alpha,3n)^{124}I$ reaction which appeared rather promising. The excitation function of this process was determined up to an alpha particle energy of 38 MeV [17]. Over the optimum alpha-particle energy range of 30 to 38 MeV the yield of I-124 is not so low, but the radionuclidic purity of the product is not as high as in the commonly used $^{124}Te(p,n)^{124}I$ reaction.

As regards Pt-193m, detailed measurements were performed on the $^{192}Os(\alpha,3n)^{193m}Pt$ reaction [15]. Those measurements were very demanding since the reaction product needed to be cleanly separated from the matrix activity, followed by rather subtle X-ray spectrometry. The optimum energy range for the production of Pt-193m was found to be between 30 and 40 MeV, the integrated yield being 10 MBq/μAh. The method is very promising since high-quality product could be obtained via this route.

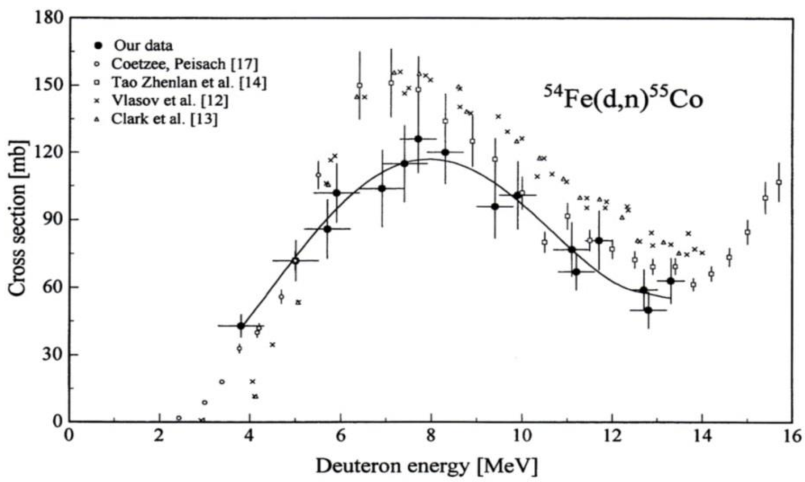


Figure 4. Excitation function of the $^{54}Fe(d,n)^{55}Co$ reaction (taken from Zaman and Qaim, 1996, Ref. [20]). Other authors used ^{nat}Fe as target material; the increasing trend beyond 14 MeV is attributed to the onset of the $^{56}Fe(d,3n)^{55}Co$ reaction.

4.2.4 Radiochemical separations

Development and application of radiochemical separations is an integral part of every radionuclide research programme. It helps to detect the radioactive product efficiently in many nuclear studies but it is an absolute necessity in the purification of products for medical use. Over the years, a large number of separation systems have been worked out (both at Juelich and Savar), a summary of which is given in Table 2. The major application of each developed system is also given.

Table 2. Radiochemical separation methods developed for various applications

Nuclear process investigated	Radionuclide of interest (decay properties)	Chemical separation method developed	Counting method	Application	Reference
(n,xt) on 16 metals	Tritium ($T_{½}$ = 12.3 a; soft β^-)	Purging of HT at > 1000 °C, collection in vacuum line	Gas phase β counting	Studies on triton emission	[4]
^{48}Ti(n,α); ^{45}Sc(n,p)	^{45}Ca ($T_{½}$ = 163 d; soft β^-)	Chlorination; precipitation	Low-level β counting	H and He gas production	[10, 12]
^{54}Fe(d,n)	^{55}Co ($T_{½}$ = 17.6 h; β^+)	Solvent extraction; anion-exchange	γ-ray spectrometry	PET study	]21]
^{58}Ni(n,α)	^{55}Fe ($T_{½}$ = 2.7 a; soft X-ray)	Anion-exchange	Soft X-ray spectrometry	He gas production	[5]
^{89}Y(n,p)	^{89}Sr ($T_{½}$ = 50.6 d; β^-)	Precipitation; cation-exchange	β counting	Internal radiotherapy	[13]
^{123}Sb(α,3n)	^{124}I ($T_{½}$ = 4.2 d; β^+)	Ion-exchange	γ-ray spectrometry	PET study	on-going at Savar
^{192}Os(α,3n)	^{193m}Pt ($T_{½}$ = 4.3 d; Auger electrons)	Distillation; solvent extraction	X-ray spectrometry	Internal Auger therapy	[16]

5 PARTICIPANTS IN COOPERATION

Persons who participated in the scientific cooperation are listed in Table 3. It should be pointed out that names of only those scientists, engineers and technical staff members are given who contributed directly, i.e. who are co-authors of technical publications. On the German side a few external scientists working in Brussels, Debrecen, Dresden, Geel and Vienna were also associated. Besides the listed authors, many more persons were involved in the cooperation: belonging to both supporting infrastructure and patronising senior administration. Without their enthusiasm and encouragement many of the projects could have not been brought to completion.

Table 3. Participants in cooperation

Germany	Bangladesh
FZ Jülich (INC)	BAEC (INST)
S. M. Qaim	N. I. Molla
G. Stöcklin	S. Khatun
H. H. Coenen	M. M. Rahman
R. Wölfle	M. R. Miah
B. Scholten	S. M. Hossain
A. Fessler	M. A. Zulquarnain
I. Spahn	S. Basunia
S. Spellerberg	M. S. Uddin
(Additionally several technical staff	Sk. A. Latif
members and external scientists)	R. Khan
	(Additionally several technical staff members)
	Rajshahi University (DACCE)
	M. R. Zaman
	(Additionally several graduate students)

6 APPRAISAL OF COOPERATIVE EFFORT

The cooperation has been running for almost 38 years. There has been no formal long-term agreement between the concerned institutions. Yet the collaboration proceeded smoothly, though at a low pace. It was based on mutual trust and scientific interests. The visits and projects were individually funded by several organizations, namely International Atomic Energy Agency (IAEA), Vienna, European Union (EU), Brussels, the Academy of Sciences for the Developing World (TWAS), Triest, the Deutscher Akademischer Austauschdienst (DAAD), Bonn, the Alexander von Humboldt Foundation (AvH), Bonn, and partly by the participating institutions themselves.

An appraisal of this long-term cooperative effort, which has run silently but steadily, may be of interest to all those who support enhanced cooperation between scientists in the North and those in the South. The research results described above have been of benefit to both sides. They covered some fundamental work on nuclear reactions as well as investigations on several application-oriented areas, such as materials´ research, nuclear data for technology, radioanalytical techniques in environmental investigations, medical radionuclide production, etc. The emphasis in all those studies was on interdisciplinary utilization of nuclear techniques to enhance our knowledge about borderline areas of chemistry and physics. Besides the research results, described in 24 international publications, some spin off advantages of the cooperation are also worth mentioning, Two Bangladeshi scientists got Ph.D. from Dhaka University based on the work done under the cooperation and INST got manpower trained in neutron activation studies. Some general advice and seminar lectures on topics outside the field of cooperation partly helped a few other scientists at INST and Rajshahi to update and extend their research programmes. Furthermore, the specialised condensed courses given at Rajshahi have led to establishment of a new Master´s course on "Radionuclide Technology". In short the whole effort may be considered as successful, from the viewpoints of both scientific development and transfer of knowledge.

7 CONCLUDING REMARKS

The chronological order of publications based on the cooperative work reflects the changing trends in radionuclide research with the passage of time. Whereas in the 1970s and 1980s the emphasis was on fundamental studies, over the last 20 years the trend has been shifting to more application-oriented work. The Bangladesh-German cooperation rendered some useful service to the development of radioactivation programme at the INST, consisting of nuclear data measurement, neutron activation analysis and medical radionuclide production. The Bangladeshi scientists worked hard and developed those areas of work further at the TRIGA Mark II research reactor; they are now doing work of considerable relevance to the national needs.

A remarkable change in technologically advanced countries over the last two decades has been to make enhanced use of charged particle accelerators in various fields, e.g. materials´ research, production of intense neutron fields, nuclear medicine, etc. In particular radionuclides for positron emission tomography (PET, see above) can be produced mainly using accelerators. The accelerator technology is therefore now expanding also in the developing world. Bangladesh is no exception; at INST a tandem accelerator has recently been installed. The FZJ in Germany has been a leading institution in accelerator production of medical radionuclides, and a young scientist from Bangladesh has already gained considerable experience in this field through his stay in Germany as an Alexander von Humboldt Fellow. The prospects of continuing and extending cooperation between Bangladesh and Germany in the new emerging field are thus bright. It is, however, incumbent that the younger scientists on both sides identify common areas of interest and continue to nurture the cooperation with zeal and mutual respect.

8 ACKNOWLEDGEMENT

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9 PUBLICATIONS UNDER COOPERATION

A. Co-operation between BAEC and FZ Jülich

1. S.M. Qaim and N.I. Molla
   Nuclear data measurements for FR-wall and structural materials
   Proc. 9th Symposium on Fusion Technology, Garmisch-Partenkirchen, FRG, June 1976, EUR 5602, Pergamon Press, 589-595 (1976)

2. N.I. Molla and S.M. Qaim
   A systematic study of (n,p) reactions at 14.7 MeV
   Nucl. Phys. **A283**, 269-288 (1977)

3. S.M. Qaim, S. Khatun and R. Wölfle
   Integral cross-section measurements of (n,x) reactions induced by 30 MeV d(Be) break-up neutrons on FRT wall and structural materials
   Proc. Symp. on Neutron Cross Sections from 10 to 50 MeV, Brookhaven, USA, May 1980, BNL-NCS-51245, 539-552 (1980)

4. R. Wölfle, S. Khatun and S.M. Qaim
   Triton emission cross sections with 30 MeV d(Be) break-up neutrons
   Nucl. Phys. **A423**, 130-138 (1984)

5. S.M. Qaim, R. Wölfle, M.M. Rahman and H. Ollig
   Measurement of (n,p) and (n,α) reaction cross sections on some isotopes of nickel in the energy region of 5 to 10 MeV using a dd gas target at a compact cyclotron
   Nucl. Sci. Eng. **88**, 143-153 (1984)

6. M.M. Rahman and S.M. Qaim
   Excitation functions of some neutron threshold reactions on isotopes of molybdenum
   Nucl. Phys. **A435**, 43-53 (1985)

7. S.M. Qaim, R. Wölfle, G. Stöcklin, M. Rahman, S. Sudár and A. Suhaimi
   Determination of (n, charged particle) reaction cross sections for FRT-relevant materials
   Radiation Effects **92**, 97-100 (1986)

8. N.I. Molla, S.M. Qaim and M. Uhl
   Activation cross section and isomeric cross-section ratio for the ^{46}Ti(n,p)^{46m,g}Sc process
   Phys. Rev. **C42**, 1540-1544 (1990)

9. N.I. Molla, S.M. Qaim, H. Liskien and R. Widera
   Excitation functions of ^{nat}Ti(n,x)^{46,47,48}Sc processes in the energy range of 12.5 to 19.6 MeV
   Appl. Radiat. Isotopes **42**, 337-339 (1991)

10. S.M.Qaim, N.I. Molla, R. Wölfle and G. Stöcklin
Differential and integral cross section measurements of some (n, charged particle) reactions on titanium
Proc. Int. Conf. Nuclear Data for Science and Technology, Jülich, Germany, May 1991, (S.M. Qaim, Editor) Springer Verlag, Berlin, 297-300 (1992)

11. N.I. Molla, S.M. Qaim and H. Kalka
Excitation functions of $^{46-50}Ti(n,p)^{46-50}Sc$ processes
Phys. Rev. **C45**, 3002-3005 (1992)

12. S.M. Qaim, M. Uhl, N.I. Molla and H. Liskien
^{4}He emission in the interactions of fast neutrons with ^{48}Ti and ^{50}Ti
Phys. Rev. **C46**, 1398-1403 (1992)

13. N.I. Molla, S. Basunia, M.R. Miah, S.M. Hossain, M.M. Rahman, S. Spellerberg, S.M. Qaim
Radiochemical study of $^{45}Sc(n,p)^{45}Ca$ and $^{89}Y(n,p)^{89}Sr$ reactions in the neutron energy range of 13.9 to 14.7 MeV
Radiochimica Acta **80**, 189-191 (1998)

14. M.S. Uddin, M. Baba, M. Hagiwara, Sk. A. Latif and S.M. Qaim
Excitation functions for the formation of some short-lived products in proton-induced reactions on silver
Radiochimica Acta **96**, 67-72 (2008)

15. M.S. Uddin, B. Scholten, A. Hermanne, S. Sudár, H.H. Coenen and S.M. Qaim
Radiochemical determination of cross sections of alpha particle induced reactions on ^{192}Os for the production of the therapeutic radionuclide ^{193m}Pt
Appl. Radiat. Isotopes **68**, 2001-2006 (2010)

16. M.S. Uddin, A. Hermanne, B. Scholten, S. Spellerberg, H.H. Coenen and S.M. Qaim
Small scale production of high purity ^{193m}Pt by the $^{192}Os(\alpha,3n)$-process
Radiochimica Acta **99**, 131-135 (2011)

17. M.S. Uddin, A. Hermanne, S. Sudár, M.N. Aslam, B. Scholten, H.H. Coenen and S.M. Qaim
Excitation functions of α-particle induced reactions on enriched ^{123}Sb and ^{nat}Sb for production of ^{124}I
Appl. Radiat. Isotopes **69**, 699-704 (2011)

18. M.S. Uddin, S.Sudár and S.M. Qaim
Formation of the isomeric pair $^{194m,g}Ir$ in interaction of α-particles with ^{192}Os
Phys. Rev. **C84**, 024605, 1-5 (2011)

19. M.S. Uddin, S. Sudár, R. Khan, S.M. Hossain, M.A. Zulquarnain and S.M. Qaim
Fast neutron spectrum unfolding of a TRIGA Mark II reactor and measurement of spectrum averaged cross sections: integral tests of differential cross sections of neutron threshold reactions
Radiochimica Acta, in press

B. Co-operation between Rajshahi University and FZ Jülich

20. M.R. Zaman and S.M. Qaim
Excitation functions of (d,n) and (d,α) reactions on ^{54}Fe: relevance to the production of high purity ^{55}Co at a small cyclotron
Radiochimica Acta **75**, 59-63 (1996)

21. M.R. Zaman, S. Spellerberg and S.M. Qaim
Production of ^{55}Co via the $^{54}Fe(d,n)$-process and excitation functions of $^{54}Fe(d,t)^{53}Fe$ and $^{54}Fe(d,\alpha)^{52m}Mn$ reactions from threshold up to 13.8 MeV
Radiochimica Acta **91**, 105-108 (2003)

22. S.M. Qaim, S. Sudár, C. Nesaraja, M.R. Zaman and A. Fessler
Influence of reaction channel on the isomeric cross-section ratio, in
Advances in Nuclear and Radiochemistry (S.M. Qaim and H.H. Coenen, Editors),
Forschungszentrum Jülich, ISBN 3-89336-362-9, 9-11 (2004)

23. M.S. Uddin, M.R. Zaman, S.M. Hossain, I. Spahn, S. Sudár and S.M. Qaim
An Am/Be neutron source and its use in integral tests of differential neutron reaction cross section data[+]
Appl. Radiat. Isotopes **68**, 1656-1661 (2010)

24. S.M. Qaim, M.S. Uddin, S.M. Hossain, I. Spahn and M.R. Zaman
Cross section measurements of a few threshold reactions induced by fast neutrons from an Am/Be source: integral tests of differential neutron reacti cross section data
Radiochimica Acta **101**, 205-209 (2013)

The International Science Programme in Bangladesh: Self-Interest or Empowerment?

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1 ABSTRACT

The International Science Programme (ISP) at Uppsala University, Sweden, is devoted to building institutional capacity in the basic sciences in low-income countries, since 1961 in physics, since 1970 in chemistry, and since 2002 mathematics. ISP collaborates with other Swedish and European universities, and with numerous universities in low-income countries and their regions, and functions as a common hub for natural science collaboration.

ISP has since the start received its main funding from the Swedish government, presently through the Swedish International Development Cooperation Agency (Sida). In Bangladesh, ISP has supported the development of scientific research and higher education in chemistry and physics since the 1970's.

The outcome of ISP support in the latest three decades is substantial and consistent with regard to awarded scientific degrees and dissemination of scientific results by supported research groups and networks. The impact on the production of scientific publications in countries with ISP-supported research groups and scientific networks is significant.

In 2012, a Master thesis in International and European Relations was published focusing on ISP's collaboration with scientists in Bangladesh. Three theoretical perspectives – realism, interdependence liberalism and constructivism – provide the framework of the case study and serve as guiding tools to understand ISP's role and motivations as an actor in international relations. It was found that, on the whole, ISP's approach can be regarded as a successful instance of North-South development support. The data indicates that benefits of the collaboration between ISP and the supported scientists in Bangladesh are felt on both sides and that empowerment does take place with regard to several key issues.

The enormous impact that ISP-related scientists in Bangladesh have on their own country seems to be wide-reaching and sustainable because it involves firm establishment of research and higher education in the basic sciences, which can solve health-related, environmental, technological etc. problems, the training of future teachers and the strengthening of human resources in many societal areas. When the objective of development assistance is determined by self-interest it is very unlikely to bring about long-lasting development or foster empowerment and local ownership.

2 INTRODUCTION

The International Science Programme (ISP) at Uppsala University, Sweden, is devoted to building institutional capacity in the basic sciences in low-income countries, since 1961 in physics, since 1970 in chemistry, and since 2002 in mathematics. It has an international reputation for effectively strengthening research and postgraduate education capacity. The Swedish policy for development cooperation 2010-2014 stresses the need to strengthen and develop scientific research as a means for strategically combating poverty in low-income countries.

While being a unit at Uppsala University, ISP collaborates with other Swedish and European universities, and with numerous universities in low-income countries and their regions. In this context, ISP functions as a common hub for facilitating natural science collaboration, in particular between Swedish universities and universities in low-income countries, contributing to their reciprocal development.

ISP has since the start received its main funding from the Swedish government, presently through the Swedish International Development Cooperation Agency (Sida). In earlier years, the International Atomic Energy Agency (IAEA), UNESCO, and the Norwegian government have also provided financial support. Uppsala University has for a long time been a significant financial contributor, and since 2012, also Stockholm University, Sweden, provides significant funding. Because of the collaborative nature of support, in kind-contribution from institutions with supported research groups as well as from cooperating host institutions is also very important.

In Bangladesh, ISP has supported the development of scientific research and higher education in chemistry and physics since the 1970's.

3 BACKGROUND

ISP provides support for the development of active and sustainable research in the basic sciences. The support is directed towards academic, institution-based scientific research groups and towards regional scientific networks. The support is collaborative and long-term, and is managed on a collegial scientist-to-scientist level with a strong ownership of activities at the receiving end. The supported activities need to be demand-driven, of strong relevance to the countries and regions concerned, and in accordance with local strategies and plans.

The basic sciences – mathematics, physics, chemistry, and biology– provide a fundamental understanding of natural phenomena and the processes by which natural resources are transformed and utilized. Interdisciplinary and applied research is important in solving a number of development challenges, but without a strong fundament of basic sciences it is difficult to sustain applied sciences and quality science, engineering and medical education. Basic sciences are therefore important for development and should be supported for three main reasons:

1) their contribution to applied sciences,
2) their role in university training and education, and
3) their role in technological development.

Additional important factors that result from scientific training include:

4) the development of scientific, critical thinking based on reproducible evidence (promoting rational governance, democracy development, and human rights),
5) the development of technology, innovation, and engineering; stimulating entrepreneurship and contributing to poverty amelioration, and
6) an increased productivity and international competitiveness.

Increased domestic capacity for research and higher education in basic sciences has a long-term impact on economic growth and poverty alleviation in a country, driven by an increasingly knowledge-based society.

In most low-income countries, however, funding for research and training in basic sciences is scarce, which was particularly pointed out in the 2011 evaluation of ISP (1). Regional and interregional cooperation is one way to overcome this, by generating complementary scientific activities, give access to advanced equipment, and increase the human capital needed for good standard postgraduate education. ISP support not only to research groups, but also to scientific networks is, therefore, strategically important.

In Asia, ISP currently provides research group support in the fields of chemistry, physics, and geophysics in Bangladesh, Cambodia, and Laos. Recently, support in the field of mathematics has been initiated in Cambodia and Laos. In earlier years, support has been provided to research groups in chemistry and physics/geophysics in Sri Lanka and Thailand.

In Bangladesh, research group support started in the 1970's. In chemistry, natural products chemistry at the University of Dhaka was the main focus up to 2002, but was then shifted to environmental chemistry regarding organic pollutants in food, biota and environmental matrices with special emphasis on analysis of pesticide residues, persistent organic pollutants, antibiotics and other food contaminants. This group is still being supported, and is lately increasingly used as a training facility for staff and students from in particular Royal University in Phnom Penh, Cambodia, and National University of Laos in the Lao PDR, which receive ISP research group support also in environmental chemistry. A scientific network has recently been formed between these groups, Asian Network of Research on Food and Environment Contamination (ANFEC), to formalize the cooperation in order to commonly develop in particular the quality and performance of environmental and food contamination analytical chemistry.

Between 1973 and 1992, support was provided also to research in inorganic and organometallic chemistry at University of Dhaka, and to natural products chemistry at Jahangirnagar University. During 1998 to 2008, support was provided to research on the biochemical and molecular basis of diabetes and its complications in the Bangladesh population, including nutritional evaluation of local food materials with particular reference to management and prevention of diabetes and cardiovascular diseases, at the Biomedical Research Group at the Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM), Dhaka.

In addition, two chemistry networks centered in Bangladesh are supported (2), both from 1994. The Asian Network of Research on Antidiabetic Plants (ANRAP) has the objective to develop cooperation between scientists in the region that work in the field of antidiabetic plants research, and has received ISP support since 1994. The Network of Instrument Technical Personnel and User Scientists of Bangladesh (NITUB), has the objective to improve the capabilities in handling, maintaining, trouble-shooting, and repairing scientific instruments in Bangladesh.

In physics, a research group in solid-state physics at University of Dhaka was supported from 1977 to 1994, and a research group in photovoltaics at Rajshahi University from 1986 to 2002. Current support is since 1986 to research on magnetic materials, in cooperation between Bangladesh University of Engineering and Technology (BUET) and the Atomic Energy Centre, Dhaka (AECD), and since 2011 to a research group in biomedical physics and technology at University of Dhaka.

4 GENERAL RESULTS OF ISP SUPPORT

In the nine-year period 2003 to 2011, the quantitative outcome per each million EUR spent by ISP-supported research groups and scientific networks together was in average:

- 12 PhD graduations, *plus*
- 50 MSc graduations, *plus*
- 87 scientific publications (40% of which in peer-reviewed, international journals), *plus*
- 113 conference contributions (40% of which international), *plus*
- 21 meetings organized (workshops, conferences, summer schools, etc.),

plus development of technical resources within research groups and networks, as well as increased collaboration with scientists at e.g. Swedish universities and in the regions. A similar quantitative outcome was observed in a study of ISP reports covering periods dating back to 1985 (3), indicating a notable consistency in such results over the last decades.

Compared to the outcomes mentioned above, the results are similar or better for the long-lasting support to research groups in chemistry and physics in Bangladesh, and to research groups in physics in Thailand (Table 1). In Sri Lanka huge investments have been mad in instrumentation. The support to research groups in Cambodia and Laos started much later than in Bangladesh and Thailand. Therefore, results are yet scarce because of the long time required to build capacity to a scientifically productive level.

Table 1. Duration of support, quantitative scientific outcome (up to 2011), and total funding of ISP research groups (up to 2011) in Bangladesh, Cambodia, Laos, Sri Lanka and Thailand

(P = physics; C = chemistry; yrs = total number of years of support, # = number of groups supported; PhD = number of doctorate graduations; MS/P = number of MSc and MPhil graduations; Int.P. = number of publications in peer-reviewed, international scientific journals; Funding € = total funding provided during the period of support, converted from SEK to EUR at present rate of exchange)

	Period	**yrs**	**#**	**PhD**	**MS/P**	**Int. P.**	**Funding K€**
Bangladesh - P	1977 - present	36	4	11	116	88	≈900
Bangladesh - C	1973 - present	40	6	44	251	59	≈980
Cambodia - P	2005 - present	8	1	0	16	3	≈164
Cambodia - C	2010 - present	3	1	0	0	0	≈60
Laos - P	2004 - present	9	1	0	2	0	≈37
Laos - C	2005 - present	8	2	0	0	0	≈27
Sri Lanka - P	1978 - 2010	32	4	34	87	134	≈3,700
Sri Lanka - C	1973 - 2009	37	12	28	54	155	≈6,378
Thailand - P	1980 - 2005	25	5	20	103	164	≈981
Thailand - C	1970 – 1995	25	4	1	35	30	≈376

In the 2011 evaluation of ISP it is noted that:

"*ISP reports an average of 192 published research papers per year over the period 2003 to 2010, from an average of approximately 42 research groups. Given that a research group generally comprises only 1-2 leading researchers together with their research students, this quantity of output per person is satisfactory*."

A comparison of the number of peer-reviewed, international publications by ISP-supported research groups and scientific networks with the data reported by UNESCO (4) for the years 2002 and 2008 gives an indication of the impact of ISP support, with regard to scientific publications, in a wider perspective (Table 2).

In physics, ISP-supported groups and networks published about 10% of the physics papers in Bangladesh and about 30% of those in African countries, both in 2002 and 2008, and 16% of the physics papers in Thailand in 2002. The impact in this respect was largest in Sri Lanka, with ISP support behind 36% of the physics publications in 2002, and 62% of those in 2008.

In chemistry, ISP-supported groups and networks published 6% of the chemistry papers in 2002 and 2-3% of those in 2008, in both Bangladesh and Sri Lanka, and about 15% of those in African countries in both 2002 and 2008.

In mathematics, only Africa South of the Sahara was subject to ISP support in 2002 and 2008. The activities were in an initial state in 2002, and no publications were reported. In the four countries subject to ISP support that year, UNESCO noted merely two publications in total. In 2008, ISP-supported activities in ten countries accounted for 33 publications, while UNESCO noted 51 in total in those countries, that is, 65% by ISP-supported activities.

With regard to quality, it is observed in the 2011 evaluation (1) that:

"*inspection of citation rates for a sample of publications supported by ISP reveals much high-satisfactory research work.*"

Further, it is observed that the rates of citation of several ISP-supported papers are above world benchmarks.

Table 2. Share of international, peer-reviewed publications by ISP-supported research groups and scientific networks of the numbers reported for 2002 and 2008 in the UNESCO Science Report 2010. The comparison only considers countries having ISP-supported activities each of the investigated years. (Chem. = chemistry including biomedical; Math. = mathematics; empty slots = no ISP support was provided)

Region/Country	Physics 2002	Chem 2002	Math. 2002	Physics 2008	Chem 2008	Math. 2008
Africa South of Sahara	30%	14%	0%	29%	15%	65%
Bangladesh	11%	6%		9%	3%	
Sri Lanka	36%	6%		62%	2%	
Thailand	16%					

5 CASE STUDY OF ISP-BANGLADESH COOPERATION

5.1 Research question and case study design

In 2012, a Master thesis in International and European Relations was published focusing on ISP's collaboration with scientists in Bangladesh (5). It explores different forms of North-South development assistance with regard to its widespread critique and examines whether the field of international research capacity building holds alternative development cooperation strategies that have the potential to reconcile some of the criticisms.

The main object of investigation within the study is the International Science Programme (ISP). The empirical research in the form of semi-structured personal interviews carried out in Bangladesh and Sweden, on the ISP-Bangladesh collaboration, constitutes the core case study evidence. Three theoretical perspectives – realism, interdependence liberalism and constructivism – provide the framework of the case study and serve as guiding tools to understand ISP's role and motivations as an actor in international relations. The main question of investigation is whether ISP can be best perceived as an instance of self-interest (realism), interconnectedness (interdependence liberalism) or social empowerment (constructivism).

The research unfolds on two levels: a theoretical and an empirical one. Both levels are intertwined, with one informing the other. The starting point of the case study is a deductive approach, i.e. several hypotheses are derived from realism, interdependence liberalism and constructivism and – in the form of concrete predictions – guide the interviews carried out with supported scientists, ISP staff and related officials. The indicators of success are based on concepts underlying the Paris Declaration for Aid Effectiveness as well as concepts from feminist, post-colonial and post-structuralist writings, i.e. local ownership, empowerment and partnership. These indicators are operationalized through 6 different themes related to research capacity building which are explored in interviews and ISP documents. The themes are:

1. Sweden's motivations;
2. Brain drain;
3. South-South collaboration;
4. Scientific (in)dependence;
5. Impact on own country; and
6. Quality of collaboration.

5.2 Theoretical background: realism, interdependence liberalism and constructivism

As one of the main International Relations (IR) theories, **realism** derives its explanatory power from the emphasis on power relations, with states as the dominant actors in the global arena, and the constant struggle for power between states motivated by political, economic etc. interests (6,7). For realists, a concept such as altruism does not possess any significant meaning because in the anarchical global society with no overarching authority to control the behavior of states, every state is considered to be struggling for survival (self-help system) and cooperation only takes place when it is considered strategically profitable (8). Hence, development assistance is viewed as an instrument of states to pursue their own goals.

Interdependence liberalism, on the other hand, is characterized by a more optimistic worldview and by a belief in change, progress and in human development. Instead of focusing on power relations, interdependence liberalism stresses (rational) interests and (free) choices of individuals and acknowledges the importance of non-state actors such as international organizations, civil society groups, NGOs, transnational corporations etc. (9). Interdependence liberalists emphasize the benefits of economic, political and social interaction between different global actors as they believe that interdependence increases the costs of conflict for all involved and fosters peaceful cooperation in the global arena. From this perspective, development assistance is viewed as a win-win situation in which the collaborating parties profit more or less equally.

Constructivism is a broad meta-theoretical approach to social theory rather than a single IR theory. Whereas empiricism makes postulations about phenomena in an objectively measurable world that can be correctly perceived through human senses, constructivism views the reality in which we live as a product of conceptualizations in the creation of which every single person is constantly involved in (10). As constructivism acknowledges the role of identity, ideas and values, the study of development assistance becomes a practice in which shared meaning, established norms and the quality of interaction are emphasized. Every state and organization must be viewed distinctively as they have different identities and derive their motivations for action from different historical contexts and related institutions.

5.3 Main results of the case study in Bangladesh

The analysis of 23 conducted interviews with ISP supported scientists, students and officials in Bangladesh and Sweden suggests that satisfaction with the ISP mode of operation and with the way that ISP has approached and supported scientific groups and networks is very high. The concept of **local ownership** has been explored with regard to the ability of supported scientists to be independent in their research and to establish South-South bridges in order to eventually overcome dependency of Northern support. This aspect is quite strong within ISP as the freedom of building alliances and sending students to other Southern universities is given. Moreover, scientists report to have freedom in the choice of research topic and methodology and are encouraged by ISP to engage in areas that are of concern to their own country. The only disadvantage with regard to local ownership that can be found in ISP's approach is the process of micro-management and monitoring that puts collaborators under constant observation and requires them to spend a large amount of time on Grant Applications and yearly Activity Reports. Although this creates pressure and stress, the supported scientists view it as necessary as they understand it as a means of transparency towards the Swedish taxpayers whose money they are using.

The idea of **empowerment** is linked to the ability to tackle problems that surround you with your own effort. The impact of ISP supported individuals on the societal level can be identified on several dimensions. Firstly, teaching and supervising students creates future human resources needed in various societal areas. Secondly, contribution to the scientific body of knowledge that is created in Bangladesh has an impact to long-term development of a knowledge-based society, which enables Bangladesh to compete with more advanced countries. Thirdly, several groups work directly on health and environmental problems as in the case of research on food safety, anti-diabetic plants, healthcare technology etc. Output in these areas is captured in detail in Activity Reports and Project Catalogues. The role of ISP in creating empowerment is most strongly expressed in the prevention of brain drain through ISP sandwich programs. It is reported that PhD sandwich programs are attractive alternatives for MPhil students who would otherwise have done their PhDs entirely abroad. The majority of graduated PhD sandwich students stays in Bangladesh and occupies high positions in academic and research institutions, public service, industry, medical facilities etc., hence, benefiting the broader society.

Regarding the **partnership** criterion, the observation can be made that the quality of the collaboration the ISP and Bangladeshi scientists does not strongly reflect the structural inequality that exists between Sweden as the richer, donating country and Bangladesh as the poorer, receiving country. Collaborators on both sides view each other as scholars who have similar goals and who trust and respect each other. Especially among the research group leaders, strong bonds with previous program directors and collaborating scientists as well friendly feelings towards ISP staff were characteristic of the answers. Younger research group members have a more distanced relationship to the ISP, but report to have never felt disrespect or encountered a condescending attitude on the side of ISP collaborators. As face-to-face meetings between the program directors and supported groups take place at least once a year, room is given for the development of a personal connection. Face-to-face interaction between North-South collaborators has been found to have great advantages for the quality and the effectiveness of development projects (11). The personal nature of the collaboration between the ISP and supported scientists can be viewed as a strength and a model to other donors.

From a theoretical perspective, constructivism and interdependence liberalism are much more likely to account for the research findings of the case study than realism. The realist view that ISP as a predominantly state-financed institution is following egoistic motives could not be confirmed in the study. In all 6 examined themes, the data indicates that benefits of the collaboration between ISP and the supported scientists in Bangladesh are felt on both sides and that empowerment does take place with regard to the freedom of supported scientists to handle the ISP grant, freedom to choose the destination of "sandwich students", the ability to conduct research on local issues etc. Interdependence liberalism offers a valuable lens to view the attained advantages of linking individuals from a similar professional background in two countries while constructivism helps to explain the good quality of the collaboration as a result personal interactions between Swedish and Bangladeshi scientists over a long period of time.

5.4 The ISP model compared to traditional strategies of development assistance

The approach that ISP has taken stands in stark contrast to orthodox North-South development approaches adopted by official donors such as development banks, national development agencies and multilateral organizations. The most fundamental difference is that ISP is not an institution that has been deliberately set up to "develop" individuals living in poorer countries, but has evolved from cooperation between scientists in the North and the South. Individuals on both sides of the collaboration work in a similar field and can interact in a more egalitarian and mutually empowering way. This kind of mutuality is rarely given in a setting were development agency officials, who are not personally linked to the professional environment of supported individuals, create strategies on how to solve their problems and often distribute financial support in an impersonal manner. This traditional way of development assistance runs the risk of perpetuating colonial beliefs as it creates an ideational hierarchy between aid donors and aid receivers.

Another contrast to official donors is that ISP works on the micro-economic instead of a macro-economic level. It follows a bottom-up approach that starts with researchers, entrepreneurs and individuals who are working in the field of health-care, environmental problems or technological problems and who are aware of the problems of the poorer population rather than starting with high-level officials who come from a separate sector in society and must follow specific bureaucratic guidelines. Through its personal contact with supported scientists, its small size and its mode of operation, ISP is much more flexible and can adapt to changing demands on the local level.

Furthermore, there are no conditionalities attached to ISP support in comparison to most funds available through institutions such as the World Bank, the EU, bilateral donors etc. Although tied aid could be globally reduced to 18 percent in the last decade (13), many donors still establish internal conditionalities which have been described by the interviewed scientists. The freedom of procuring the best and cheapest laboratory equipment, developing own technology or sending students for exchange to any country with the donor’s money, which is given within the ISP, is an exceptional instance in the area of development support.
Finally, ISP has a long-lasting impact on the supported countries in comparison to a large amount of Official development assistance, which is mostly organized as project aid. ISP supports groups over a very long period of time, focuses on the promotion of basic scientific knowledge, which can tackle societal problems and contributes to the creation of future teachers and human resources for other societal areas. This view has been shared by the former Sida official who stated in the interview that:

“You can compare ISP's work to other things like projects on material infrastructure that are now rusting away, you can compare it to democracy projects which focus on promoting NGOs etc. that are withering away because they are not constituted by the local people but by some individuals, you can compare it to money that has been running through general banking support and is now in Swedish bank accounts and so on, but what the ISP has been doing is for real, you can never take it away, it's there and it has many traces in society.”

6 CONCLUSION

The outcome of ISP support in the latest three decades is substantial and consistent with regard to awarded scientific degrees and dissemination of scientific results by supported research groups and networks. The impact on the production of scientific publications in countries with ISP-supported research groups and scientific networks is significant, in particular in African countries. In mathematics, already after six years of activity the ISP had a very large impact of the publication rate in the Southern African countries where support is provided. In Asian countries with ISP support, the impact on publication rate was larger in physics than in chemistry.

The social science study conducted by Kuhn (2012) found that, on the whole, ISP’s approach can be regarded as a successful instance of North-South development support which can be followed by other donors to the extent that is feasible in their specific field of activity. Although certain aspects have been criticized by interviewees such as the pressure to compose detailed activity reports by the end of the year, the lacking information system for students and a too strong focus on basic sciences are seen as problematic aspects, the reported advantages of the ISP approach by far exceed the disadvantages.

The enormous impact that ISP-related scientists in Bangladesh have on their own country seems to be wide-reaching and sustainable because it involves firm establishment of research and higher education in the basic sciences, which can solve health-related, environmental, technological etc. problems, the training of future teachers and the strengthening of human resources in many societal areas.
The reasons for the satisfaction of Bangladeshi scientists with ISP's work have been the long-lasting support, involvement of individuals from a similar background at ISP, a bottom-up, micro-economic approach, untied distribution of grants, promotion of South-South collaboration and a sincere motive. The last aspect might be the crucial starting point for the effective implementation of other approaches because when the objective of development assistance is determined by self-interest, which interviewees have experienced in collaboration with other donors, it is very unlikely to bring about long-lasting development or foster empowerment and local ownership.

REFERENCES

1. GDH, 2011. *Report on the Evaluation of the International Science Programme*. GDH Pty Ltd, GPO Box 1877, Canberra, ACT 2601, Australia. (http://www.isp.uu.se/digitalAssets/112/112090_ispevaluation2011.pdf)
2. C. Kiselman (editor), 2011. *Proceedings of the International Conference on Regional and Interregional Cooperation to Strengthen Basic Sciences in Developing Countries*, Addis Ababa, Ethiopia, 1-4 September 2009. Acta Universitatis Uppsaliensis, 88. (http://uu.diva-portal.org/smash/record.jsf?pid=diva2:393463&rvn=1)
3. P. Sundin, L. Abrahamsson, E. van Groningen, 2012. *The International Science Programme at Uppsala University: 50 years experience of capacity building in basic sciences in developing countries.* SANORD International Symposium, Aarhus University, Aarhus, Denmark, 6-7 June 2012.
4. UNESCO, 2010. *UNESCO Science Report 2010*. (www.uis.unesco.org/Library/Documents/UNNESCOSR10-eng.pdf)
5. T. Kuhn, 2012. *The International Science Programme in Bangladesh: A case of self-interest, interconnectedness or social empowerment?* Division of Political Science, Department of Management and Engineering, Linköping University, Sweden. (http://liu.diva-portal.org/smash/record.jsf?pid=diva2:556118&rvn=1)
6. H. Morgenthau, 1948. *Politics Among Nations: The Struggle for Power and Peace*. New York: Alfred A. Knopf.
7. K.N. Waltz, 1979. *Theory of International Politics.* New York: McGraw-Hill Companies.
8. B. Buzan, R. Little, 1993. *The Logic of Anarchy: Neorealism and Structural Realism.* New York: Columbia University Press.
9. K.E. Jørgensen, 2010. *International Relations Theory: A New Introduction.* Basingstoke: Palgrave Macmillan.
10. D. Della Porta, M. Keating, 2008. *Approaches and Methodologies in the Social Sciences: A Pluralist Perspective.* Cambridge: Cambridge University Press.
11. E. Mawdsley, J.G.Townsend, G. Porter, 2005. Trust, Accountability, and Face-To-Face Interaction in North-South NGO Relations. *Development in Practice*, 15(1), pp. 77-82.
12. OECD, 2013. *Tied Aid: The Right to Choose*. Available online, accessed 15 April 2013. (http://www.oecd.org/dac/untied-aid/untyingaidtherighttochoose.htm)

Ethical Issues in Scientific Publications; Role of the Committee on Publication Ethics (COPE)

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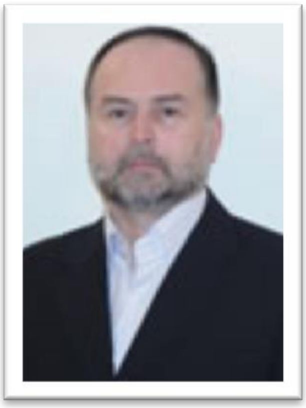
1 ABSTRACT



The Committee on Publication Ethics (COPE) was established in 1997 by a small group of medical journal editors in the UK but now has over 8500 members worldwide from all academic fields. Membership is open to editors of academic journals and others interested in publication ethics. Several major publishers have signed up their journals as COPE members. COPE provides advice to editors and publishers on all aspects of publication ethics and, in particular, how to handle cases of research and publication misconduct. Work is guided by elected Council members who are trustees of COPE as a charity. Currently there are 18 Council members from 7 countries and a range of disciplines (biomedicine, feminist media studies, geophysics, life sciences, literary studies, mathematics, psychiatric nursing).

2 INTRODUCTION

Publication of a scientific study as an article in a journal by researchers or as a thesis book by the students or other relevant occasions, all represent the final stage of a scientific project. Scientists in the world communicate with each other by writing. Sometimes a paper is the outcome of many years work of the scientists. Therefore it needs to be correct, reliable, right, and written in full adherence to code of ethics in publication. Usually, code of ethics in publication is not something to be taught in the universities and thus students and researchers and even academics only learn it by experiences. After acceptance of an article for publication in a journal, the authors are asked to sign special copyright form from the publisher where authors must verify that all ethical codes have been adhered and if there is something related to any conflict of interest should be disclosed. In that form depending on open access or non-open access format, authors sign that publisher will be the owner of the article (non-open access form) and thus authors should adhere the rules of the publisher. Here the first point comes up and that is “have the authors read and understood the items inside the form carefully before signature?” Ethical misconducts are very diverse and beyond the space of this short paper but the point is that in most of cases misconducts in publications happen unintentionally due to lack or little knowledge of the scientists about code of ethics. This is not restricted to any part of the world and is seen worldwide. Of course in the cases of misconducts, saying a scientist has not been aware of the codes cannot be an excuse. Therefore the best thing to do is to disseminate such learning tools to the academics, researchers, and students. Moreover, a scientist must always have a strong sense of ethical responsibility to apply at every stage of scientific process form start of the work when writes the proposal to the end stage of the study when writes the paper. Common ethical breaches includes data fabrication and falsification, plagiarism, redundant or duplicate publication, and misconducts from the authors’ sides and also special misconducts coming up from side of editors, reviewers, or the publishers. One of the major international parties that deal with misconducts in publications and provides code of conducts is the Committee on Publication Ethics (COPE). COPE started by a few medical journals in 1997 while now has more than 8500 members all over the world who are editors of journals in all academic subjects. COPE's principal objects are the promotion, for the public benefit, of ethical standards of conduct in research and ethical standards in the publication of academic journals. COPE also provides meetings, and access to e-learning packages for members. COPE audit how well their journals match ethical guidelines.

Work in the COPE is guided by elected Council members who are trustees of the COPE as a charity. COPE's income is derived exclusively from subscriptions from its members – journal editors, publishers and others affiliated with publishing. Currently there are 18 Council members from 10 countries and a range of disciplines (biomedicine, feminist media studies, geophysics, life sciences, literary studies, mathematics, psychiatric nursing). COPE offers a range of useful tools for journal editors and writers which are: guidelines, flowcharts, elearning, code of conduct, ethical editing, newsletters, seminar, COPE discussion and documents, and international standards for editors and authors.

3 COPE GUIDELINES

COPE has produced the following guidelines:

1. Code of Conduct and Best Practice Guide for Journal Editors:
   The COPE code of conduct for journal editors is designed to provide a set of minimum standards to which all COPE members are expected to adhere. The Best Practice Guidelines are more aspirational and were developed in response to requests from editors for guidance about a wide range of increasingly complex ethical issues.

2. COPE ethical guidelines for peer reviewers:
   Peer reviewers play a central and critical part in the peer-review process, but usually come to the role without any guidance and unaware of their ethical obligations. COPE has produced some guidelines which set out the basic principles and standards to which all peer reviewers should adhere during the peer-review process in research publication. The aim has been to make them generic so that they can be applied across disciplines.

3. Code of Conduct for Journal Publishers:
   Publishers who are Committee on Publication Ethics members and who support COPE membership for journal editors should follow this code, and encourage the editors they work with to follow the COPE Code of Conduct for Journal Editors; Ensure the editors and journals they work with are aware of what their membership of COPE provides and entails; Provide reasonable practical support to editors so that they can follow the COPE Code of Conduct for Journal editors. Publishers should define the relationship between publisher, editor and other parties in a contract; respect privacy; protect intellectual property and copyright; foster editorial independence.

4. Guidelines for Retracting Articles:
   Journal editors should consider retracting a publication if they have clear evidence that the findings are unreliable, either as a result of misconduct or honest error; the findings have previously been published elsewhere without proper cross-referencing, permission or justification; it constitutes plagiarism; it reports unethical research. This has been well advised how to be done by the COPE-designed flow charts.

5. Guidelines for the Board of Directors of Learned Society Journals:
   Notwithstanding the economic and political realities of their journals, directors of Learned Societies should respect that their editors should make decisions on which articles to publish based on quality and suitability for readers rather than for immediate

financial or political gain. Directors and employees should not be able to overrule these decisions. Second, membership of the board of directors should include non-society members to ensure some degree of independence. Third, all members should declare conflicts of interest and the board should have a policy to manage members' conflicts of interest. Fourth, the board of directors must maintain confidentiality and not divulge information about the journal to third parties.

6. Guidance for Editors on Research:
   Regulations regarding what type of study requires ethical approval vary worldwide. In some countries all studies require ethical approval but in others not. This may lead to submission to journals of manuscripts relating to such studies that do not satisfy the journal's normal requirement for independent ethical approval, and rejection of the manuscript because of misunderstanding of local regulations.

7. Cooperation between research institutions and journals on research integrity cases: guidance from the COPE:
   Institutions and journals both have important duties relating to research and publication misconduct. Institutions are responsible for the conduct of their researchers and for encouraging a healthy research environment. Journals are responsible for the conduct of their editors, for safeguarding the research record, and for ensuring the reliability of everything they publish. It is therefore important for institutions and journals to communicate and collaborate effectively on cases relating to research integrity.

A series of flowcharts (also available translated into Italian, Spanish, Chinese, Croatian, Japanese, Persian and Turkish – more planned) as a tool to help various sectors of the publishing society to deal with misconducts are available in the COPE website. Also more information about COPE and its rules and also cases is available to members. Editors of journals are encouraged to become a member of COPE to get helpful information regularly. For more information please admit to the following site (http://publicationethics.org/).

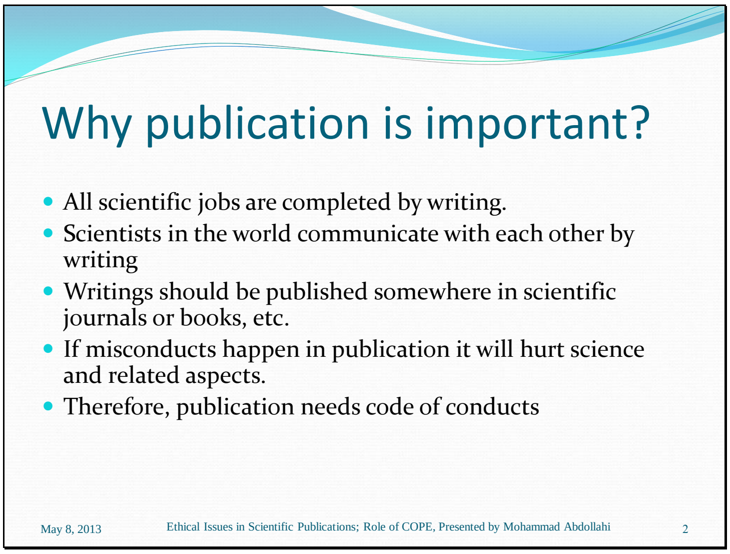


Figure 1. Why publication is important?

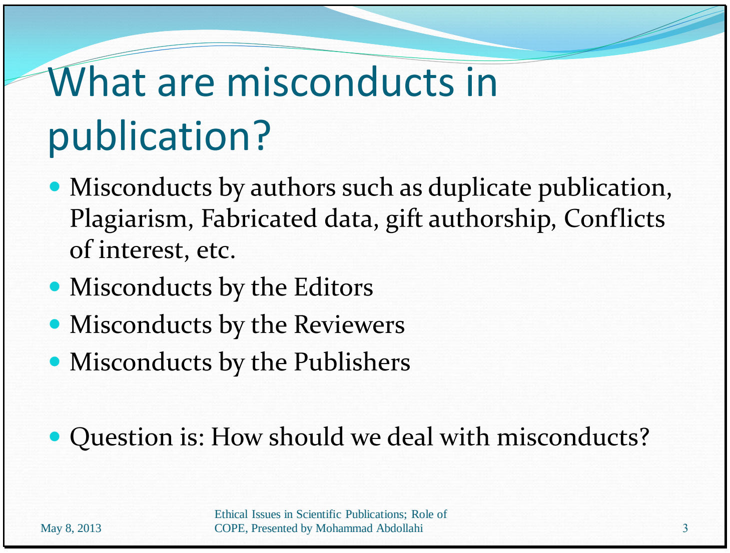


Figure 2. What are misconducts in publications?

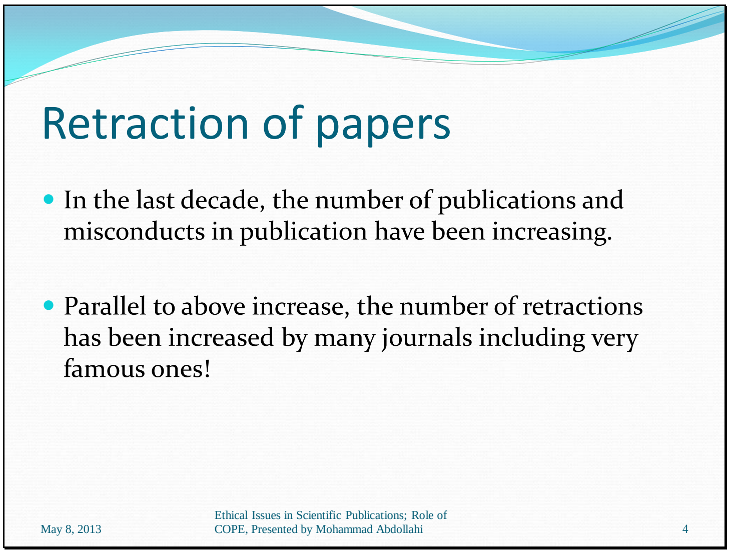


Figure 3. Retraction of papers.

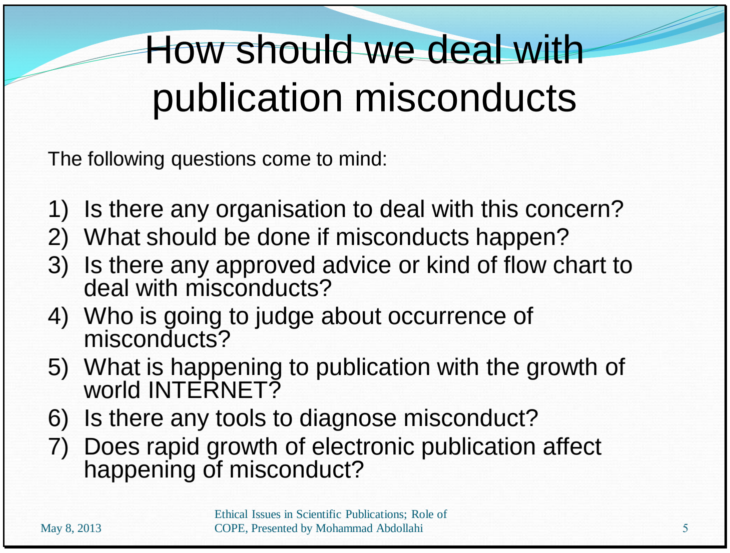


Figure 4. How should we deal with publication misconducts.

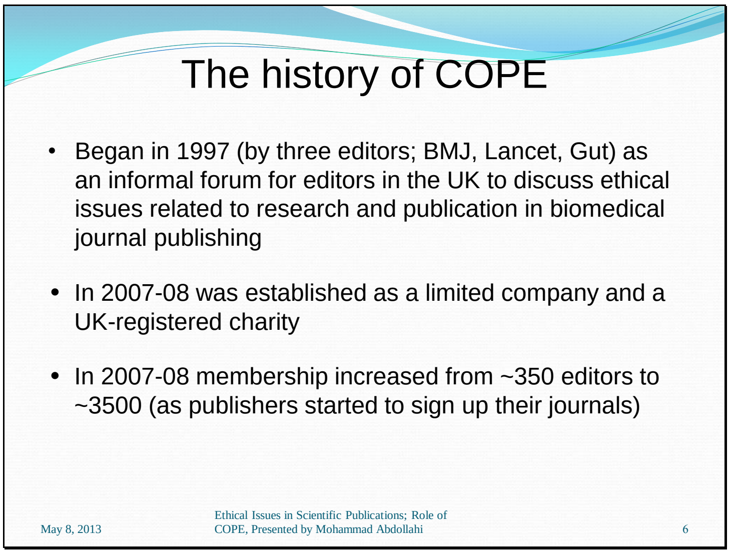


Figure 5. The history of COPE.

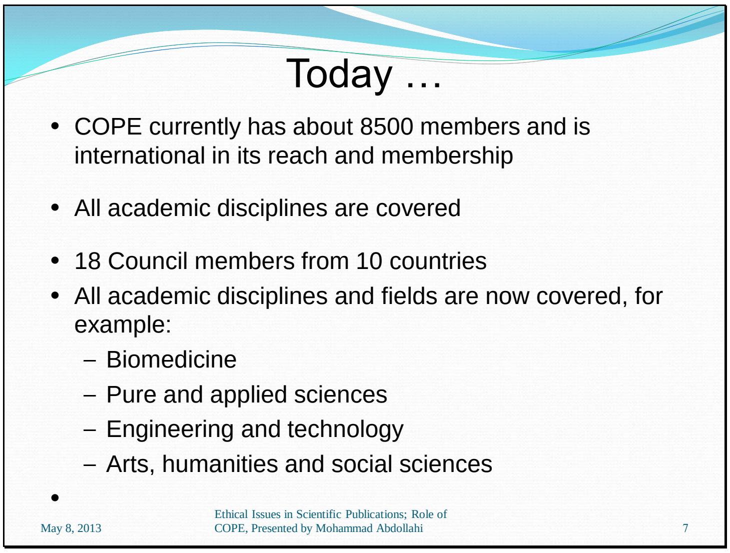


Figure 6. Today…

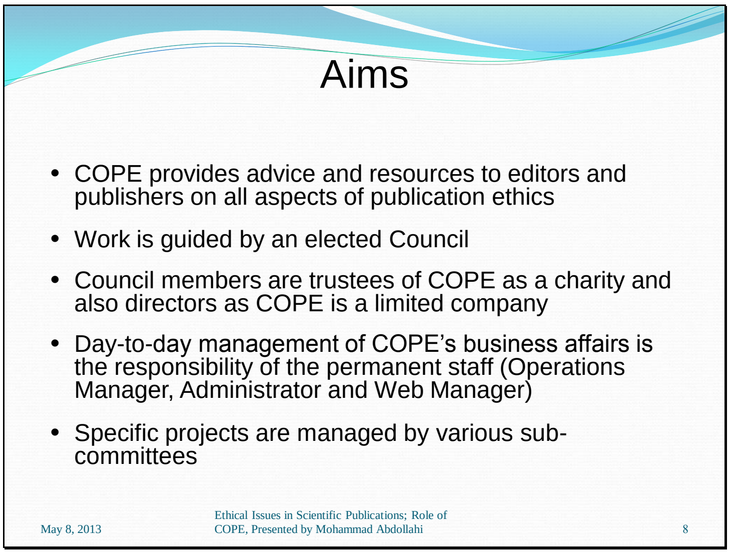


Figure 7. Aims.

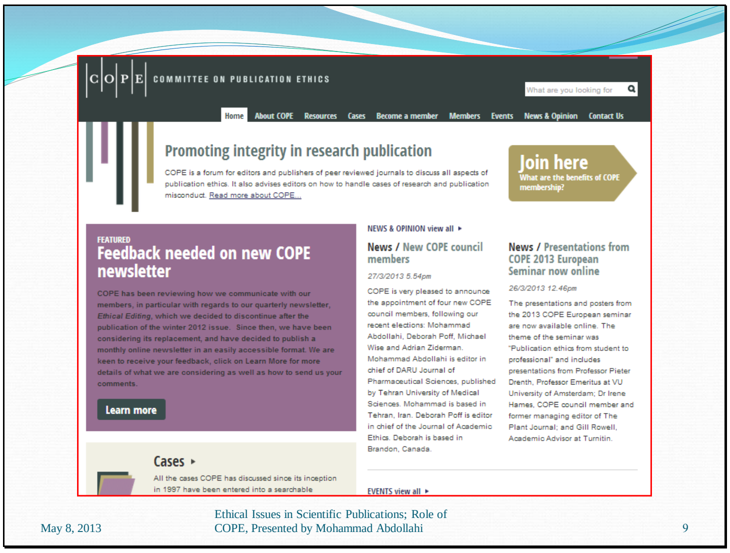


Figure 8. Promoting integrity in research publication.

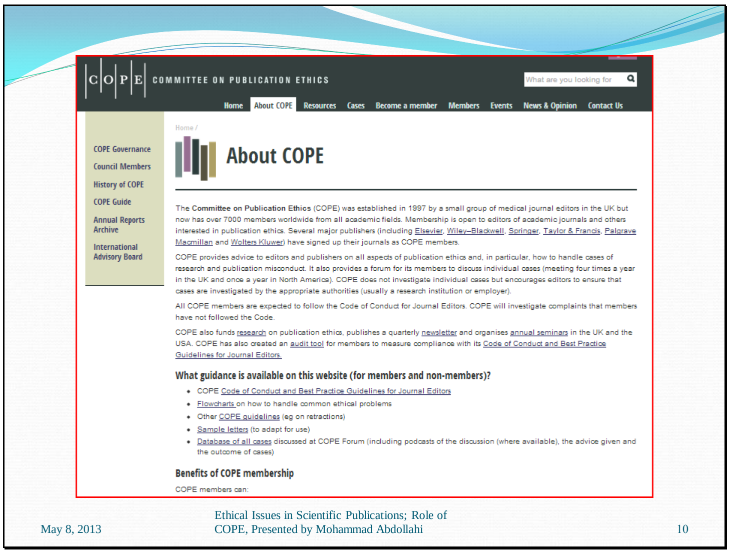


Figure 9. About COPE.

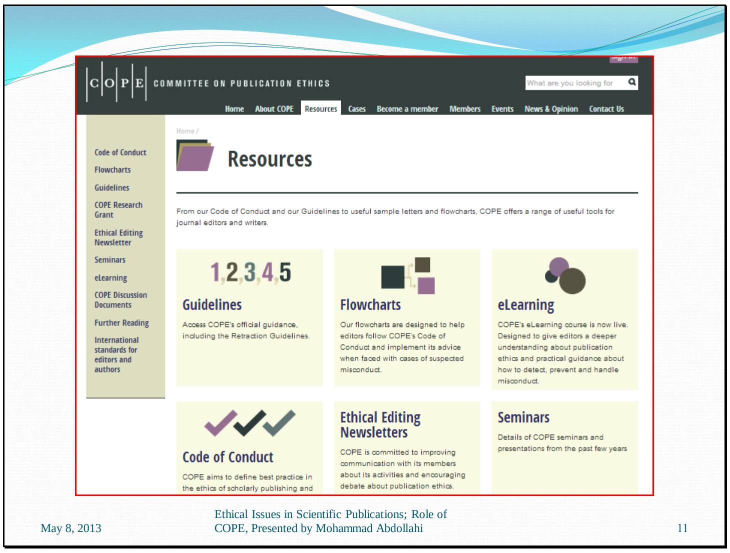


Figure 10. Resources.

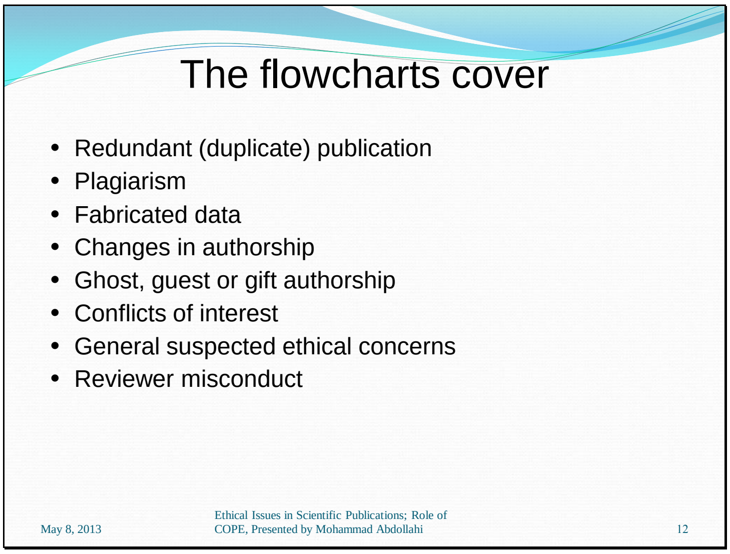


Figure 11. The flowcharts cover.

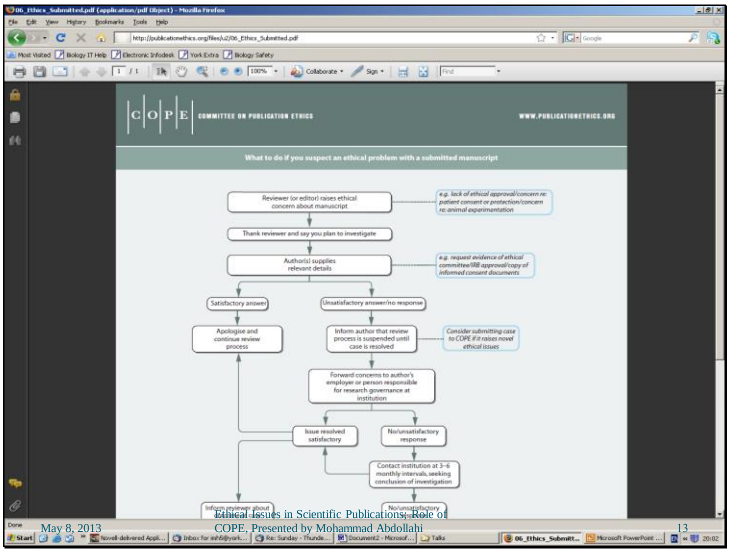


Figure 12.

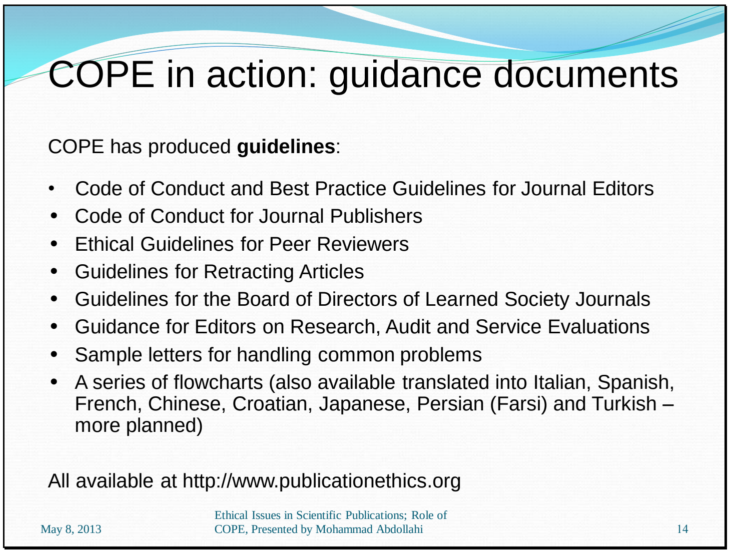


Figure 13. COPE in action: guidance documents.

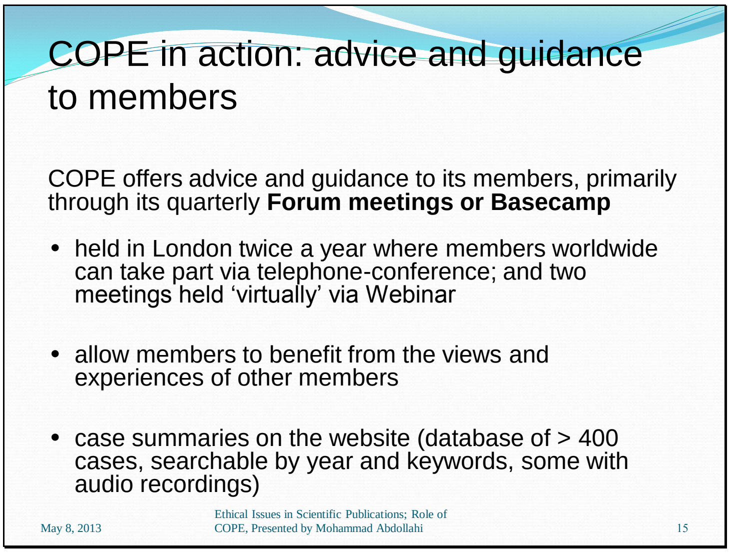


Figure 14. COPE in action: advice and guidance to members.

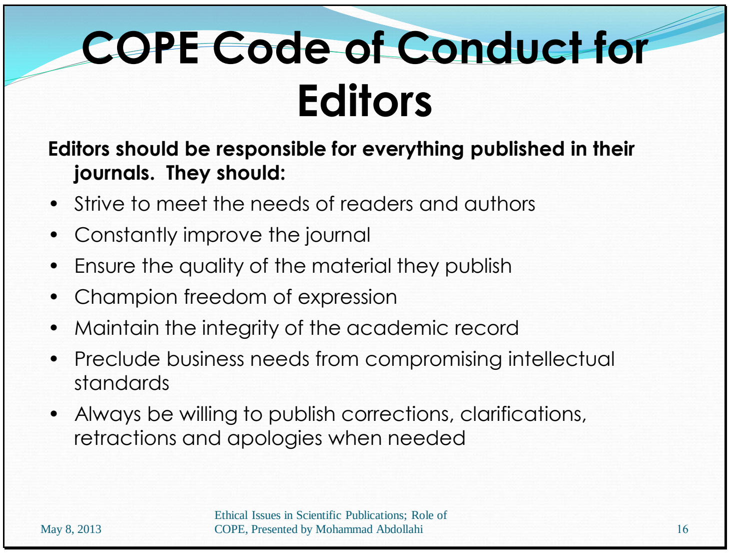


Figure 15. COPE Code of Conduct for Editors.

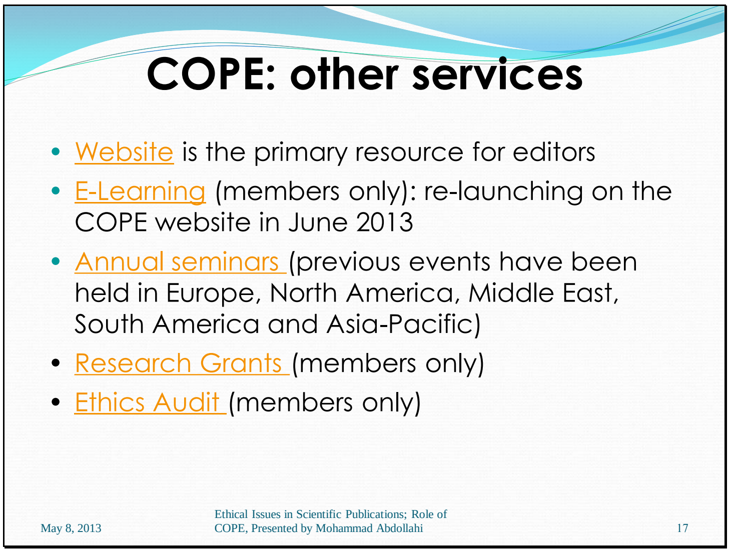


Figure 16. COPE: Other services.

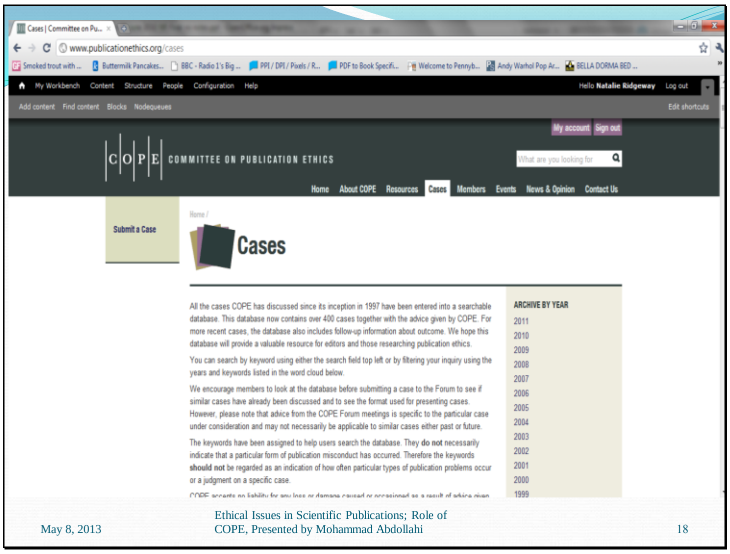


Figure 17. Cases.

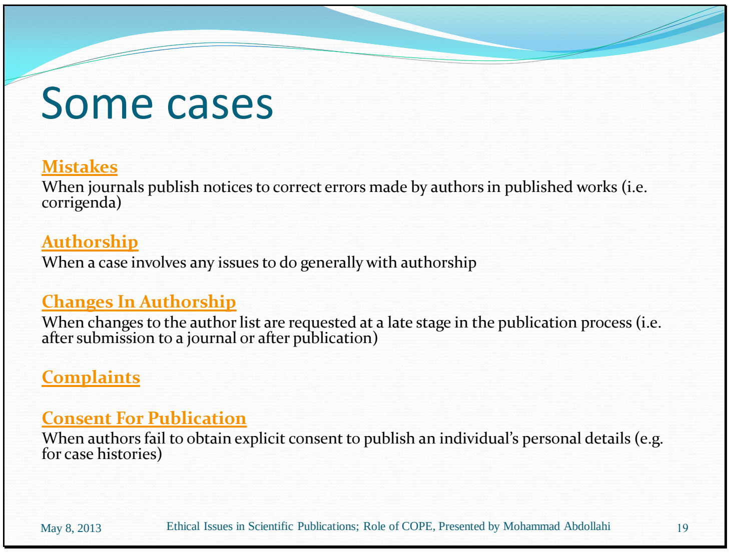


Figure 18. Some cases.

Figure 19. Cases.

Figure 20. Cases.

Figure 21. Cases.

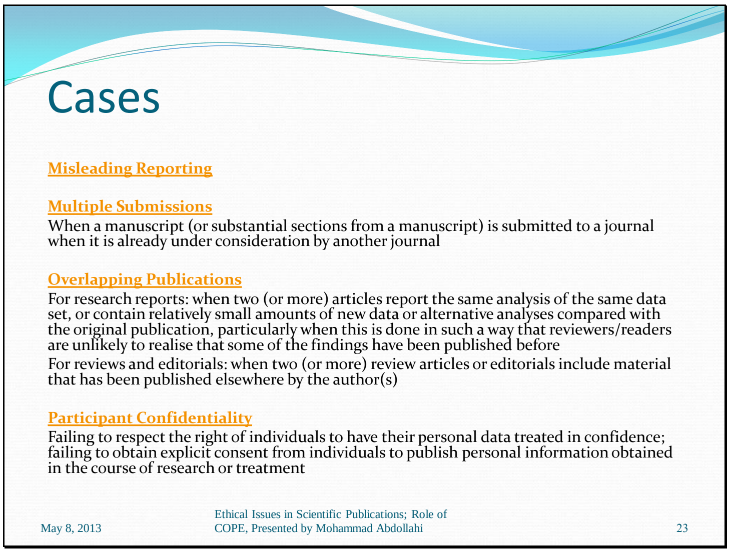


Figure 22. Cases.

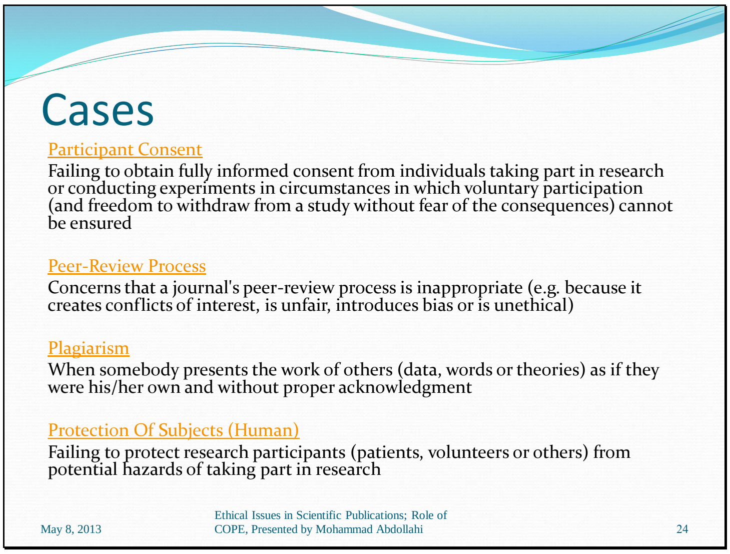


Figure 23. Cases.

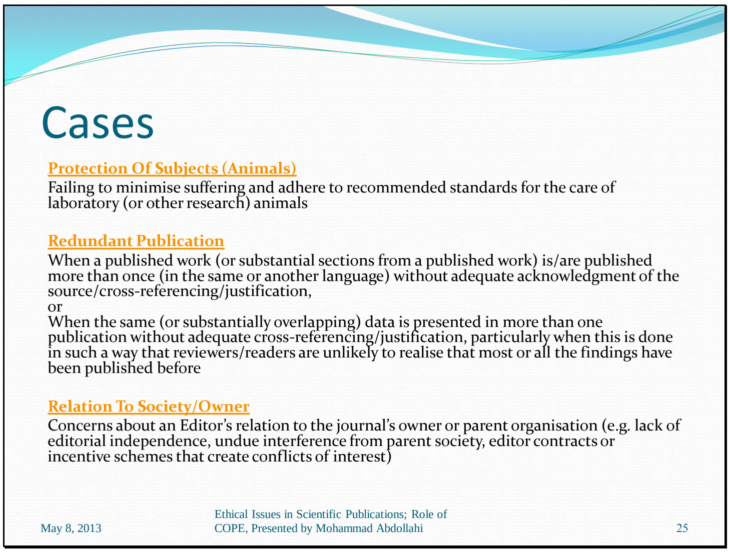


Figure 24. Cases.

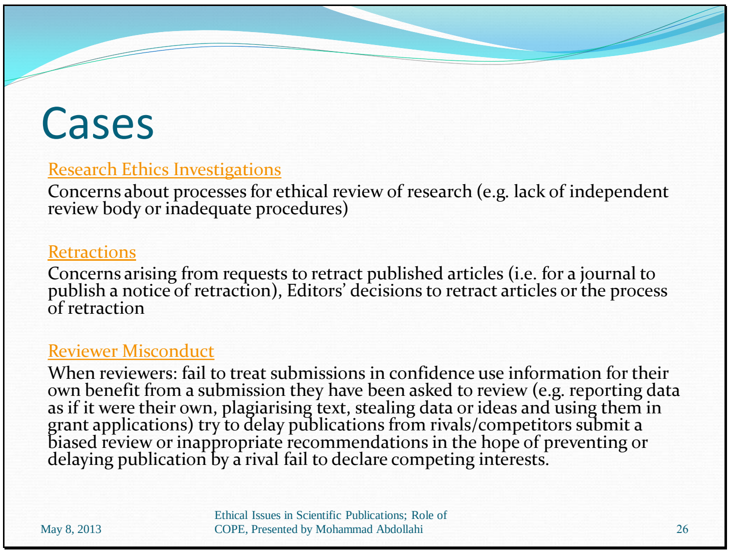


Figure 25. Cases.

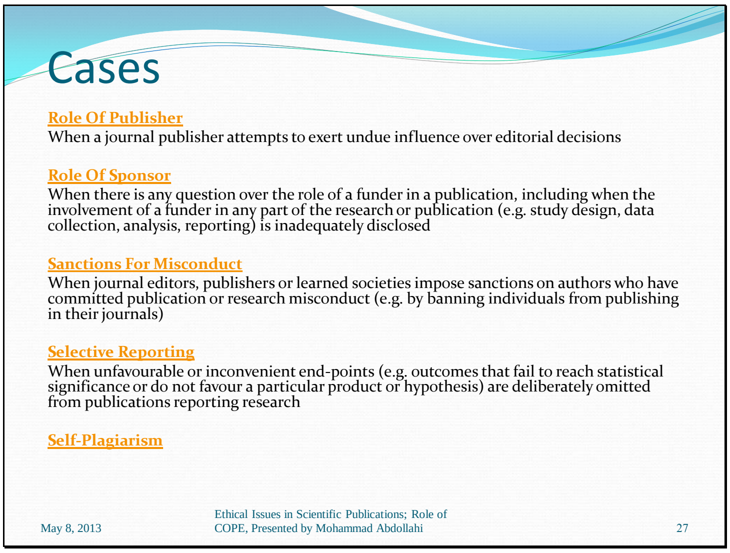


Figure 26. Cases.

Figure 27. Cross check by the software.

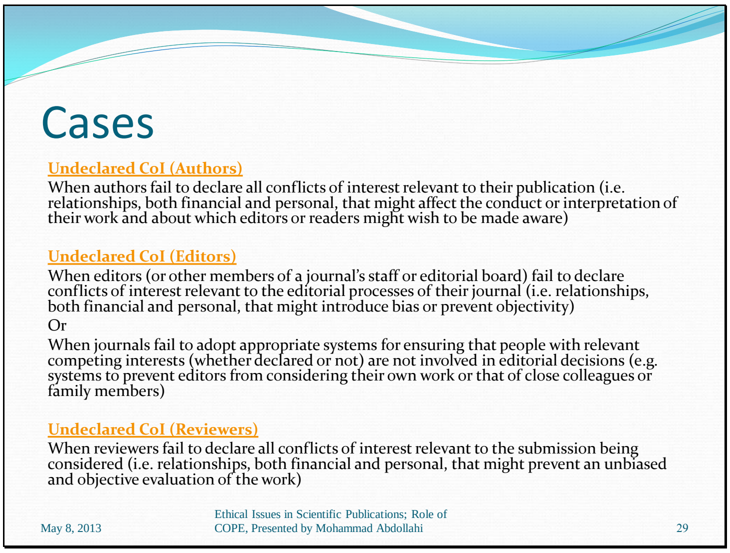


Figure 28. Cases.

Figure 29. Cases.

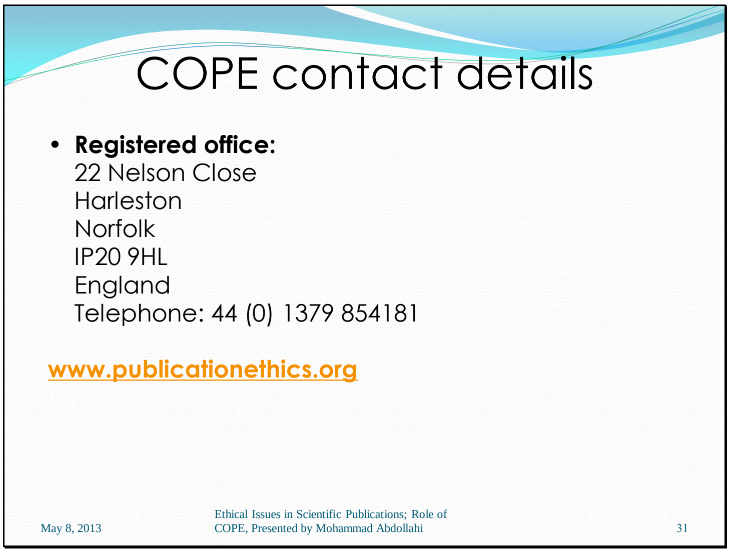


Figure 30. COPE contact details.

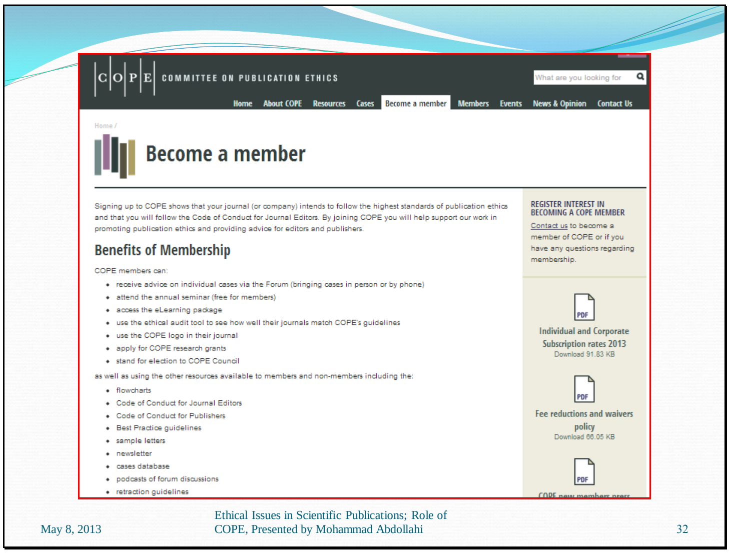


Figure 31. Become a member.

Structural and Magnetic Properties of Core-Shell Manganese-Oxide Nanoparticles fabricated by Inert Gas Condensation Technique

FEROZ A.KHAN[1]*, M.BAH[1], I.SHAH[1], P.NORDBLAD[2]

1 ABSTRACT

Core-shell Manganese oxide magnetic nanoparticles have been fabricated at room temperature by Inert Gas Condensation (IGC) technique. The core-shell structure has been confirmed by Scanning Electron Microscopy (SEM) and also by High Resolution Transmission Electron Microscopy (HRTEM). The particles of varying size distribution form random clusters and agglomeration. HRTEM images suggest an antiferromagnetic core surrounded by ferrimagnetic shell with an average size distribution of 30-50 nanometer. A significant exchange bias effect has been observed between the core and shell with the shift in hysteresis loops along the field axis within the temperature TN>T>TC where TN is the Neel temperature of the antiferromagnetic core and Tc is the ferrimagnetic Curie temperature of the shell. The hysteresis loop shift is observed to be maximum around the Neel' temperature and the shift keeps reducing gradually with the increase in temperature upto the Curie temperature at which the material enters into the paramagnetic phase. The exchange bias effect is attributed to the fluctuating ionic interaction between the Mn+2 and Mn+3 which is strongest near the boundary of the core and shell.

2 INTRODUCTION

The recent studies on magnetic core-shell nanoparticles in different 3d transition metal elements in their oxide forms have drawn in considerable attention for its possible applications in nano-devices and also in the field of medical sciences for targeted drug delivery. Magnetic materials in diversified geometries ranging from complex bulk structures to a broad variety of low dimensional systems have also stimulated interests in this field of research [1]. With the dimension of the magnetic materials being gradually miniaturized from the bulk to the nano-structured low dimension, the horizon of applications of these materials is also widening with their applications e.g., in magnetic ferrofluids, recording media, catalytic uses in cells , biomedical materials etc., are the few among the known applications. Manganese (Mn) being one of the transition metal elements are in use in the bulk form in variety of applications for ages. However, investigation of isolated Mn nanoparticles are very rare, although other elements in the 3d transition series e.g., Fe, Ni, and Co are widely used in technology for over decades [2-4]. Mn as an substitute and as an additive in elemental form has already been studied for uses in electronic devices at certain frequency regime [5] in ferrite materials. Manganese in oxidation form and in low dimension e.g., in nanometer sizes is lately gaining interests for its complex magnetic responses at different temperatures and in

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different oxidation states. In this work we have fabricated Manganese Oxide core-shell nanoparticles by Inert Gas Condensation (IGC) technique. A brief account of the studied structural and magnetic properties has been highlighted.

3 EXPERIMENTAL

Core-Shell nanoparticles are fabricated in a Kurt J.Lesker inert gas condensation (IGC) chamber. This machine is specially designed for fabrication of nanoparticles through gasification of the pure metallic samples by resistive heating above the melting temperature. Helium gas is used as the inert gas which is injected into the deposition chamber and is circulated by a Root blower to drag away the evaporating particles to be deposited onto the filter. A chamber pressure of 10-5 Torr is maintained using subsequently a rotary vacuum pump and a diffusion pump. After evacuating the chamber the Mn ingots in a Platinum boat is slowly heated by passing electric current .A slowly ramping up technique is used to ensure the uniform heating of the material above its eutectic temperature where the material is melted emitting a whitish bright glow. Upon further application of power the melt started evaporate. Because of the helium turbulence over the Mn ingots a Molybdenum mask is used in order to prevent the small ingots from flying off the platinum boat. After evaporation of the Mn ingots the electric power is ramped down slowly. The evaporation chamber is brought back to the atmospheric pressure and the deposited particles are carefully scratched out of the filter.

4 RESULTS AND DISCUSSION

Figure 1 shows the Scanning Electron Microscopy (SEM) of the as deposited MnO core-shell nanoparticles. The figure shows chain of clusters of MnO agglomerated over a few hundred nanometers. The image also indicates that the nanoparticles are assembled in irregular matrices and thus making the sample highly electric insulating in nature. Figure 2 shows a High Resolution Transmission Electron Microscopic (HRTEM) image of the core-shell MnO nanoparticle. The distinct core and the shell together forms a composite nono-particle of average size 30-50 nanometer. There are possible states of anti-ferromagnetic core surrounded a ferrimagnetic shell, or ferrimagnetic core surrounded by an antiferroagnetic shell which gives rise to exchange bias magnetic interactions in this kind of core-shell structures. While the bulk of the core and shell remains unaffected and maintain their intrinsic magnetic phases, it’s the spins close to the interface of the core and the shell that show exchange coupling as a result of spin canting.

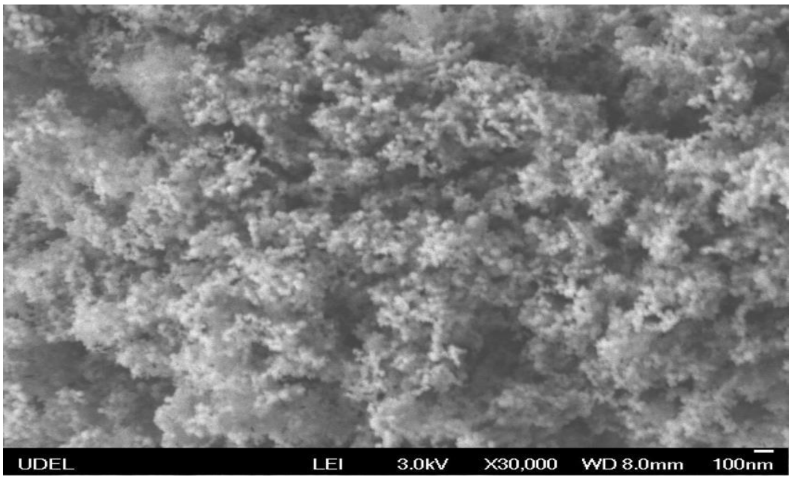

Figure1. Scanning Electron Microscopy of core-shell MnO nanoparticles.

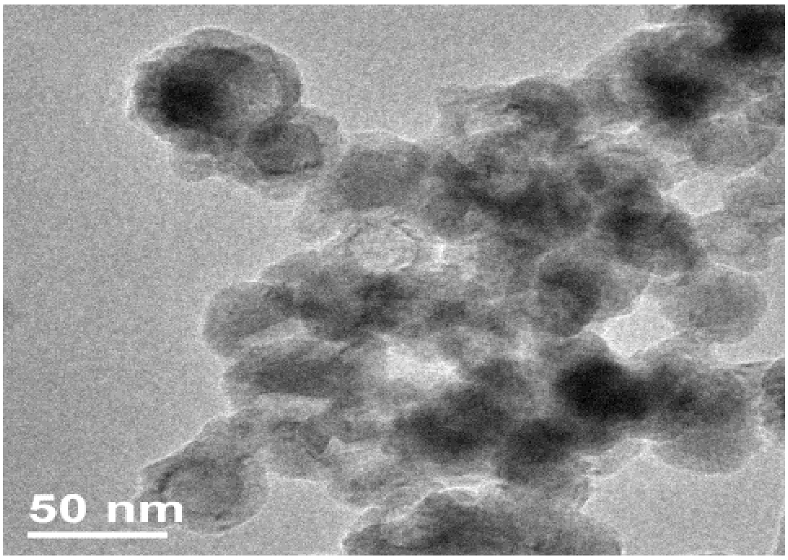

Figure 2. High Resolution Transmission Electron Microscopic image of Core-Shell MnO Nanoparticles.

Figure 3 shows the X-ray Photoelectron Spectroscopic image of the core-shell MnO nanoparticles. The peak positions of Mn2p3/2 and Mn2p1/2 are at 640.84 eV and 652.52 eV indicating a somewhat complex oxidation state of Mn. While the standard peak positions of Mn2p3/2 and Mn2p1/2 are at 639 eV and 640.8eV respectively [6] our results of XPS is indicating a multiple oxidation states of the MnO core shell nanoparticles.

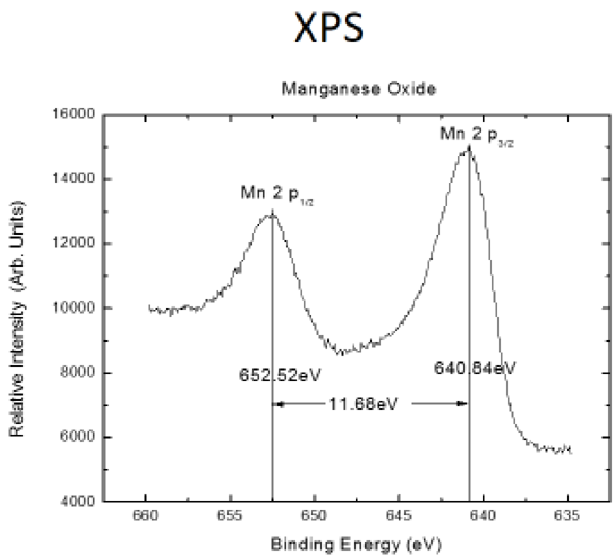

Figure 3. X-ray Photoelectron Spectroscopy (XPS) of MnO core-shell nanoparticles.

M-H at T =300K

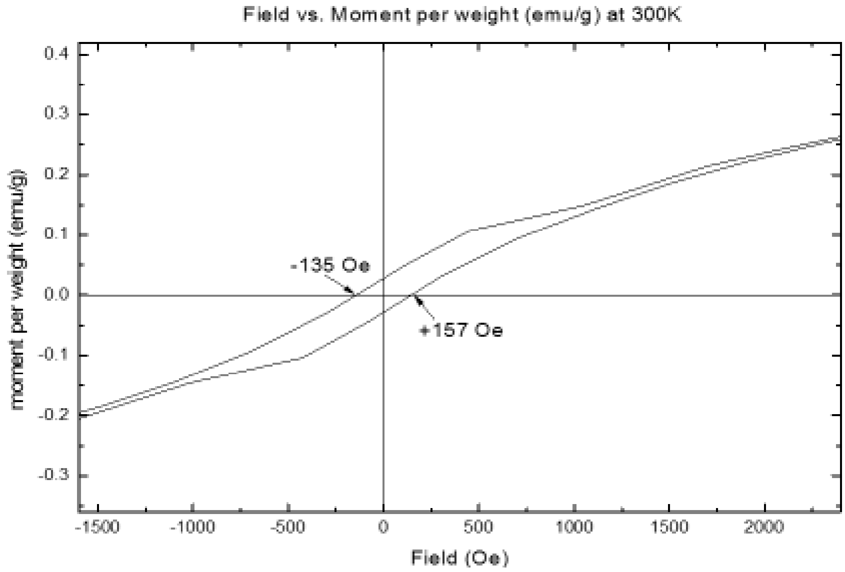

Figure 4. Magnetization versus Field curve of MnO core-shell nanoparticles at 300K.

Figure 4 shows the magnetic hysteresis curve MnO at room temperature (300 K). The curve shows no sign of magnetic saturation within the applied field range. The curve shows a ferromagnetic nature around the room temperature. Figure 5 shows the M-H curve at low temperature (5K). At an applied field of 7 Tesla, the curve maintains similar nature but with a shift of hysteresis towards the field axis. This nature may be attributed to the exchange bias effect which is prominent around this temperature.
-0.4 -0.3 -0.2 -0.10 0.1 0.2 0.3 0.4-8 104 -6 104 -4 104 -2 104 0 2 104 4 104 6 104 8 104 Magnetization (emu) Magnetic Field H (Oe) M vs H curve of Manganese Oxide core-shell nanoparticles at T = 5K

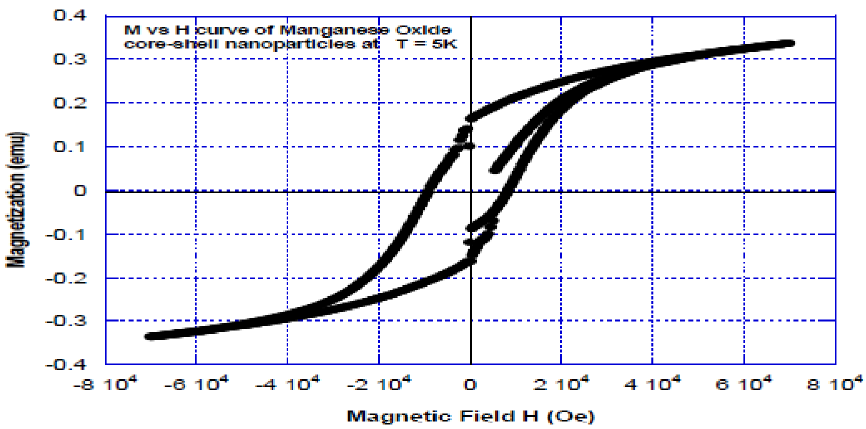

Figure 5. Magnetization versus Field curve of MnO core-shell nanoparticles at 5K.

Figure 6 shows the Field cooled (FC) and Zero Field Cooled (ZFC) magnetization curves of the MnO core-shell nanoparticles. We observed two temperatures of interest in this curves The ZFC curve shows a peak around 43 K which is assumed to be the blocking temperature , the temperature at which the magnetic spins are frozen. The FC and ZFC curves bifurcate around 60 K which is the temperature where the spins are unblocked and could show dynamic behavior e.g., spin relaxation around the core-shell boundary region.

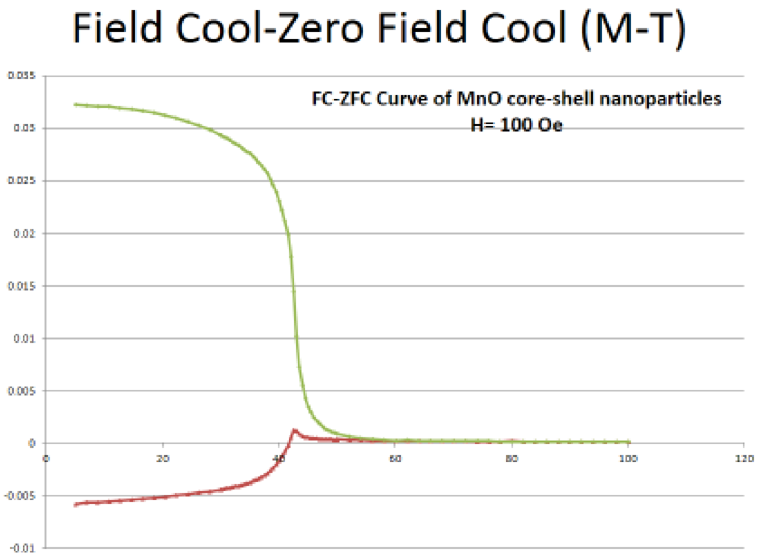

Figure 6 Field cooled (FC) and Zero Field Cooled (ZFC) of MnO core-shell nanoparticles.

5 CONCLUSION

Core-shell magnetic nanoparticles of Manganese oxide fabricated by Inert Gas Condensation (IGC) technique has proven to be an ideal system for studies of the intricate magnetic spin dynamics. The material can be of huge technological interest in magnetic recording media, magnetic shielding and also in the field of medical sciences involved in targeted drug delivery. The complicated oxidation states of Manganese in this rather new Core-shell form calls for further studies on this material

6 ACKNOWLEDGEMENT

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REFERRENCE

1. R.Skomsky, J.Phys.Condens.Matter 15 (2003) 841.

2. X.L.Dong, Z.D.Zhang, Q.F.Xiao, X,G,Zhao,Y.C.Chuang, S.R.Jin,W.M.Sun,Z.J.Li, Z.X.Zheng,H.Yang, J.Mater.Sci.3391998) 1915.

3. X.L.Dong,J.D.Zhang,X.G.Zhao,Y.C.Chung,S.R.Jin,W.M.Sun, J.Mater.Res.(1999) 1782.

4. P.Z.Si,E.Brück,Z.D.Zhang, O.Tegus, W.S.Zhang, K.H.J.Buschow,J.C.P.Klaasee.

5. A.Zubair,S.A.Siddiqui, F.A.Khan and m.A.Alim , Phys.Stat.Solid A,209,12(2012).

6. V.Dicastro,G.Polzonetti, J.Electron Spectrosc.Relat.Phenom.48(1989) 117.

The Photovoltaic Power

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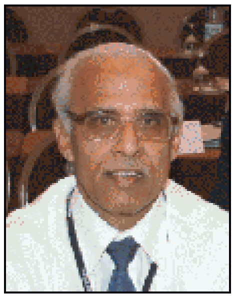

1 ABSTRACT

This contribution treats the fundamentals of the photovoltaic power production, the optimal arrangements and utilisation of its systems and discusses the reasons for the fast development of more than 35 % per year of this mode of power production in the world with the installed capacity of more than 100 gigawatts at the end of 2012.

2 INTRODUCTION

As we know, the Sun is the source of the renewable photovoltaic, wind, hydraulic and biomass energies. The Sun pours a flux of about 1000 Watts / m^2 on the surface of the Earth. Less than 1% of this energy is used in the" atmospheric engine" to produce winds and the remaining more than 99% goes into heat. It is obvious from this that the most efficient way of tapping the solar energy is its direct conversion into useful energy via the photovoltaic means or by producing heat to run generators. The heat energy of the atmosphere produces water evaporation from the oceans, seas and other water sources and results in rain and snow which are the source of hydraulic energy. In the case of biomass, the direct solar energy via the photosynthesis process and the atmospheric heat come into play together. Ideally as all of these renewable energies do not produce any of the glasshouse gases (such as Co2 and CH4 that seem to be increasingly disturbing the dynamics of the Earth's atmosphere), they are contributing more and more to the matrix of energies being used in the world.

3 FUNDAMENTALS OF THE PHOTOVOLTAIC ENERGY

It is obvious that the photovoltaic and the wind energies are variable in intensity and intermittent in time. Until one finds effective ways of storing them, they have to be used in combination with the other stable primary sources of energy such as fossil fuels: petrol and gas and nuclear energy or a combination of them to take care of this variability and intermittence.
In this write-up, we shall deal with the ***fundamentals*** of the photovoltaic (PV) energy.

1. NP-junction

To produce a PV cell, one starts generally with a 100 mm by 100 mm square and 160 micrometer thick wafer of highly pure crystalline Si- semiconductor. It is doped into an N-type semiconductor with the substitutional impurity of Phosphorus atoms that have five valence electrons compared to 4 in Si. After completing the covalent bonding with the neighbouring Si-atoms, one electron is left free to move around leaving behind a positively charged Phosphorus ion. One dopes another Si-wafer into a P-type with the substitutional impurity of Boron atoms that have only 3 valence electrons. Here, one is left with a vacancy of one electron for completing its covalent bonding with the Si atoms. It picks up an electron from the neighbouring Si-covalent bonds, converts the Boron-impurity into a negatively charged ion and the resulting hole (positive charge) in the Si covalent bond moves around by exchanging electron with the other Si atoms. Here, as a rule, one can also use other types of atoms to dope the wafers into N- and P-types.

Now, to produce a NP- junction, these N-type and P-type wafers are put together in a very close contact. Here, the junction refers to the boundary, where the two regions meet. Due to this contact, the free electrons from the N-type diffuse across the junction into the P-type leaving behind fixed, positively charged “donor ions”, and from the P-type, the holes (positive charges) diffuse across the junction into the N-type leaving behind fixed, negatively charged “acceptor ions”. This diffusion of electrons and holes across the boundary continues till an electrostatic equilibrium is reached on both sides of the junction. The equal number of electrons and the holes that cross the junction neutralize themselves leaving behind a region of space charge without any free carriers called the **depletion zone**. This space charge creates an electrostatic potential barrier of 0.5V for the Si-based NP-junction against the flow of electrons from the N-type towards the P-side and for the holes, from the P-type to the N-side, Fig. 1.

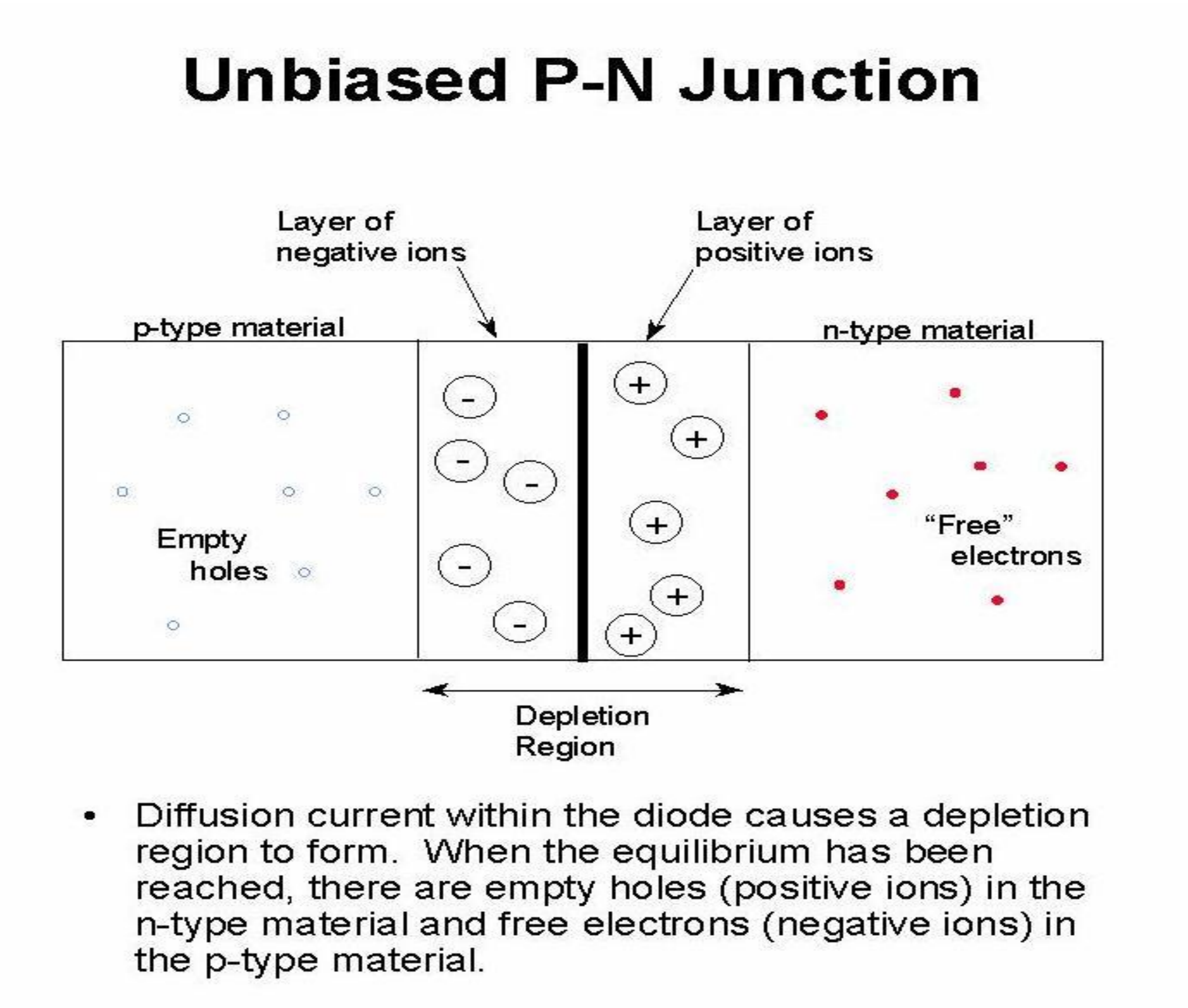

Figure.1. An unbiased NP-junction (vertical cut of a PV cell, Fig.2) with its depletion region (Wikipedia).

2. PV-cell

The PN-junction with its electrical connections: the bottom of the cell is covered with a metal for good conduction and a metallic contact grid is fixed on the cell, is the basic element for a PV-cell, Fig.2.

Figure.2. A crystalline Si-PV cell (Wikipedia).

Its N-type surface always faces the incident sun radiation that produces in the Si-semiconductor electron and hole pairs in the depletion region. The current of electrons flows in the external circuit due to the potential of 0.5V and the holes move in the opposite direction.

3. PV-cell conversion efficiency

The band gap of Si is 1.1eVcorresponding to the radiation wavelength of 1.1 μm of the near infrared region. Thus, the energy of the photons in the solar radiation spectrum, Fig.3.

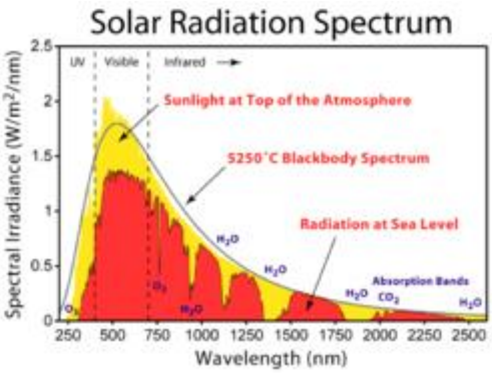

Figure.3 Solar radiation spectrum (Wikipedia).

has be to be at least 1.1eV to excite an electro-hole pair from the valence band to the conduction band of Si. The photons with energies less than this band gap will not be absorbed and this corresponds to about 25% of the energy in the incident solar spectrum. For the solar spectrum with energies higher than 1.1eV, though electron-hole pairs are created, even here 30 % of the solar spectrum energy is lost in heat. Hence, the Si-PV- cell conversion efficiency just due to the nature of the solar spectrum is only 45%. In fact, the theoretical conversion efficiency limit called the Shockley-Quiesser limit (1) - based on the detailed balance of thermodynamics, for a one gap (1.1eV) Si- PV-cell is **29 %.** However, the best industrial conversion efficiency for a Si-PV-cell is around 15% (though values up to 20 % have been reported), Fig.4.

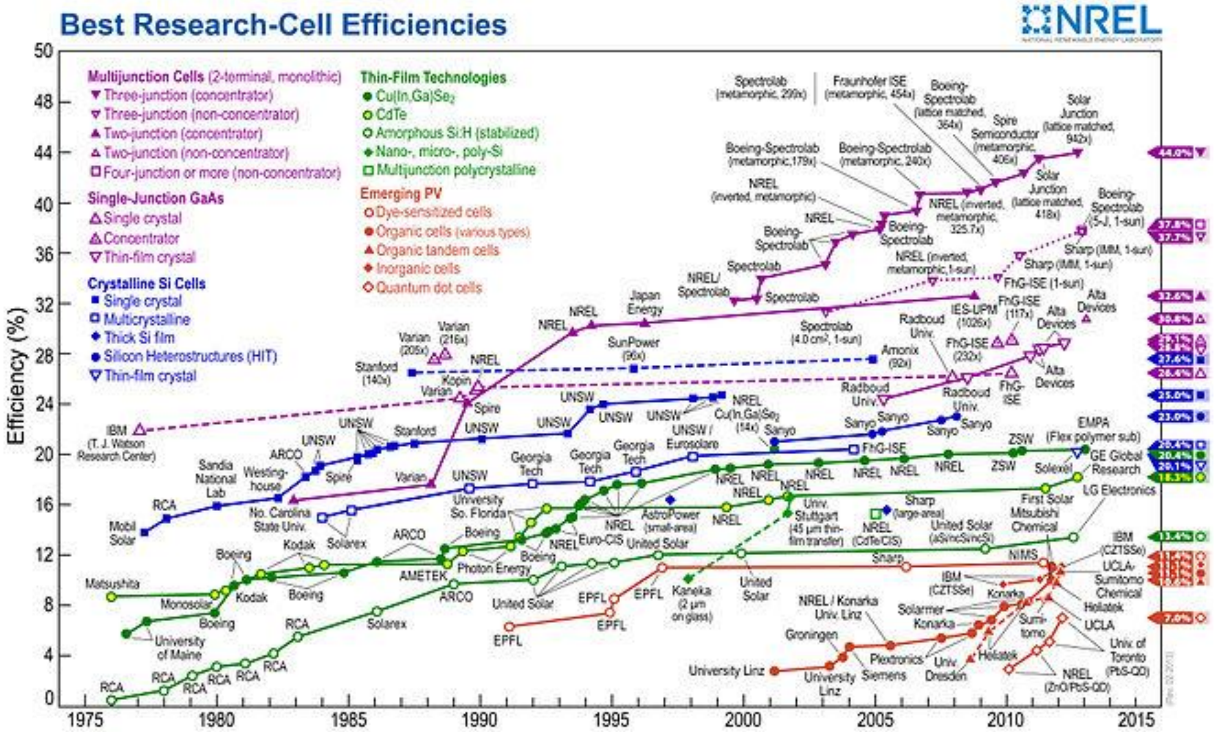

Figure. 4. Best research-cell values of efficiencies for the different types of PV cells (Wikipedia).

This shows that there are other factors such as recombination, power loss because the cell voltage at the maximum power is less than the band gap (as pointed out below), the resistive loss and the reflection of radiation from the surface of the PV-cell, that affect the cell conversion efficiency. In fact, the untreated Si-surface can reflect more than 30% of the incident light. Here, various antireflection methods such as roughening the cell's top surface and anti-reflection coating are used to reduce the reflection to the minimum. Moreover, a glass cover plate is fixed on the top to protect the cell from the elements. Finally, the cell's efficiency decreases about 0.5 % per degree C increase in its temperature.

4. Power of a PV cell

A 100 mm by 100 mm square PV cell with 15% conversion efficiency and the sun flux of 1000Watt/m^2 with a normal incidence, produces 1.5 Watts power. This corresponds to 150 Watts/ m^2. For a normally working cell, the output current I remains rather constant as a function the cell voltage up to about 0.4 V and then it decreases fast to zero for its maximum voltage of 0.5 V Hence, the maximum power output of the cell P = VI amounts to 0.4I. However, if there is a need, one can incorporate and use the maximum power point tracking (MPPT) system that determines and fixes automatically the**" knee point**" of the current and voltage curve for the cell's maximum power.

5. PV- modules/panels and Arrays

These PV cells are wired together into ensembles called modules/panels. Then, these modules are connected together into arrays and fixed on racks on the ground or other appropriate supports such as the roof tops to produce the desired power, Figs.5, 6. A square module of 100 PV cells should produce 150 Watts. If one wants 3.6 kW for a household, one would need an array of 24 modules. Now, we have this amount of power, the question is as to how to share this power in terms of voltage and current for different uses. When the cells are connected in series, the current remains the same as of

the individual cell throughout, but the final voltage will be the sum of the individual cell voltages (0.5V) of the chain. However, for the parallel connections, the voltage remains the same (0.5V), but the current will be the sum of the individual currents of the chain. For example, if one wants this 3.6 kW power to charge a set of 12V batteries. One has to divide the 2400 cells of the array into 100 batches of 24 cells connected in series and the batches themselves connected in parallel. This arrangement will distribute the power as P= = 12V. 300 A.
When charging the storing acid batteries, one has to ensure oneself that they are charged and discharged safely under the control of an MPPT charge controller that also takes care of the power fluctuations due to temperature and daily and seasonal insolation variations. Moreover, if the DC power produced by the PV system is to be used for water pumping for agriculture and electric motors or other applications that need AC current, it has to be converted into the AC form of the required frequency via an appropriate D**C/AC inverter**.

Fig.5. An array of 24 modules (Wikipedia)

Fig.6. A PV solar module (Wikipedia)

6. Orientation of PV systems and performance

For a fixed small or medium sized PV system to have the optimal power output, the solar radiation should reach it at right angle to its surface. For this, in the Northern hemisphere, it has to be fixed facing the South and , depending on its situation, with a tilt of between 15° to 45° relative to the horizontal. As to the output power, in countries like Spain**,** it increases from about 06h00 to 09h00 to reach the maximum value and then it starts to decrease around 15h00 implying that the system's rated power is available for 6 hours a day. For a 3.6 kW system, one gets at least 21.6 kWh every day. It is obvious that in each place, one has to find as to how the system's power output varies during the day.
For the industrial systems of MW capacity, single or double sun **tracking systems** are used; they can increase their output by 30 to 45% outweighing their extra cost and complexity.

7. Standalone systems

The principal virtue of the small and medium PV systems of hundreds of kW capacity is that they can be installed in far out isolated areas without the need of installing the expensive transmission lines. They can be/are used in agriculture for water pumps for irrigation and for the daily use of small and medium-sized communities. However, these systems have to be connected to appropriate batteries or other energy storing systems, when there is no sun and particularly during the nights. Moreover, one can set up **hybrid systems**, where the PV systems are used along with the energy produced from the locally produced biomass or small hydraulic systems or where possible from the wind via the small wind mills. In fact, the PV and wind powers are quite complementary in their modes of operation.

8. Grid connected systems.

In the urban areas, the independent PV systems, through the appropriate financial arrangements, can be/are connected to the public grid to feed it, when there is an excess in energy production by them during the day, and use the grid energy, when there is a lack of production from it.

9. Dirt, dust, snow and partial shading

For its optimal functioning, the PV system must be kept clean from dirt, dust and snow. It has been observed that an uncleaned system may lose up to half of its power output after one year. As to the partial shading of modules or arrays due to clouds, trees or other structures, it can be very **damaging** not only for its output, but also for the system itself. Of course, the central element in this case, is the PV cell itself. When a cell suffers shading, not only it does not produce any current, but it becomes "reverse biased" and sucks in the power from its chain, gets overcharged, heats up leading to its breakdown and short circuiting. This short circuiting does not lead only to the loss of power, but it may end up in fire of the cell and eventually the system itself. To avoid this extreme case, one uses bypass diodes across groups of cells to minimize the effect of partial shading. In this case, one loses power only in the shaded region of the system. However, it should be noted that in the case of complete shading, the system loses its power, but it does not suffer any physical damage.

10. Some other points

The discussion in this text up to now has been limited to the crystalline Si-PV cells, where the cost of production of modules has come down to **less than $1 per Watt**. Here, on can use the cheaper polycrystalline Si-PV cells that have a little lower conversion efficiency of about 8 to10%. Instead of one band gap PV systems discussed up to now, one can use the fast developing multiband gap PV cells and the flexible thin film PV systems treated below. Moreover, large amount of research work is being done on other types of PV cells based on different materials and, particularly, on nanosystems such as quantum dots, graphene and nanowires of different materials.

11. Concentrated Photovoltaics (CPV) based on silicone-on glass Fresnel lens

Instead of single gap PV cells such as those based on crystalline Si discussed here, one can use the multi-gap PV cells. For example, the three-gap PV cells have a much higher conversion efficiency that can go up to 44% compared to 15% for those based on crystalline Si. Although these cells are normally used in space satellites, they are still very expensive for normal use due to the high cost of these materials. However, during the last few years a few mm^2 sized and less expensive three-gap PV cells based on GaInP (gap: 1.86eV), GaInAs (1.2eV), Ge (0.6eV) have been successfully produced and used. They are used in conjunction with the cheap thin Fresnel lenses that focus, say, 500 times more sunlight on these cells than they will receive directly (2,3). To produce a panel of these thin Fresnel lenses, the Fresnel microprisms of transparent silicone are formed directly on a negatively profiled mould of a thin silicate glass plate by the polymerization of a silicon compound. This panel with the Fresnel lenses is then fixed on to a panel of multi-gap PV cells, where each lens precisely covers a PV cell, to have the final CPV panel.

The cells of the multi-gap PV cell are stacked up vertically with the highest gap 1.86eV at the top facing the sun, then 1.2eV followed by 0.6eV; this allows each gap to convert independently. The industrial conversion efficiency of this **CPV** is 30%, which is twice that of the crystalline Si-PV cell and this is being pushed towards 35%. Moreover, in spite of the intense flux of radiation on the cells, they do not need any external cooling and their expansion temperature coefficients are very small.

To exploit these CPV's efficiently their panels and arrays have to be very carefully and continuously lined up at right angle to the incoming sunlight using the double tracking system - implying that they will be more apt for the MW industrial set ups than for the relatively small household uses.

12. Thin film Photovoltaics

The thin films as large surface modules are produced by depositing PV materials such as amorphous silicon and other thin film silicon, cadmium telluride, copper indium gallium selenide and the different organic PV material, on glass, plastic and metallic **substrates**. At present, the conversion efficiency of these thin PV film–based modules is approaching 8- 9%. With the improvement in technology, the production cost of these modules is coming down quite fast towards less than $0.5/W. Moreover, due to their inherent flexibility, these thin P V films are being directly integrated more and more into the construction of buildings in what is called the **photo-integrated photovoltaics** – leading to a further lowering of the cost for their installation.

13. Space-based PV installations

We have seen that the operation of the Earth based PV installations is by nature intermittent due to the day and night cycle and variable because of the presence of the atmosphere. As a rule, one can avoid these inherent problems by locating the PV installations at the Earth's geostationary orbit (35,800 km above the equator) in space. In space the solar radiation flux of 1.360kW/m^2 is not only 36 % greater than on the Earth, but it is continuous as it does not suffer from its day and night intermittence and the variability, because of absence of the atmosphere; this also avoids the maintenance problems due to wind, dust, rain and snow (4). The energy produced up there in space is supposed to be beamed to the Earth via the microwave transmitters installed with the PV system. Whether or not the idea of PV power produced in space and transmitted to the Earth can be put into practice, only the future will tell.

4 CONCLUSION

This contribution treats the basics of the PV power and its systems. Even though its temporal operation is intermittent, it has an availability of around 30% per day compared to 22 to 25 % for the windmills. Their intermittence can be reduced by coupling them (hybridisation) with other local sources of energy such as biomass or even small hydraulic systems or small windmills. With an effective lifetime of 20 to 25 years, the installation of the PV power systems is progressing more than 35 % per year in the world with the installed capacity of **more than 100 gigawatts** at the end of 2012 (5). This phenomenal increase is mainly due to two factors: the sun light is available everywhere during the day and the fast decreasing cost to **less than $1/watt** of producing reliable solar modules. Moreover, the development of new types of more efficient such as multigap PV cells should give additional boost to the PV power development in the available matrix of energies used in the world.

REFERENCES

1. William Shockley and Hans J. Queisser, Journal of Applied physics, 32 (1961) p. 510 – 519.
2. Solar CPV – Soitec (France) Information documents.
3. V. D. Rumyantsev A17, 18, No.S1 (2010).
4. SolarHigh.org 2011.
5. International Energy Agency (IEA), 2013.

APPENDIX A

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Representative, MOFA	
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70.	Prof. Ali A. Moosavi-**Movahedi**	Iran
71.	Prof. Sami **Al- Mudhaffar**	Iraq
72.	Prof. Zaghloul **El-Naggar**	Egypt
73.	Prof. Ibrahim Saleh **Al- Naimi**	Qatar
74.	Prof. Anwar **Nasim**	Pakistan
75.	Prof. Munir **Nayfeh**	Jordan/ United States
76.	Prof. Robert **Nigmatulin**	Tatarstan/ Russia
77.	Prof. Gulsen **Oner**	Turkey
78.	Prof. Ramdane **Ouahes**	Algeria
79.	Prof. Sinasi **Ozsoylu**	Turkey
80.	Prof. Munir **Ozturk**	Turkey
81.	Prof. Iqbal **Parker**	South Africa
82.	Prof. Syed Muhammad **Qaim**	Germany
83.	Prof. Subhi **Qasem**	Jordan
84.	Prof. Atta-ur-**Rahman**	Pakistan
85.	Prof. Najih Khalil **El-Rawi**	Iraq
86.	Prof. Makhmud **Salakhitdinov**	Uzbekistan
87.	Prof. Hussein Samir **Salama**	Egypt
88.	Prof. Eldar Yunisoglu **Salayev**	Azerbaijan

89.	Prof. Jawad A. **Salehi**	Iran
90.	Prof. Boudjema **Samraoui**	Algeria
91.	Prof. Lorenzo **Savioli**	Italy
92.	Prof. Mohammed Musa **Shabat**	Gaza/ Palestine
93.	Prof. Misbah-Ud-Din **Shami**	Pakistan
94.	Prof. Ali **Al-Shamlan**	Kuwait
95.	Prof. Ahmad **Shamsul-Islam**	Bangladesh
96.	Prof. Muthana **Shanshal**	Iraq
97.	Prof. Zabta Khan **Shinwari**	Pakistan
98.	Prof. Ahmedou M **Sow**	Senegal
99.	Prof. Mahmoud **Tebyani**	Iran
100.	Prof. Ahmet Hikmet **Ucisik**	Turkey
101.	Prof. Gulnar **Vagapova**	Tatarstan/ Russia
102.	Prof. Omar M. **Yaghi**	Jordan/USA
103.	Prof. Jackie **Ying**	Singapore/USA
104.	Prof. Bekhzad **Yuldashev**	Uzbekistan
105.	Prof. Khalid **Yusoff**	Malaysia
106.	Prof. Khatijah Mohd **Yusoff**	Malaysia
107.	Prof. Salim **Yusuf**	Canada
108.	Prof. Mikhael **Zalikhanov**	Balkar/Russia

APPENDIX E

LAUREATES OF THE IAS-COMSTECH IBRAHIM MEMORIAL AWARD

Prof. Ugur **Dilmen**	1996	Turkey.
Prof. Mohammad **Abdollahi**	2005	Iran.
Prof. Mohammed Manna **Al-Qattan**	2007	Saudi Arabia.
Dr Faris **Gavrankapetanovic**	2009	Bosnia.
Dr Saima **Riazuddin**	2011	Pakistan.
Prof. Liaquat **Ali**	2013	Bangladesh.
Prof. Jackie **Ying**	2015	Singapore.

APPENDIX F

COUNCIL OF THE
ISLAMIC WORLD ACADEMY OF SCIENCES
(2017-2021)

President:	**Abdel Salam Majali**	Jordan.
Vice-President:	**Noor M. Butt**	Pakistan.
Vice-President:	**Munir Ozturk**	Turkey.
Vice-President:	**Khatijah Mohd Yusoff**	Malaysia.
Treasurer:	**Adnan Badran**	Jordan.
Secretary General:	**Ahmad Abdullah Azad**	Australia.
Member:	**M. Shamsher Ali**	Bangladesh.
Member:	**Mohammed Asghar**	France.
Member:	**Mostefa Khiati**	Algeria.
Member:	**Amdoulla Mehrabov**	Azerbaijan.
Member:	**Muthana Shanshal**	Iraq.
Member (Ex-officio):	**Moneef R. Zou'bi**	DG- IAS/Jordan.

IAS EXECUTIVE STAFF

Moneef R. Zou'bi	*Director General.*
Lina Jalal Dadan	*Programme Officer.*
Najwa Daghestani	*Programme Officer.*
Taghreed Saqer	*Executive Secretary.*
Hamzah Daghestani	*Finance Officer.*
Habes Majali	*Public Relations Officer.*
Hamdi Bader	*Driver.*

APPENDIX G

DECEASED FELLOWS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES (IAS)

Prof. Mohammad **Ibrahim**	(1911-1988)	Bangladesh.
Prof. Djibril **Fall**	(1930-1992)	Senegal.
Prof. Salimuzzaman **Siddiqui**	(1897-1994)	Pakistan.
Prof. Abdus Salam **Mia**	(1925-1995)	Bangladesh/USA.
Prof. Suleiman Gabir **Hamad**	(1937-1996)	Sudan.
Prof. Mohammad R **Siddiqi**	(1908-1998)	Pakistan.
Prof. Abdullah M **Sharafuddin**	(1930-1998)	Bangladesh.
Prof. Achmad **Baiquni**	(1923-1998)	Indonesia.
Prof. Mumtaz Ali **Kazi**	(1928-1999)	Pakistan.
Prof. Faramaz G **Maksudov**	(1930-2000)	Azerbaijan.
Prof. Ali **Kettani**	(1941-2001)	Morocco.
Prof. Mohamed Kamel **Mahmoud**	(1926-2003)	Egypt.
Prof. Samaun **Samadikun**	(1931-2006)	Indonesia.
Prof. Iftikhar Ahmad **Malik**	(1936-2008)	Pakistan.
Prof. J (Younis) Ario **Katili**	(1929-2008)	Indonesia.
Prof. Ibrahima Mar **Diop**	(1921-2008)	Senegal.
Prof. Syed Zahir **Haider**	(1927-2008)	Bangladesh.
Prof. Muhammad Ilyas **Burney**	(1922-2008)	Pakistan.
Prof. Badri **Muhammad**	(1943-2009)	Malaysia.
Prof. Pulat **Khabibullaev**	(1936-2010)	Uzbekistan.
Prof. Mohammed A **Waqar**	(1941-2010)	Pakistan.
Prof. Souleymane **Niang**	(1929-2010)	Senegal.
Prof. Ahmad Nawawi **Ayoub**	(1937-2010)	Malaysia.
Prof. Kamal H. **Batanouny**	(1936-2011)	Egypt.
Prof. Mohamed B E **Fayez**	(1927-2011)	Egypt.
Prof. Mazhar M **Qurashi**	(1925-2011)	Pakistan.
Prof. Mahmoud **Hafez**	(1912-2012)	Egypt.
Prof. Jamal **Nazrul-Islam**	(1939-2013)	Bangladesh.
Prof. **Riazuddin**	(1930-2013)	Pakistan.
Prof. Naeem Ahmad **Khan**	(1928 -2013)	Pakistan.
Prof. Mehmet Nimet **Ozdas**	(1921-2014)	Turkey.
Prof. Ugur **Dilmen**	(1955-2015)	Turkey.
Prof. Ibrahim Gamil **Badran**	(1924-2015)	Egypt.
Prof. Fakhruddin **Daghestani**	(1936-2016)	Jordan.
Prof. Ibrahima **Wone**	(1926-2016)	Senegal.
Prof. Syed Qasim **Mehdi**	(1941-2016)	Pakistan.
Prof. Korkut **Ozal**	(1929-2016)	Turkey.
Prof. Mohammad Salimullah	(1949-2016)	Bangladesh.
Prof. Attia A Ashour	(1924-2017)	Egypt.

Prof. Mustafa Doruk	(1932-2017)	Turkey.
Prof. Ishfaq Ahmad	(1930-2018)	Pakistan.
Prof. Naci Bor	(1928-2018)	Turkey.
Prof. Salambek Khadjiev	(1941-2018)	Chechnya.

APPENDIX H

PUBLICATIONS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES

CONFERENCE PROCEEDINGS

- *The Islamic Academy of Sciences.* Proceedings of the Founding Conference (1986). Published by the Islamic Academy of Sciences, **Editor: A. Kettani (Morocco).**
- *Food Security in the Muslim World.* Proceedings of the first international conference, Amman (Jordan) (1987). Published by the Islamic World Academy of Sciences, **Editor: S. Qasem (Jordan).**
- *Science and Technology Policy for Self-Reliance in the Muslim World.* Proceedings of the second international conference, Islamabad (Pakistan) (1988). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), H. El-Mulki (Jordan), and M. Al-Halaiqa (Jordan).**
- *New Technologies and Development of the Muslim World.* Proceedings of the third international conference, (Kuwait) (1989). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), and S. Qasem (Jordan).**
- *Technology Transfer for Development in the Muslim World.* Proceedings of the fourth international conference, Antalya (Turkey) (1990). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), A. Altamemi (Jordan), and M. Ergin (Turkey).**
- *Science and Technology Manpower Development in the Islamic World.* Proceedings of the fifth international conference, Amman (Jordan) (1991). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), A. Altamemi (Jordan), and H. El-Mulki (Jordan).**
- *Environment and Development in the Islamic World.* Proceedings of the sixth international conference, Kuala Lumpur (Malaysia) (1992). Published by the Islamic World Academy of Sciences, **Editors: S. Al-Athel (Saudi Arabia), and F. Daghestani (Jordan).**
- *Health, Nutrition and Development in the Islamic World.* Proceedings of the seventh international conference, Dakar (Senegal) (1993). Published by the Islamic World Academy of Sciences, **Editors: N. Bor (Turkey), A. Kettani (Morocco), and Moneef R. Zou'bi (Jordan).**
- *Water in the Islamic World: An Imminent Crisis.* Proceedings of the eighth international conference, Khartoum (Sudan) (1994). Published by the Islamic

World Academy of Sciences, **Editors: M. Ergin (Turkey), H. Dogan Altinbilek (Turkey), and Moneef R. Zou'bi (Jordan).**

- *Science and Technology Education for Development in the Islamic World.* Proceedings of the ninth international conference, Tehran (Iran) (1999). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), M. Doruk (Turkey), and Moneef R. Zou’bi (Jordan) (ISBN 9957-412-7).**
- *Information Technology for Development in the Islamic World.* Proceeding of the tenth international conference, Tunis (Tunisia) (2000). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), M. Doruk (Turkey), and Moneef R. Zou’bi (Jordan) (ISBN 9957-412-03-5).**
- *Biotechnology and Genetic Engineering for Development in the Islamic World.* Proceedings of the eleventh international conference, Rabat (Morocco) (2001). Published by the Islamic World Academy of Sciences, **Editors: A. S. Majali (Jordan), M. Ergin (Turkey), and Moneef R. Zou’bi (Jordan) (ISBN 9957-412-07-8).**
- *Materials Science and Technology and Culture of Science.* Proceedings of the twelfth international conference, Islamabad (Pakistan), (2002). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou’bi (Jordan) (ISBN 9957-412-06-x).**
- *Energy for Sustainable Development and Science for the Future of the Islamic World and Humanity.* Proceedings of the thirteenth international conference, Kuching, Sarawak (Malaysia), (2003). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou’bi (Jordan) (ISBN 9957-412-08-6).**
- *Science Technology and Innovation for Socioeconomic Development of OIC-Member Countries Towards Vision 1441.* Proceeding of the fourteenth international conference, Kuala Lumpur (Malaysia), (2005). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou’bi (Jordan) (ISBN 9957-412-11-6).**
- *Higher Education Excellence for Development in the Islamic World*. Proceeding of the fifteenth international conference, Ankara (Turkey), (2006). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou’bi (Jordan) (ISBN 978-9957-412-18-0.**
- *Science, Technology and Innovation for Sustainable Development in the Islamic World: The Policies and Politics Rapprochement*. Proceeding of the Sixteenth international conference, Kazan (Tatarstan), (2008). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou’bi (Jordan) (ISBN 978-9957-412-19-7).**
- *Science and Technology and Innovation for Sustainable Development in the Islamic World: Policies and Politics Rapprochement*, Proceeding of the sixteenth international conference, Kazan (Tatarstan), (2008). Published by

the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-19-7).**

- *Science and Technology and Innovation for Sustainable Development in the Islamic World: Policies and Politics Rapprochement,* Proceeding of the sixteenth international conference, Kazan (Tatarstan), (2008) - Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-19-7).**
- *Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination,* Proceeding of the seventeenth international conference, Shah Alam *(Malaysia); 2009.* Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-22-7). Online.**
- *The Islamic World and the West: Rebuilding Bridges through Science and Technology,* Doha (Qatar), 2011**.** Published by the Islamic World Academy of Sciences, **Editor: Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-24-1). Online.**
- *Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation*, Dhaka (Bangladesh), 2013. Published by the Islamic World Academy of Sciences, **Editors: Moneef R. Zou'bi (Jordan), and Najwa F. Daghestani (Jordan). Online.**

BOOKS

- *Islamic Thought and Modern Science.* Published by the Islamic World Academy of Sciences (1997) **- Author: Mumtaz A. Kazi**.
- *Qur'anic Concepts and Scientific Theories.* Published by the Islamic World Academy of Sciences (1999) – **Author: Mumtaz A. Kazi.**
- *Personalities Noble* **Editor: Hakim Mohammed Said**, Second Revised Edition. Published by the Islamic World Academy of Sciences (2000), **Editor: Moneef R. Zou'bi** (Arabic-English). **(ISBN: 9957-412-01-6).**
- *Declarations of the Islamic World Academy of Sciences.* Published by the Islamic World Academy of Sciences (2005), **Editor: Moneef. R. Zou'bi (ISBN: 9957-412-09-4)**.
- *Islamic World Academy of Sciences Outreach.* Published by the Islamic World Academy of Sciences (2005), **Editor: Moneef R. Zou'bi (ISBN: 9957-412-10-8)**.
- *Intellectual Property Rights: An Introduction for Scientists and Technologists.* Published by the Islamic World Academy of Sciences (2006), **Author: Mohamed B. E. Fayez (ISBN: 978-9957-412-18-0)**.
- *The Discoveries in the Islamic Countries* – Arabic Edition Published by the Islamic World Academy of Sciences (2012), **Authors: Ahmed Djebbar, Cecile de Hosson and David Jasmin (ISBN: 978-9957-412-23-4)**.
- *The Essentials of Science, Technology and Innovation Policy* – Published by the Islamic World Academy of Sciences (2013), **Author: Omar Abdel Rahman (ISBN: 978-983-9445-95-4).**

Periodicals

- *Medical Journal of the Islamic World Academy of Sciences* (ISSN 1016-3360) – quarterly. Honorary Editor: **Prof. Şinasi Özsoylu**, Responsible Editor: **Dr Nedim Aytekin**.
- *Newsletter of the Islamic World Academy of Sciences* – quarterly. Chief Editor: **Moneef R. Zou'bi**.
- *Islamic Thought and Scientific Creativity* (in Arabic) **-** quarterly Journal of the Organisation of the Islamic Conference (OIC) Standing Committee on Scientific and Technological Co-operation (COMSTECH). Arabicised version published by IAS with the support of the Royal Academy for Islamic Civilisation Research (Al-Albait Foundation) (publication ceased in 1996).

Other Publications

- An *Overview* of the IAS, Chief Editor: **M. R. Zou'bi.**

- IAS Postcards.

APPENDIX I

IAS SUPPORTERS

The Hashemite Kingdom of Jordan
The Islamic Republic of Pakistan
The State of Kuwait
The Republic of Turkey
Malaysia
The Republic of Senegal
The Republic of Sudan
The Islamic Republic of Iran
The State of Qatar
The Republic of Tunisia
The Kingdom of Morocco
The State of Sarawak/Malaysia
The Republic of Indonesia
The Republic of Tatarstan/ Russian Federation
The State of Selangor/ Malaysia
The Sultanate of Oman
The Republic of Kazakhstan
The Republic of Bangladesh

The OIC Standing Committee on Scientific and Technological Co-operation (COMSTECH), Pakistan.
The Islamic Development Bank (IDB), Saudi Arabia.
The OPEC Fund for International Development, Vienna, Austria.
Arab Fund for Economic and Social Development (AFESD), Kuwait.
Arab Potash Company, Jordan.
United Nations Educational Scientific and Cultural Organisation (UNESCO), France.
Islamic Educational Scientific and Cultural Organisation (ISESCO), Morocco.
The World Bank, USA.
The United Nations Environment Programme (UNEP), Kenya.
Kuwait Foundation for the Advancement of Sciences (KFAS).
Turkish Scientific and Technical Research Council (TUBITAK).
The Royal Scientific Society (RSS), Jordan.
Pakistan Ministry of Science and Technology.
Ministry of Science, Technology and the Environment, Malaysia.
University Cheikh Anta Diop, Dakar, Senegal.
Ministry of Higher Education and Scientific Research, Sudan.
National Centre for Research, Sudan.
Ministry of Culture and Higher Education, Iran.
Iranian Research Organisation for Science and Technology (IROST).

The Academy of Sciences, Tehran, Iran.
The Academy of Medical Sciences, Tehran, Iran.
Saudi Arabian Oil Company, Saudi Arabia (ARAMCO).
Ihlas Holding, Turkey.
Arab Bank, Jordan.
Jordan Kuwait Bank, Jordan.
Rafia Industrial Company, Jordan.
Secretariat of State for Scientific Research and Technology, Tunisia.
Academy of the Kingdom of Morocco.
Petra Private University, Jordan.
Higher Council of Science and Technology (HCST), Jordan.
Pakistan Academy of Sciences.
Majlis Islam Sarawak, Malaysia.
Tabung Baitulmal Sarawak, Malaysia.
Sasakawa Peace Foundation, Japan.
Royal Jordanian Airlines, Jordan.
Arab Jordan Investment Bank, Jordan.
National Centre for Human Resources Development, Jordan.
Al Bukhary Foundation, Malaysia.
Bilkent University, Turkey.
US National Academy of Sciences, USA.
International Islamic Charity Organisation, Kuwait.
Perdana Leadership Foundation, Putrajaya, Malaysia.
Arab Gulf Programme for United Nations Development Organisations (AGFUND), Riyadh, Saudi Arabia.
Fouad Alghanim & Sons Group of Companies, Safat, Kuwait.
Saudi Basic Industries Corporation (SABIC), Riyadh, Saudi Arabia.
World Islamic Call Society, Tripoli, Libya.
Tatarstan Academy of Sciences, Tatarstan, Russian Federation.
Jordan Phosphate Mines Company, Amman, Jordan.
University of Industry of Selangor (UNISEL), Shah Alam, Malaysia.
International Islamic Academy of Science and Biotechnology (IIALSB), Shah Alam, Malaysia.
Ministry of Foreign Affairs of Qatar: The Permanent Committee for Organizing Conference, Qatar.
Doha International Centre for Interfaith Dialogue (DICID), Qatar.
R.B. Suleimenov Institute of Oriental Studies, Kazakhstan.
Prime Ministry of Bangladesh, Bangladesh.
Foreign Ministry of Bangladesh; Bangladesh.
University Grants Commission of Bangladesh, Bangladesh.
Bangladesh Academy of Sciences, Bangladesh.
Sheikh Mohammed bin Hamad Al Thani, Qatar.
Eng. Awni Shaker Al Aseer, Saudi Arabia.
Eng. Amjad Abu Aisheh, Jordan.
Jordan Islamic Bank, Jordan.
Dr Mahmood Abdel Razzak Abu Shaireh, Jordan.

Necmettin Erbakan Üniversitesi, Konya, Turkey.
Turkish Academy of Sciences (TÜBA), Ankara, Turkey.

APPENDIX J

IAS Waqf	IAS Endowment Fund
Islamic World Academy of Sciences Jordan Islamic Bank Shemeisani Branch Account No.: 809/$91 Telephone : +962 6 5677107 Facsimile: +962 6 5691700 PO Box 925997 Amman 11110 Jordan.	Islamic World Academy of Sciences Arab Bank Fifth Circle Branch Account No : 0134/034765-5/710 Telephone : +962 6 5526870 Facsimile: +962 6 5526874 PO Box 141107 Amman Jordan.

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http://www.iasworld.org

Medical Journal of the IAS on the Internet
http://www.medicaljournal-ias.org