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Contours of South-South Cooperation and Biotechnology in Asia: Strategising for Agricultural and Industrial Growth

In several Asian economies, biotechnology is being adopted for harnessing development and efforts are on for integrating biotechnology in the national development plans. While some countries have progressed well, many others continue to face challenges in terms of sustaining the momentum and are facing problems in moving beyond the initial stages, particularly in wider application and commercialisation of biotechnology.

This policy brief suggests that a focused approach to biotechnology is essential for developing countries in Asia and calls for closer interaction and effective collaboration among countries and among various funding agencies, bilateral/multilaterals, besides UN agencies. While the potential of biotechnology is obvious the progress so far is the proof of the pudding. Hence the lessons learnt so far combined with well developed strategies will propel many countries to the next stage of developing and utilization of biotechnology.

This policy brief has identified some issues that deserve attention lest the bottlenecks should impede the utilisation of biotechnology. It advocates some plans besides increased commitment from national governments, aid agencies and UN agencies. The progress in Africa is gathering momentum and this progress has to be sustained. South-South cooperation (SSC) can play an important role in this. While some problems are specific to the respective countries some common problems are faced by many countries and finding innovative solutions for them would benefit all these countries.

Biotechnology in Asia

It is evident that biotechnology has taken deep roots in Asia. Large as well as small economies are giving more importance to biotechnology now. As a result, there is a new dynamism in biotechnology policy and funding in Asia. In many countries it is the state that promotes biotechnology by investment, policy frameworks, through public-private partnerships and by identifying priority sectors/areas in biotechnology. In some countries biotechnology is integrated into the broader framework of research funding for new and emerging technologies (see Table 1).

In 2010 China's National Science Foundation approved 2250 projects in biotechnology area, amounting to Yuan 0.73 billion and accounting for 16 per cent of the total S&T projects approved in China. The investment in biology and biochemical sectors increased more than three times during 2003-2008 and current investments exceed Yuan 20 billion. In 2009, the Federal Government allotted Yuan 5.1 billion under the National High-tech R&D Programme. The funding is for developing more than 40 drugs and vaccines, besides supporting projects in biochips, industrial microbes and fermentation technology. Another programme that included functional genome of silkworm and rice was allotted Yuan 2.6 billion in 2009.

RIS Policy Briefs are prepared to communicate results of RIS research on specific policy issues to the policy makers. This policy brief is prepared by Dr. Sachin Chaturvedi, Senior Fellow, RIS; Dr. K. Ravi Srinivas Associate Fellow, RIS; and Mr. Kunal Sinha, Research Assistant, RIS on the basis of the discussions at the 5th Asian Biotechnology and Development Conference, held at Kandy, Sri Lanka in December 2010.

Box1: China: Biotechnology in Agriculture and Biofuel Production

In 2008 the biotechnology agriculture market in China is valued at 51 billion yuan, of this biotechnology plants constitute 70 per cent while animal vaccine constitutes 10 per cent and biopesticides constitute 12 per cent. In transgenic cotton 93 per cent of the area under transgenic cotton is based on the technology developed by Chinese Academy of Agricultural Science. This accounts for 70 per cent of total area under cotton cultivation in China. China is now making the transition from grain based fuel ethanol to ethanol based on non-food crops like sweet sorghum and lignocellulosic feedstocks. For this China is investing heavily in biotechnology R&D to develop processes and technology. In 2007, China built up the first ethanol company based on cassava in Guangxi Province with an annual output of 200 thousands tons. This is expected to be a substitute for the use of 200 thousands ton gasoline used in the province annually.

China thus has investments in biotechnology which are diversified across sectors[1] (see Box 1).

In South Korea the average annual growth rate had been 14 per cent during the last three years. The turnover of pharmaceutical and bio-industry was more than $13 billion in 2008 and it is estimated that in 2010 the turnover is more than $15 billion. The total investments in biotechnology increased to $ 4856 million in 2008 from $ 2038 million in 2002[2] (see Table 2) .

Singapore is giving importance to biomedical industry and one of the objectives is to emerge as a global destination in that sector. For this it has devised programmes to attract investment and human resources in this sector. It is estimated that biomedical industry will have a turnover of $20 billion, employing 10,000 people in 2010. Singapore is integrating the thrust to biomedical sector with its policy on medical tourism and support to research in life sciences. The Economic Development Board of Singapore (EDB) envisages that Singapore will be a key business base for top ranking world-class companies in biomedical sector and emerge as a regional centre for clinical trials and drug development. For this EDB has invested in R&D, Human Resources Development, and nurtured start-up companies by co-investments and venture capital in this sector. Between 2003 and 2010 many initiatives like Regional Emerging Diseases Intervention (REDI) Center, Centre for Molecular Medicine, Duke-NUS Graduate Medical School, NUS-GSK Initiative for Health in Asia (NIHA) and BioPolis hub for biomedical research were launched to enhance the capacity in R&D as well as in human resources.[3]

Table 1: National Policy Framed/Biotechnology Strategy and Biosafety Rules – A Sample

Country	Year *	Biosafety Rules
Bangladesh	2010	Implemented
China	1990	Implemented
India	1983	Implemented
Indonesia	1990	Implemented
Japan	2002	Implemented
Korea	2004	Implemented
Malaysia	2005	Implemented
Nepal	2006	Implemented
Pakistan	2009	Implemented
Iran	2004	Implemented
Singapore	2006	Implemented
Sri Lanka	2009	Implemented
Thailand	2004	Rules being drafted

**- Year of policy formulation/ last revision*

1 Li Zhe. 2010. "History, Hot Spots and International Cooperation of Biotechnology in China." Pesentation made at the 5th ABDC, Kandy Sri Lanka.

2 Lim Dongsoon. 2010. "The Statistics and Economic Perspectives of Biotechnology Industry in Korea." Pesentation made at the 5th ABDC, Kandy Sri Lanka.

3 Hong Phua Kao. 2010. "The Biomedical Industry and Medical Tourism in Singapore." Pesentation made at the 5th ABDC, Kandy Sri Lanka.

Table 2: Sales and Growth Rate of the Korean Bio-industry (mil. US$ %)

Year	2002	2004	2006	2007	2008	CAGR(02-07)
Biopharmaceuticals	691	1,047	1,313	1,814	2,179	21.1
Biochemicals	122	154	218	252	298	16.1
Biofoods	957	1,137	1,463	1,416	1,460	7.3
Bioenvironmental	105	121	175	216	230	14.0
Bioelectronics	9	17	28	62	67	38.9
Bioprocesses and equipment	74	49	80	91	284	25.0
Bioenergy and bioresources	46	10	17	27	68	6.8
Bioassay, bioinformatics and R&D service	34	69	105	118	270	41.1
Total	2,038	2,604	3,400	3,997	4,856	15.6

In West Asia many countries have both the nuclei of basic infrastructure and human resources capacity in biotechnology, molecular biology in plants, animals and biomedicine. In this region tissue culture and molecular markers are the main applications while some countries like Iran and Turkey have capacities for producing GM crops. In Iran itself there are 46 research and academic institutes, involved in biotechnology research. Biotechnology is ensconced in many of the technology parks in Iran. Iran has a biotechnology policy and applies genetic engineering for production of transgenic crops and in animal biotechnology, including producing clones of animals and transgenic animals like transgenic goats.[4]

Smaller economies are investing in and promoting biotechnology commensurate with their capabilities and resources. For example, Vietnam has invested about US $10million in biotech in 2010. Vietnam is producing biopesticides and is applying tissue culture while it is considering development and cultivation of GM crops.[5] An interesting development is Biocon and Avasthagen, both based in India are investing in biotechnology in Malaysia.

Sri Lanka and Nepal have embarked upon National Plans for Biotechnology Development and this is expected to give a big boost to biotechnology in both countries.

In India, the government invested about 600 US$ million in 2010 in biotechnology. In terms of capacity building also there are many initiatives ranging from new centers for advanced research to programmes that encourage young scientists to pursue research in biotechnology.[6] These are supplemented by multilateral initiatives and programmes like Grand Challenges Programme of Gates Foundation. Over the years South Korea has entered into many bi-lateral ventures/projects in developing countries. The public sector in Asia is also enhancing its capability and this is evident in development of GM crops using Bt gene technology developed by public sector in India and China. The increase in the number of patents in biotechnology, number of publications in SCI and other indicators like number of persons skilled/qualified in biotechnology also show that biotechnology has been in the upswing in Asia . The thrust given by the national governments is an important factor in this growth and the private sector response has also been positive. Recent developments in Africa indicate that national governments are giving priority to biotechnology and many new initiatives have been taken in capacity building (see Box 2).

Appropriate Technology

The economies in Asia need to realise that there is more to biotechnology in agriculture and forestry than transgenic plants. Within Asia, there are several economies which need support and hand-holding in this area. The tissue culture technology has been well adopted to suit diverse needs in many countries like Malaysia, India and Sri Lanka in both agriculture and forestry. The factors that limit application of non-GM technology in agriculture should be identified. Often countries lack the capacity to apply tissue culture on a massive scale and to train farmers and communities to use them. But as at least half a dozen countries in Asia-Pacific have now applied non-GM technologies widely, there is enough scope for South-South

4 Ofoghi Hamideh. 2010. Presentation made at the 5th ABDC, Kandy Sri Lanka.

5 Thanh Vu Nguyen. 2010. "Bio-Industry in Vietnam: Overview and Prospective." Pesentation made at the 5th ABDC, Kandy Sri Lanka.

6 Rao S.R.2010. "India's Path to Innovation in Life Sciences and Biotechnology." Pesentation made at the 5th ABDC, Kandy Sri Lanka.

collaboration in this. It is suggested that the capacity of various countries to use/apply GM and non-GM technologies be assessed *vis-a-vis* their needs. Based on this technological needs assessment and capacity, action plans can be designed to encourage technology transfer and collaboration among developing countries and such collaboration would need access to technologies and facilities to succeed. These can be integrated with the regional/bi-lateral S&T capacity building/aid programmes.

Appropriate technology for small and marginal farmers in different crops and horticultural plants may provide a major boost to their incomes by increasing yield and returns on quality produce. It is possible to produce large-scale multiplication of superior clones of various species using tissue culture and the plants produced through this technique may also be fortified with suitable mycorrhiza for better establishment in the field for improved growth.[7] However, there is no need to reinvent the wheel in this regard. The focus should be on certified seed programme for crops like potato, ginger, turmeric, etc. and grafted crops like apple, citrus, etc. There may also be a focus on ecologically important crops and on endangered and threatened crops. There may also be a focus on introduction and multiplication of exotic germplasm of high potential.[8]

In countries like Bhutan, which are rich in biodiversity, the focus can be on bioprospecting and sustainable use of bioresources particularly medicinal plants and plants that are endemic to that region. There is much scope for South-South co-operation in this. In Sri Lanka tissue culture technology in plantains has been successfully transferred to poor and marginal farmers and has resulted in increase in their incomes and yields besides increase in export revenue for the country. Such examples indicate that appropriate biotechnology is an important option for developing countries in increasing productivity as well as growth. These can be used as part of poverty alleviation strategies if they are planned and targeted properly. In this context it is important that developing countries should assess their microbial resources and their potential for development purposes. A country specific programme on appropriate biotechnologies ranging from biopesticides, and tissue culture to enzymes and vaccines can go a long way in matching the needs and capabilities of countries that lack resources and capacity to apply biotechnology in all sectors.

The Malaysian experience in tissue culture in forestry sector is worth emulating by other countries.[9] Malaysia has used tissue culture extensively in forestry, and in vitro germination and plant production in a mass scale has been undertaken. The advantages include quality plants suitable for commercial application. Using tissue culture technology 12 species are commercially produced.

This calls for a well designed strategy to introduce tissue culture in resource poor countries, particularly in Africa. In this there is enough scope for South-South Collaboration. Initiatives like the DBT supported platform for transgenics at ICRISAT can be helpful in shortening the time needed to develop new varieties and if this succeeds this model can be replicated elsewhere.[10] But what is equally important is that countries should identify the microbial resources that can be used effectively by applying biotechnology and bioinformatics. They should develop plans to harness them and marine biotechnology is an important area that deserves more attention. As tissue culture technology can be used by many countries that are yet to acquire the capacity to develop GM products and apply them widely, it is important that the tissue culture technology is chosen by these countries to increase productivity and to offer new technology to small and medium farmers who may be able to benefit from these technologies.

Human Resources

The importance of human resources in biotechnology need not be over-emphasized. Development and utilization of human resources in biotechnology in the Asian economies is highly uneven. In this context there is a need to go beyond the numbers and focus on both quality and capacity. While in some countries like Singapore, there are incentives for highly qualified personnel to move into, in many other countries the decline in national agricultural research system coupled with lack of trained human resources at the university level poses a serious challenge to the biotechnology plans of those countries. As biotechnology demands expertise in various sub-fields and as biotechnology today is often applied

7 Saxena Sanjaya. 2010. "Micro-Propagation Park at TERI." Presentation made at the 5th ABDC, Kandy Sri Lanka.

8 Ibid.

9 Kandasamy Isparan Kodi. 2010. "Malaysian Experience in Biotechnology." Presentation made at the 5th ABDC, Kandy Sri Lanka.

10 Sharma K. K. 2010. "Translational Platform for Transgenic." Presentation made at the 5th ABDC, Kandy Sri Lanka.

with bioinformatics, nanotechnology and information and communication technologies, it is essential that human resources are developed in biotechnology as well as in supporting fields and technologies. Countries like India, China and South Korea have invested heavily in human resource development in biotechnology building upon their university and higher educational institutional capacities, but this option is not available to many developing countries as they lack resources including finance to embark upon such plans. On the other hand such countries can still develop sufficient capacity in human resources by dovetailing their human resources development strategy with their S&T policy and biotechnology policy.

It may not be necessary that all developing countries should invest heavily in basic research in biosciences to the extent of spreading their resources too thin. Rather they may think in terms of developing capacity to apply biotechnology and undertake applied research and development. For many developing countries, developing an appropriate human resources strategies cannot be viewed in isolation of the human resources capacity and capability in National Agricultural Research Systems (NARS). Hence it is important that countries should invest in enhancing the human resources in NARS for biotechnology as well as in setting up research centers in biotechnology besides supporting biotechnology in higher education. In our view agencies like UNESCO can help developing countries in human resources development. The programme sponsored by the Government of Japan in human resources development in Asia is an example of a successful programme that has helped many countries. Such programmes can be replicated and the lessons learnt therefrom in can be used widely.

Biotechnology Statistics

The importance of statistics for policy making and research is obvious. In statistics relating to biotechnology there are many gaps and often there is no credible statistics that can be used for analysis. One of the problems is in the definition of biotechnology and how countries classify sectors in biotechnology. But this is not an insurmountable problem as the OECD economies have evolved a definition and on the basis of that data is being collected for last several years. Asian and other developing economies may us the same definition or may consider making necessary amendments, so as to capture various stages of biotechnology and start collecting their own statistics. The idea is to provide policy makers with credible data on human resources, investments, production, imports, exports and consumption.

As a result, there is a wide variance in statistics that emanates from different sources. Lack of capacity in data collection and analysis can be an issue here and this needs an urgent attention because in the absence of credible and reliable data it is difficult to assess the impacts of biotechnology as well as to develop appropriate strategies. These issues relating statistics on biotechnology have been discussed in the earlier conferences as well. As more countries are investing in biotechnology and as countries that are ahead in biotechnology are stepping up their investments and developing strategies for application biotechnology in a wide range of industries and services the importance of statistics becomes all the more obvious. Today biotechnology is applied widely in agriculture and industries and biotechnology in service sector is emerging as an important contributor to biotechnology sector. The growth of Contract Research Organizations (CROs) in India, the boom in medical tourism/health services across borders and globalization of biotechnology R&D cannot be ignored. But in the absence of valid data on these it is difficult to assess their costs and benefits and their socio-economic impact including jobs created and foreign exchange earned.

For this there is need to develop a time bound action plan so that this issue is addressed immediately. To begin with, a survey of available statistics and mechanisms/institutional frameworks for such collection and analysis can be undertaken to find out the gaps, strengths, issues in methodology and comparison of data across countries over a period of time. If this problem is addressed adequately, the efforts will bear fruit within the next few years and in subsequent years the availability of reliable data can be taken as matter of fact than faith.

Innovation Systems' Approach

Utilization of biotechnology cannot be considered in isolation of the overall capacity to innovate and adopt technology. Many countries

which are global leaders in biotechnology innovation could emerge as leaders as they had developed sufficient capacity to innovate and benefit from biotechnology when biotechnology's potential became obvious in the late 1970s and early 1980s. They either had other factors like regulatory capacity, well developed industry, universities and research institute that can do research on basic life sciences and policy framework that enabled them to make optimum use of biotechnology or developed them over the years. It has been shown that even late comers can catch up with other countries in biotechnology, at least in some sectors, for example, Malaysia in forestry, genetics if they have the capacity to innovate and invest.

As of now the literature on biotechnology innovation and innovation capacity in developing countries is found wanting in many aspects. There are many studies that focus on a single sector like health or agriculture but there are no studies that provide an in-depth analysis of biotechnology innovation in developing countries contextualizing that in the overall framework national capacity in innovation and the policy frameworks in vogue. As pointed out earlier, dearth of reliable statistics is a major issue. As countries are planning to give more importance to biotechnology and are increasing their budgetary allocation on biotechnology, it is important that their capacity for innovation in biotechnology is assessed and the strengths and weaknesses of the National Innovation Systems (NIS) are identified so that countries can develop policies that are realistic and that enable them to identify gaps in the NIS.

It is suggested that an Innovation Survey on biotechnology in developing countries is undertaken. The survey can be done jointly by a network of institutes working in science and public policy studies. The survey will have both quantitative and qualitative aspects and will supplement the current literature on NIS. It will be based on a methodology that will be applied uniformly. The survey is expected to bring out information and analysis that can supplement what is available. Such a survey will be of relevance and use to policy makers, academics and industry. It can supplement similar studies done by other agencies in various other sectors like UNCTAD in the realm of ICT.

Intellectual Property and Regulatory Issues

Intellectual property rights and Freedom to Operate are important issues in developing countries as IP rights can be used to deny technology or restrict its transfer while Freedom to Operate is essential for plant breeders and scientists to develop new varieties, new products.

Adoption of Nagoya Protocol on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits arising out of their utilization is an important step forward. The working group negotiations can be described as "sinusoidal" with highs and lows over a period of six years that included nine meetings, with the 9th meeting spread over three sessions that culminated at the 10th COP.[11] The negotiations almost failed but for some skillful backroom diplomacy.

There are several key challenges one may face like the enhanced pace of patenting of genes and genetic materials, lack of funding for meeting various capacity needs and required technological support. It would also be an important issue to see whether adequate ratification by user and provider parties is coming through and what if major user countries do not ratify.[12]

Some of the key challenges developing world is facing at this point are as follows: lack of will to push for the long pending review of Article 27.3 of TRIPS; pressing demand for data exclusivity under the Article 39.3 of TRIPS; and continued demand for harmonsation in biotech R&D under GATS and product patents in biogenerics.[13] The pressure through TRIPS-Plus provisions and WIPO's Substantive Patent Law Treaty (SPLT) are some of the other challenges.

The developing countries need to compare costs and benefits when considering the monitoring and enforcement aspects of GMO regulations and balance them between the potential environmental and health risks *vis-a-vis* economic interest.[14] While doing so risk analysis and compensation mechanism also needs to be developed. We need to think on issues like what kind of regulations we need, what exactly should be regulated, how strict they should be, how GMOs should be regulated compared to their conventionally bred counterparts, and what is the impact of regulation on the trade of GM products and on the research and development climate for GMOs.[15]

11 Parayil Govindan. 2010. "Way from Nagoya on ABS: Concerns for CBD." Presentation made at the 5th ABDC, Kandy Sri Lanka.

12 Ibid.

13 Tripathi K. K. 2010. "IPR and Technology Transfer: Experience from India." Presentation made at the 5th ABDC, Kandy Sri Lanka.

14 Chaturvedi Sachin. 2010. "IP and Challenges Before Developing Countries." Presentation made at the 5th ABDC, Kandy Sri Lanka.

15 Ibid.

Box 2: Biotechnology in Africa

Biotechnology is taking roots in Africa and this is happening across the regions in Africa. The 8th AU summit in Addis Ababa in Jan. 2007 endorsed the development of a 20-year African Biotechnology Strategy. As of now in many countries like Kenya, Tanzania, South Africa, Nigeria, Mozambique, and Zimbabwe GM crops with different traits like heat tolerance, drought tolerance, starch enhanced, and insect resistance are either being developed or are undergoing trials. South Africa has successfully commercialised Bt cotton.[16] A major hurdle in Africa is the lack of human resources and regulatory capacity. Initiatives have been taken to address both, for example, AU-NEPAD supported Agency African Biosafety Network of Expertise (ABNE) has been founded to enhance the capacity to address biosafety issues and to build a Pan-African network of experts. Regarding biosafety frameworks 12 countries have developed National Biosafety Frameworks (NBFs) while 11 countries have interim NBFs and 30 countries have no biosafety frameworks or are in the process of developing NBFs. A major issue in Africa is the lack of private sector investment in biotechnology and as a result biotechnology is largely driven by public sector. Now that the funding agencies have taken the position that Africa which missed the Green Revolution largely, should not miss the biotechnology revolution in agriculture, biotechnology in Africa is likely to get more funds in the future. This importance for biotechnology also provides immense scope for Asia-Africa co-operation in biotechnology, particularly in investment, human resources development and development of regulatory capacity.[17]

Climate Change

Climate Change is emerging as a major issue in agriculture on account of its impact on food production and food security. Integrating biotechnology in the agricultural research and development agenda is hence very important for developing countries which are expected to be affected by global climate change. CGIAR centers and National Agricultural Research Systems are involved in meeting these challenges.[18] Biotechnology can be used to meet the triple challenge of responding to climate change, increasing food production and maintaining sustainability of agriculture. But there are many challenges like the capacity of developing countries and LDCs to take advantage of biotechnology in this and availability of resources for this.[19] Biotechnology is used in developing flood tolerant and drought resistant varieties. Biotechnology may also be used to unravel the mechanisms and metabolisms in plant so that plants, that can cope up with abiotic stresses, can be developed.

Developing countries hence should integrate biotechnology in the agricultural and food production strategy as well as in adaptation and mitigation strategies to meet the challenges arising on account of global climate change. In this they would need assistance from UN agencies, like CGIAR while South-South co-operation at regional level is another option that has to be harnessed.

Potential for South-South Cooperation

The application of biotechnology to solve the problems of low agricultural productivity, enhancing food security and meeting health needs of a growing population demands policy intervention and crafting appropriate strategies that enhance the innovative capacity and integrating biotechnology policy in the overall development strategy. Biotechnology offers immense scope for South-South Cooperation and learning from other countries as well using the facilities available in other countries. Some of the successful collaborations are:

- Developing diagnostic for Chagas disease - Brazil-Argentina collaboration;
- Developing Cholera vaccine in India - Bangladesh collaboration;
- China-India collaboration on mitochondrial DNA, and
- Brazil and Cuba cooperation to solve health problem of meningitis in Africa

While the opportunities for biotechnology are many, there are numerous challenges that have to be faced. This policy brief analyses the issues in light of recent developments and survey of literature and calls for a focused approach to utilization of biotechnology in development strategy and suggests that UN agencies, national governments and other stakeholders should collaborate in this.

16 Ambali Aggrey. 2010. "Current Status of Biotechnology R&D Capacity in Africa." Presentation made at the 5th ABDC, Kandy Sri Lanka.

17 Makinde Diran. 2010. "Biotech and Society Interface: Concerns and Expectations." Presentation made at the 5th ABDC, Kandy Sri Lanka.

18 Sharma K.K. 2010. "Integrating biotechnology into agricultural research and development agenda." Presentation made at the 5th ABDC, Kandy Sri Lanka.

19 Srinivas K.R. 2010. "Biotechnology, sustainability and climate change." Presentation made at the 5th ABDC, Kandy Sri Lanka.

South-South cooperation is an important phenomenon in biotechnology as countries are in different stages of development and are using biotechnology cooperation which can go a long way in transfer of technology, capacity building and enhancing the capacity to adopt technologies and joint development of products. We suggest following areas for cooperation. Many factors negatively impact potential for collaboration and these include trade barriers, restrictions in FDI, differences in regulatory systems and capacity of firms to absorb technology.

- Unlike ICT, there is no global mechanism for collecting reliable statistics on capacity and level of industrial activities across Asia. There is an urgent need to launch a credible initiative in this regard.
- National governments should devote more resources to collection of statistics and in undertaking surveys and data collection regularly. Capacity building is also an issue here and needs to be addressed.
- Organizations like OECD, UNESCO's Institute on Statistics can help developing countries in this. UN agencies like UNU-IAS, UNIDO, FAO, UNCTAD and development funding agencies like the World Bank and ADB, etc. can support initiatives in biotechnology statistics.
- South-South collaboration in biotechnology can be transcontinental involving both public and private sectors. Successful examples of South-South collaboration in development of vaccines, diagnostic kits and in mitochondrial DNA research indicate that skills and capacities can be complemented resulting in win-win outcomes.
- The level of cooperation may vary from country to country. In case of first generation biotechnology, contractual research/production for development of micropropagation protocols for new crops suitable for appropriate business needs may be initiated.
- National governments should work together to reduce these barriers and foster more collaboration. Various institutional mechanisms like bilateral/trilateral councils can be formed to identify and prioritize south-south collaboration in biotechnology.
- Specific funds can be set up to facilitate such collaboration while institutions in South should be encouraged to work more on South-South collaboration. Some of the UN agencies, that are encouraging SSC approach involving other agencies and funding agencies, can go a long way in giving a fillip to these efforts.

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