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Benefits of new tools in biotechnology to developing countries in south Asia: A perspective from UNESCO

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ABSTRACT

South Asia, once considered as a laggard, has grown at about 6% on average over the past two decades and the current growth outlook is much brighter. However, this growth is not always well distributed and the challenges of institutionalising policies and mechanisms to ensure inclusive growth are now being seriously considered by these countries governments.

The targets set by south Asian countries are primarily based on the investments in infrastructural sector with an objective to generate educated and skilled human resources. The other most important inclusive growth area is the core public services; Agriculture, Health, and Energy, which are increasingly becoming technology driven. Biotechnology has been increasingly seen now to be an area of technology that holds the greatest new potential to address problems arising from low productivity, overburdened health systems, high-cost unsustainable energy supplies and the need for developing new materials for industrial and environmental applications.

This article attempts to highlight perspectives on some of the emerging areas of biotechnology that have good potential for economic development in the context of south Asia, as well as discuss briefly some of UNESCO's initiatives in biotechnology for that region.

1. Introduction

A large number of national government's, have taken cognizance that biotechnology can provide valuable tools for meeting a number of developmental challenges in different areas of development (UN General Assembly Resolution 58/100, document A/60/184 of 2 August 2005). In agriculture for instance, the United Nations estimates that, by 2050, the world will need to increase food production by 70% if we are to avoid global food shortages (FAO, 2009a). Biotechnology can address this issue via the use of crop genomics, biofertilizers and integrated pest management. Biotechnology can also be used to render plants resistant to droughts, floods and diseases, to fortify crops to combat human diseases such as vitamin A deficiency or anaemia caused by iron deficiency in undernourished populations, or to provide alternative sources of fuel (biofuels). Biotechnology has already revolutionized the health care system with new diagnostic tools, medicines and drug delivery systems.

The Asia-Pacific region, with its rapid economic expansion, has benefited from the use of these tools to address some of its developmental challenges of low crop productivity, overburdened health systems, high-cost unsustainable energy supplies and the need for new materials for industrial and environmental applications. In economic terms, Asia-Pacific biotech revenues have grown by 25% in 2008 (Burrill et al., 2008; Ernest and Young, 2009) with several countries, including China, Singapore, India, Indonesia, Malaysia, Philippines and Thailand investing heavily in biotechnology sector, closely following the OECD members in Asia-Pacific, viz. Japan and South Korea (OECD, 2008).

However, despite this bright outlook, there are also huge variations in the way some of the countries, particularly in south Asia (Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka) are benefiting from biotechnology. On one hand, there is India who has been investing heavily in the sector, generating revenues to the tune of USD$2 billions in 2006/7 and having over 3000 patents related to the biotech industry from 1995 to 2004 (Department of Biotechnology, India; Annual Report, 2009). On the other hand, there are several countries which are just at the first generation technologies (like Bangladesh, Pakistan and Sri Lanka) and in some countries, the technology is not widely applied (like Nepal, Bhutan and Maldives, where the focus has been mainly on tissue culture) (*for overall review of each country, please see* UNESCO, 2009). The greatest challenge lies, firstly, in amassing sufficient human capital capable of sustaining scientific and technological enterprise (Frew et al., 2007), secondly, the political will and management foresight required to harness the developing technologies and, thirdly, having the ability to seek unique but efficient research, development,

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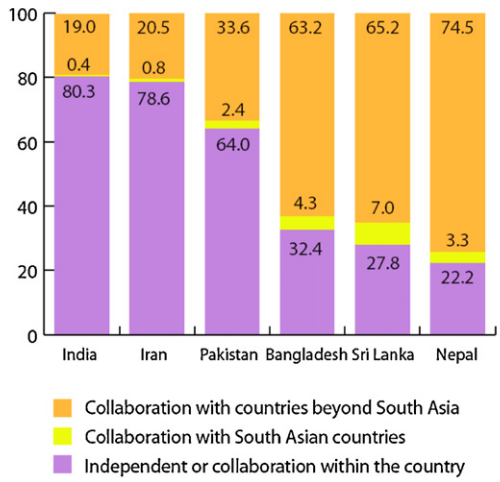

Fig. 1. Scientific collaboration involving south Asian authors, 2007 (%). *Note*: Data concern published articles and proceedings only from the Science Citation Index Expanded, Social Sciences Citation Index and Arts and Humanities Citation Index. *Source*: UNESCO Science Report 2010, data taken from Thomson Reuters Web of Science database.

production and marketing strategies in tune with an evolving intellectual property right regimes (Dutfield, 2009). However, there are some positive positions taken by some governments in terms of the research policies being put in place and direct investments in the biotechnology sector. For example, in Nepal, the percentage of biotechnology share of the total S&T budget, figured at US $125 million in 2008, has been around 40%. A National Biotechnology Research and Development Centre is also being set up based on the 2006 Biotechnology Policy (Adhikari, 2009).

Another determinant for having a sound biotechnology sector is building adequate national capacities in the basic sciences (UNESCO, 2007a). Efficient applied research, technology transfer, modern education, health care, environment care and innovation, all call for a sound national infrastructure for the basic sciences and necessitate a commitment to strengthen capacities in basic sciences through national efforts and international co-operation. Notwithstanding this, many developing countries today are decreasing their support for the basic sciences or are quite simply providing insufficient funding. This is contrasted, for example, in how the abundance of scientists and engineers with intellectual capital and the flexibility to interact between academia and industrial clusters, seen largely in north America and Europe, have accelerated the growth of the biotechnology sector in the past two decades (UNESCO, 2010).

Regional cooperation is seen as one important way to bridge these gaps. The sharp GDP growth in south Asia region (6% on average over the past two decades) has provided strength in terms of prudent fiscal policies and ambitious social expenditure policies, which in turn resulted in national governments building impressive institutional infrastructures, networks and capabilities in different areas of biotechnology (Asian Development Bank Outlook Report, 2009). However, these countries have not been able to exploit fully their synergies and expertise in the sphere of biotechnology for mutual benefit (generation of employment, creation of intellectual wealth and enhancing industrial growth) (UNESCO, 2010, Fig. 1). The recently established University of South Asian Association for Regional Cooperation (SAARC) – is looked upon as a platform for capacity development efforts through specific research plans in science and technology with precise goals and objectives (7th Inter-Governmental Meeting on the Establishment of South Asian University, New, Delhi, 21–22 September 2010). SAARC has recently taken initial steps to initiate cooperation in biotechnology joint research and fellowship programmes amongst its members states (3rd Meeting of the Working Group on Biotechnology, Colombo, 4–5 June 2009) (SAARC, 2010). While regional initiatives are necessary, there is also a need for bilateral and multilateral collaborations, such as those undertaken through organizations like WHO, UNESCAP, UNESCO, FAO, etc., who over the decades, have helped countries in identifying needs, developing national policies and action plans, framing regulatory regime and in strengthening institutional capacities in biotechnology.

In the 1980s, UNIDO spearheaded the creation of the International Center for Genetic Engineering and Biotechnology (ICGEB) with components in Italy (Trieste), India (New Delhi) and recently in South Africa (Cape Town). Ever since, ICGEB, has been engaged in building national capacity in industrial, agricultural, pharmaceutical, animal and human health biotechnology. It has now more than 30 affiliated centres around the world, some of which have emerged into centres of excellence. Many of the above centres are located in developing countries and countries with economies in transition (ICGEB Annual Report, 2010). They highlight the importance of local research capabilities in the development of the local industrial base. Often times, there is a cultural disincentive to such collaborations; Scientists in Asia have a tendency to look past each other and focus on collaborations with the United States or Europe, partly because these collaborations get them more credit from their school administrations. Notwithstanding the importance of such international cooperation, there is however a need for more regional cooperation. By identifying common regional interest of the participating scientists, the scope of scientific alliances can be widened (Liu, 2008). This is even more imperative in the wake of new multidisciplinary areas of biotechnology that are coming to surface, promising a paradigm shift in the way we can solve critical problems in agriculture and medicine.

This overview will therefore attempt to present some perspectives on some of these interesting areas of biotechnology and its potential usefulness in the context of south Asian economic and social development as well as discuss UNESCO's recent initiative with the government of India in establishing a regional centre for biotechnology education, research and training for south Asia.

1.1. Biomaterials and bioengineering

According to WHO, there is a growing trend in the percentage of population in Asia that are diagnosed with diabetes mellitus due to hereditary or environmental factors (WHO, 2010). Diabetics must control their blood glucose levels via exogenous administration of insulin. In practice, multiple injections of insulin are administered, but insulin injections cannot duplicate the physiological pattern of insulin release and at the same time it is painful and chances of infection at the site of administration are very high. The oral route is the most familiar, easy and patient friendly. This route, however, is not available for insulin, as it undergoes inactivation by acids and proteases in the gastro intestinal tract. Bioengineering has been able to provide a solution to this problem by developing a pH sensitive oral insulin delivery capsule using cross-linked polymeric structures. New approaches to biomaterials fabrication, often incorporating physical as well as chemical fabrication techniques, have paved the way for new approaches to diagnostics. As in the design of biomimetic medical devices, a crucial aspect of this work is the ability to make information-rich materials that assay multiple targets and allow multiple outputs.

Bioengineering is not only restricted to medical research. Disinfection of drinking water continues to be a challenging problem and more so in a developing and over-populated region like Asia, where majority of population resides in rural areas and do not have access to safe potable water. According to the scientists at the National Environmental Engineering and Research Institute in India, a staggering 70% of the available water in India is polluted and sewage