Biotechnology and Development

Monitor

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Looking back and looking forward

The need to monitor, build new alliances and use new means

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Editorial:

Looking back and

For the last twelve years, to many the Monitor has been a great neutral source of information. It was established as an early 'alert' system. Many of the trends the magazine predicted in the past have now become reality. For example, genetically modified (GM) crops abound; knowledge and information, which were once public property, are now privately patented; and, as an extension of this, much public research has become privatized. Whilst many things have changed over these past 12 years, the need for concise, reliable, impartial and valuable information, articulating the relevance, process and impact of biotechnology on developing countries, remains the same. In fulfilling this need the Monitor continues to occupy a unique position.

This Jubilee Issue briefly reflects on twelve years of rich history. Though its primary focus is on the future, we also deal with the question why monitoring was important in the past, and why it is essential today. We assess various monitoring strategies for gathering information on the impact of biotechnology on developing countries, and explore additional means we could use in order to ensure we continue to receive the information we need.

As Guido Ruivenkamp points out, monitoring is needed to give people the knowledge and capability to influence processes that otherwise might lead to an ever-widening gap between the industrial transformation of agriculture and the social context in which it occurs. He notes that appropriation and substitution – two important long-term processes of industrialization – have become important in biotechnology, leading to the industrial transformation of agriculture. The relevance of his analysis is underlined by Raymond Feddema, who was able to acquire a copy of South Korea's master plan for its future in biotechnology. After having successfully followed a path of industrialization, by 2010 the country plans to become one of the world leaders in biotechnology.
To mark the milestone of a 50th edition, we invited readers to give us feedback on the following questions: what should we monitor and how should we monitor? Due to limitations of space we are not able to print all the contributions we have received; however, some of them are included in this edition.

Several articles discuss the steps taken to provide affected groups in developing countries the means and knowledge to have an explicit and determining role in the future development of biotechnology. In most of these articles, networking plays a central role. In a second article, Guido

Monitoring biotechn
Looking back for fin

Biotechnology is no longer an issue of the future, as it was in the 1980s, but is embedded in specific social processes. The industrial transformation of agriculture and biotechnological developments are influencing each other. The economic concentration in the seeds sector has reached an unexpectedly high level and the relationships both between farmers and seed companies and between farmers and food processing companies are changing. In the past the Monitor has described how biotechnology is interwoven with these social processes. In the near future the Monitor may also pay attention to initiatives that aim to reconstruct biotechnology to locally-specific initiatives.

looking forward

Ruivenkamp argues that the *Tailor-made Biotechnologies Network* is an important means to build up local capabilities and knowledge. Johanna Ulmanen compares Dutch and Swedish approaches to ensuring local capacity building. She shows that while both approaches to development have the same goal – to improve the livelihood of people – they focus their activities on different target audiences, i.e. DGIS on farmers, SIDA on researchers. In a regional seminar organized for the Monitor, Marilyn Minderhoud-Jones describes an approach that brought these two target audiences together, as well as other audiences such as journalists. The link between policymakers and researchers is further explored by George Essegbey, who shows how Ghana is trying to come to terms with biotechnology, and develop an appropriate policy accordingly. Rajeswari S. Raina, discussing innovation capability in India, makes a case for the involvement of social scientists, who are becoming increasingly important not only in the process of translating developments in the science-industries to a larger public, but also in policy research and development. What it means to take stakeholders on board in the field when tailor-made biotechnologies are developed is shown by Jasper Buijs. The process of building up networks, alliances and organizations is not without its problems and Frederik Oberthur makes a case for overcoming predetermined thinking, when discussing possible cooperation between NGOs and *National Agricultural Research Systems* in Brazil.

When it comes to exploring additional tools for monitoring, several authors point to the potential of exploiting online technologies for biotechnology and development. The Community Biodiversity Development and Conservation Program is a global network preparing itself for its next phase of activities, by using interactive technologies to build up knowledge and capabilities in the South. Robert Chakanda explains that this includes the development of an online course on biodiversity and conservation. Interactive and new technologies help develop new channels and forge new networks and alliances, and thus cut across traditional boundaries of space, time and scope, argues Dai Forterre. The Monitor would like to have a similar global impact in biotechnology. The Monitor's unique constituency – at present 5000 subscribers in 130 countries, two thirds of whom are in developing countries – is a network of networks in its own right. The Monitor, entering a new phase in its own development, wants to use additional means to disseminate information. Drawing from an article written by Lara van Druten in 2001, we present some ideas on how the Monitor could reach out and become a dynamic, global and stronger network by the use of interactive technologies.

This Jubilee Issue ends where it begins: by providing some reasons why monitoring may and will be important in the future. In an attempt to gain insight into what the future holds, Philipp Kauffmann notes two current realistic driving forces that might heavily shape the future of biotechnology and the position of developing countries: fundamentalism and utilitarianism. The rights-based approach of many local communities might prove to have less influence than that of a utilitarian approach. Marianne Heselmans describes what would be the basis for a realistic scenario from a Chinese and an Egyptian point of view. Soraj Hongladarom from Thailand introduces another important factor shaping the future of biotechnology: information technology. He argues for a more effective use of information and communication technologies.

The jubilee issue is the springboard to a new era: one in which we will not only continue to be a strong global network of knowledge, but in which we will also strive to be a dynamic thought-leader, using cutting-edge technology to monitor and disseminate information. ◁▶

ological developments: ding new perspectives

From appropriation to control at a distance

Twelve years ago the Biotechnology and Development Monitor was launched to inform the public about the potential impacts of biotechnological developments on the social economic situation of farmers, especially in developing countries. In view of the analysis of the introduction of biotechnology in the agroindustrial production chain (Ruivenkamp 1984-1989) the necessity was felt to warn organizations in developing countries both of the potential trade shifts in agricultural products and of the shifts in power relations between farmers' organizations and transnational food and seed companies.

The analysis has made clear that the development of biotechnology is not isolated but – on the contrary – strongly interwoven with two long-term, historical processes of the industrial transformation of agriculture: appropriation and substitution. However, the analysis has also shown that biotechnology is not only influenced by the specific context in which it is developed, but that it also influences and even modifies these processes. So, it is clear that neither a social nor technological deterministic approach should be followed but an approach in which the mutually influencing relationship between context and technology is taken seriously.

Concerning the industrial appropriation of some biological activities of farming, such as soil fertility and the reproduction of plants through the supply of chemical fertilizers and hybrids, the analysis has shown that biotechnology is influenced by this process as well as reinforcing and changing it. Through the development of tissue culture, cell fusion and r-DNA techniques the seeds companies are becoming increasingly able to intervene more radically and efficiently in the genetic structure of plants and to determine where, when and how a crop should be sown, harvested and processed. Instead of the industrial appropriation of biological activities of the farmers, it is the global use of these new seeds by farmers in different regions of the world that is becoming the main characteristic element of a new social organization of food production. Indeed, plant biotechnology implies that the historical process of an industrial appropriation of farming activities is gradually changing into the control at a distance of the farming activities by the seeds companies. And it is precisely through the supply of these new seeds with specific properties that the companies can program 'from a distance' the way crops are cultivated – with or without herbicides, for example. Wherever the crops are planted, under whatever political regime, their cultivation will increasingly be programmed by the technical/social properties of the seeds. And just as the technical properties of the high-yielding varieties of the Green Revolution (their increased demand for chemicals, for example) have included and excluded certain groups of farmers in certain continents, transgenic plants may also include and exclude specific groups of farmers and therefore may have a socially differentiating effect. Indeed, the analysis makes clear that the social relations between farmers and input-supplying industries are already changing in such a way that farmers will increasingly become 'workers in the open air' for an industrializing agriculture and that the seed companies will increasingly become the actors that program where and how these transgenic crops will be cultivated. It is therefore still necessary to inform the reader about these shifts in the power relations between the various actors of the food production chain. And especially to inform those organizations in developing countries that are dealing with these global shifts in a reorganizing food production system.

From substitution to interchangeability

The second historical process that is reinforced by modern agrobiotechnological developments is the substitution of agricultural raw materials by industrial semi-products and synthetic products. Through the development of new enzymes and microbiological processes, the possibilities for substituting one agricultural raw material by another raw material are increasing. The same analysis has made clear that the new biocatalysts enable food manufacturing companies to extract and produce food components from a broad spectrum of different agricultural and synthetic sources, which have increasingly become interchangeable sources of raw materials for the production of food components. It is no longer the substitution of one product by another synthetic product but the interchangeability of products that is the new main characteristic of the global organization of food production. This also implies changes in the power relationship between farmers and food processing companies. These biotechnological developments enabled the food processing companies to 'liberate themselves' from a specific supply of an agricultural or synthetic product. The borders between different crops and agricultural sectors are fading and the differences both between crops and between their producers are diminishing. Through the industrial application of enzymes, it does not matter anymore whether a sweetener, such as glucose, is made from sugarcane, corn, or sorghum. All these plant materials can be used as a glucose source for the production of beverages, for example. If food products become separated from their specific agricultural sources, it implies that food production can become flexible in the agricultural sources it uses. Evaporated milk can then be made from cows' milk or soya milk. Margarine – not substituting butter but existing alongside it – is increasingly made from various interchangeable plant oils and microbiologically produced fatty acids. Most importantly, however, the production of food products from interchangeable sources implies political-economic changes. The price for a 'flexible and liberated' food production system has to be paid by some social groups. And the main political impact of interchangeability is not only that products and their producers – beyond their sectoral borders – become each other's competitors but also that the traditional organization of farmers and workers around specific crops (e.g. the sugarcane plantation workers) lose their political significance. These social organizations lose their power to negotiate prices and salaries at the point that biotechnological developments make it possible to substitute, for example, sugarcane by high fructose corn syrup made from corn or by aspartame produced by microorganisms.

Shifts in social power relations

The reorganization of food production, strengthened by the introduction of new biocatalysts, is leading to a political involution of those organizations (farmers' organizations and unions) that still aim to aggregate their members around 'vanishing sectors'. At the same time the companies that manufacture these new biocatalysts are getting a tighter grip on the reorganization of the food production, especially when they are also allowed to patent the products and techniques that play a crucial role in the reorganization of global food chains. Biotechnology derives its great political significance from the fact that research and applications are concentrating on the strategic links in the agroindustrial production chain, such as seeds for sowing, basic chemical ingredients, enzymes, amino and fatty acids – products that contribute to the realization of a shift in the power relations between different social organizations. These goods have therefore been labelled as 'politicizing products' because they fulfil a crucial role in the worldwide reorganization of the farming and food production process.

The Biotechnology and Development Monitor started a dissemination of information about these 'politicising biotechnological products', emphasizing that the long-distance supervision of agricultural production, the mutual interchangeability of product groups and their producers, and the patenting of these politicizing products and techniques are becoming core elements of a power shift in the social organization of global food chains. However, the biotechnological developments are changing not only the political landscape of agriculture and food production but also the personal contexts of various actors. And the distribution of information from the Monitor to more than 160 countries, like the information from many other journals, contributed to an increasing debate among scientists, farmers' groups, consumer and environmental organizations on the developments embedded within the industrial transformation of agriculture becoming.

From a pro-anti debate towards a social debate on reconstructing biotechnologies

This debate on the impacts of biotechnological developments became pro-anti in nature. An increasing number of organizations started criticizing the potential development of genetically modified crops and organized activities to counterbalance the prediction made in 1989 that 'Not only will new varieties be developed in interaction with agrochemicals, like herbicide-resistant crops, but later on crops with an in-built protection against insects and diseases and even new crops with a changed and higher composition of food nutrients and nitrogen-fixation crops will also be developed' (Ruivenkamp 1989,120).

Despite the development of much opposition, the historical processes towards an industrial transformation of agriculture prevailed and resulted in a huge growth in the amount of herbicide and insect tolerant crops in the world – from 1.7 million hectares in 1996 to 52.6 million hectares in 2001 (James 2001,2). Moreover, the upscaling and 'scientification' of food-conservation techniques – originally primarily applied on-farm but increasingly taken over by industry – and the transformation of these conserving and processing techniques into techniques to separate food into components made it possible for food products to become increasingly disconnected from agricultural produce. A new food production system is emerging in which a number of nutrients like fats, proteins and carbohydrates are assembled from a broad range of interchangeable agricultural and biochemical sources. Additives like flavouring and colouring agents are added and this packet of ingredients is put together in the recognizable form of a traditional foodstuff and sold to consumers. Finally, the patenting of the politicizing biotech products, like enzymes and plant breeding techniques, continued despite worldwide opposition to the patenting of life.

It is clear that the intensive pro-anti (non-)debate has not prevented the occurrence of these social changes, like the spread of transgenic crops, the development of biocatalysts and the patenting of politicizing products. It may even be emphasized that biotechnology in itself may explain why these social changes – despite much opposition – are taking place.
Another effect of biotechnology is that it undermines the traditional meanings of various social categories, such as public and private research, companies as economic entities and policymakers as political actors. Within the reorganized food system all kinds of hybrid institutional forms are emerging. These hybrid forms are transforming companies from economic entities into primarily political actors and transforming the traditional differences between public and private research institutes so they become integrated elements of public/private scientific networks producing politicizing products. Indeed, the most important impact of biotechnology is that it challenges the capacity of *group-identity formation*. Most actors subjectively still refer to their traditional social categories (for example as being a scientist working in a public or private research institution, or for example as being a sugar-cane plantation worker) while objectively they are positioned in a changed social environment.

The desynchronization between the ongoing reorganization process of food production and the traditional subjective identity formation (as members of farmers' organizations, unions, or environmental organizations, or as scientists or political party members) renders it possible for new forms of political control to emerge that are not tackled by the current debate. Mechanisms of control that are directly embedded in the reorganization of food production and carried out through the development and supply of new seeds and biocatalysts, reflect a development towards a politicization of production in which scientists and their laboratory products, gain a direct political identity, while policymakers, become depoliticized. However, the same process might also create space enabling the same individuals – subject to the new forms of control – increasingly to reflect on these developments and look for a new basis on which a subjective reconstruction of identities in relation to biotechnological developments may take place. Indeed, the most important contribution of the Monitor is the description of locally-specific initiatives that no longer feel comfortable with the dualistic approach of either accepting biotechnological developments by participating in them without changing them or protecting themselves against the biotechnological developments by rejecting them completely. Instead of this pro-anti position, characterized by insufficient imagination to bring about change, some initiatives in various regions are following a more constructive approach. They are trying to find a way out of the schizophrenic situation of complete acceptance or refusal and aim to develop a balanced and dialectical approach of integrating and indigenizing some biotechnological innovations, attuned to local resources. In the near future the *Biotechnology and Development Monitor* may aim to pay more attention to these concrete attempts in different countries to reappropriate, modify and attune biotechnologies to endogenous developments. ◆

Guido Ruivenkamp
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The Monitor's Readers

The Monitor as a network is only as strong as the people who keep it alive and dynamic. On reaching the milestone of the 50th edition, we have invited readers to give us feedback on questions such as 'What should we monitor and how should we monitor?' and 'What does our network of readers want from the Monitor?' Below is a snapshot from our readership.

Vision

We are envisioning a world where information on biotechnology and development is shared truly, respectfully, equally and impartially. A world in which the Monitor improves decision making in the field of development, the application of biotechnology, its regulation and its research. A world in which the Monitor supports all those who would like to contribute to knowledge building in the South as well as in the North.

Dr. M. Subhan Qureshi (43), Pakistan – Head of Reproductive Biotechnology, Veterinary Research Institute NWFP of the Government of NWF.

1. The Monitor should cover developments in various fields of biotechnology in man, animals and plants, focus on new products, applications of new technologies at community levels and achievements made by individuals. Articles from junior scientists may be accommodated; donors of biotechnology projects may be identified; work on local plants and animals species should be covered.

Raanan Katzir (67), Israel – Director of SACOG (Sustainable Agriculture Consulting Group)

2. The Monitor should continue to monitor and inform about agricultural innovations and technologies, emphasizing biotechnology, sustainable agriculture, arid zone agriculture, China, India, and water resources. Web-conferencing would be an important tool to connect similar-minded professionals in other regions of the world.

Niels Louwaars (44), Netherlands – Manager of International Cooperation for Advanced Research Institute.

3. The Monitor should focus on independent, science-based information for non-specialist professionals who support public debate on biotechnology and informed decision making; it should be a combination of paper and interactive digital forms; and reach out to professionals in research/development (public, NGO, private) areas.

Anton Waspo (30), Indonesia – Researcher, Member of ELSPAT, NGO on Rural Development, Agriculture and Women

4. The Monitor could provide ideas and guidelines on how to learn about biotechnology and the conspiracy of the biotechnology multinational companies. It should give balanced information about global developments and the practice and experience from the field in other regions and countries.

Shuji Hisano (34), Japan – Researcher Hokkaido University, Department of Agricultural Economics. Fellow at Wageningen University, the Netherlands.

5. It would be nice if you would reserve more pages for the critical review/ analysis of public documents issued, for example, by the UN, OECD, or expertise groups, keeping a balance between theoretical and empirical, local and global, North and South contributions.
The Monitor has a different mission to other related academic journals. Free access both through print and internet should be maintained

Emre Ilker (30), Turkey – Ege University, Faculty of Agriculture.

6.The Biotechnology and Development Monitor gives us very useful knowledge about techniques and developments of countries' biotechnology research projects and their results. Another important thing is that it is free of charge. Knowledge is good if it is shared.

Fernando Daniel Castano (44), Argentina – Assistant Professor of plant breeding. Faculty of Agronomy, University of Mar del Plata.

7. The Monitor should explore the necessity of publishing scientific or technical articles by asking readers to present short notes to be considered for publication, regarding either per se research or teaching at Universities and Institutes about applied biotechnologies.

Mission

The Monitor analyzes developments in biotechnology and its effect and impact worldwide through interdisciplinary approaches and integration of theoretical and empirical information from the natural and social sciences. It considers global, international, national and local levels, regulatory and production systems and economic and social developments and needs. For example: inventions and innovations, economic growth, employment, agricultural development, biodiversity, food safety and food security, basic needs, indigenous knowledge systems, social differentiation and human rights.

Jariya Boonjawat (56), Thailand, university professor. Female.

8. The Monitor should focus on policy issues in different countries. Web-browsing and searching is an important tool to use.

Sietze Vellema (37), the Netherlands – Researcher (technology management and policy) at ATO BV.

9. The Monitor should focus on starting again from the debate on regulation and public policy and try to avoid a dominance of more populist approaches to technology transfer and development. The Monitor should come in a printed version and its outreach should involve policy makers and media people in a number of regions in the South.
The Monitor could accomplish this by embracing the recent initiative towards organizing regional workshops and to give a publication a place in the on-going policy debates in these regions. The journal can then create South-South linkages and move towards less reliance on effort and funding in the Netherlands.

John Komen (36), the Netherlands – Political scientist, research officer. International Service for National Agricultural Research (ISNAR)

10. The Monitor should provide a balanced mix of 'academic', possibly peer-reviewed articles analysing new and evolving trends in fields of interest such as biosafety management and capacity building, management of intellectual property, economic and social impact of biotechnology and institutional and national strategies for agricultural biotechnology, together with more magazine-style items: clippings from other sources, opinion articles, book reviews, interviews, etc.
It should keep the print version and gradually develop web-based tools, and possibly other formats, to diversify and reach a wider audience.

George E. Pilz (60), Honduras – Taxonomic Botanist, professor of Botany and Genetics at the Escuela Agrícola Panamericana, in Tegucigalpa.

11. The Monitor should focus on clean and impartial content and outreach. It should focus on balanced impartial reporting of what is happening in the world of biotechnology and development. An open and frank discussion of the topics covered by the Monitor requires an extremely competent and dynamic editorial staff. If your publication begins to express politics and mould opinions it has lost its function fulfilling 'the need for concise, reliable, impartial and valuable information on these subjects'.

Luis Campos Baca (56), Peru – Biologist, Director del Programa de Investigaciones para el Aprovechamiento Sostenible de la Biodiversidad, Instituto de Investigaciones de la Amazonía Peruana.

12. The Monitor should focus on means and tools to spread its information; putting the latest biotech information forward and exchanging with other networks about experiences in the field.

Rajaratnam Muhunthan (32), Sri Lanka, postgraduate research student, Institute of Agriculture, University of Peradeniya.

13. In my view, a journal like the Monitor could realize its vision by: addressing the issues subject-wise; inviting articles; conducting periodical surveys and questionnaires; conducting E-conferences and debates; and including a 'letters to the editor' column. There are many ways to learn about other people's experiences, but from my own experience, I feel the online E-conference and debates make it very alive and interesting.

Ricardo Peñuela Pava, BSc MBA (43), Colombia – Biology Department & Bioethics Institute Pontifica , Science Faculty, Universidad Javeriana.

14. The Monitor should provide a comprehensive database on institutions, researchers and different biotechnological applications on agriculture and health issues. It should share information on national and regional focal points of managing data and getting direct access to databases.

Lotte Asveld (26), the Netherlands, philosopher and researcher at the University of Technology, Delft. Female.

15. I liked it the way it is, reporting on different projects around the world, and I think the opinion articles are very important. Maybe you could add some short articles in the first pages. I appreciate your neutrality very much and also that you have room for different opinions. Not many people are neutral about biotechnology. Maybe you can organize more space for discussion? This makes people actively involved. Maybe a platform on the internet for discussion and exchange of information or meetings and lectures?

South Korea plans its biotechnology future

Will South Korea belong to the group of leading industrial nations in biotechnology industries by the year 2010? According to a plan drawn up by the South Korean *Ministry of Commerce, Industry and Energy* (MOCIE) it will. MOCIE now ranks South Korea as thirteenth in the world of biotechnology. The government report *Korea Bio-Vision 2010* outlines the country's path towards seventh place by 2010. This report provides the strategy for the coming eight years to propel the country as one of the global leading biotechnology economies.

The state as an engine of growth

It will not be the first time that the South Korean government has played an important role in the direction of economic development. Government interventions have been vital for South Korea's successful economic development over the past four decades. As for the high performing economies of Japan and Taiwan, the Korean government targets and actively pursues strategic industrial policies.

During the 1960s and 1970s, the state played a dominant role in the targeting of key industries for development. Huge industrial conglomerates, *chaebols*, had to comply with the directions given by the government. During the first decade it was predominantly light industry (textiles and other mainly wooden products) for the domestic market as well as export. At the same time the government pursued a policy to develop human resources by stressing the need to enhance the educational capacity of the country. In the 1970s the state shifted the emphasis from light industry to heavy and chemical industry resulting in a boost in steel, machinery and petrochemical industrial output.

At the end of the 1970s the economic strength and the societal embedding of the *chaebols* in South Korea was such that they started to operate as equal partners with the state to promote economic development. Their political and economic leverage allowed the *chaebols* to discuss future directions of industrial policies with technocrats in different ministries to an extent that made the government-business relationship more symbiotic.

From the 1980s high value added production became the cornerstone of industrial development. Besides assembly and machinery (electrical household equipment, shipbuilding, cars etc.), the government and *chaebols* agreed to start the establishment of a vast information technology base in order to catch up with highly industrialized countries. An important reason behind this policy was South Koreans' fear of stagnation in economic development. Only a solid knowledge based economy could prevent a flight of highly educated and well-trained Korean citizens abroad. Therefore to become a leading nation in information technology was a new objective of the South Korean government. To achieve this position the government developed a plan in 1982 to concentrate on the development and production of new generations of semiconductors. The plan provided enterprises with a comprehensive framework to reach a prominent place in the semiconductor industry within a decade. A highly structured approach at all successive stages was to guarantee South Korea a place among the leading IT countries. All facilities in terms of finance, education, and professional support from domestic resources as well as from abroad were mobilized to meet the targets. At an early stage experts from abroad were flown in to fill the knowledge gap and create a reservoir of sophisticated Korean experts in the country.

The government allocated ample financial means to develop the sector. A ten-year master was adopted that was to bring the Korean semiconductor sector among the top five in the world by 1994. Besides fostering a broader and more sophisticated industrial base, technocrats of different ministries calculated that the US$ 12 billion the government was investing in the plan would easily be recouped once the semiconductor industry began to flourish.

The results were surprising. With exceptional speed the targets were met and South Korea found itself suddenly among the leading IT nations in the world. The economy of the country had entered a new phase with a clear emphasis on the IT industry. Korean firms played an active role in the development of new generations of semiconductors and sold their products worldwide. Within the country the spin-off of the development of the IT industry was shown in the industries that had been developed over the past two decades. Korean shipyards developed state-of-the-art technologies based on the IT sector in order to remain competitive on the world markets. So did the steel industry and other industries in the country.

The South Korean government did not become complacent after the successes in the IT sector. It is still supportive today in order to continue further development of the sector and to safeguard its competitiveness. Although economists and political scientists have cast doubt in recent years on the capacity of the South Korean state to maintain its prominent role in economic development, there are no signs that it has given up. Successive governments continue to combine forces in society in order to catch up with other developed countries in the world.

Scope of biotechnology industry.

Bio-energy	Biogas, fermentation of methane
	Ethanol for fuel use
Bio-foods	Added material in foods
	Functional enzyme
	Amino acids, bio macromolecules
	Enzyme for factory use, spicery
Bio-medicine	Hormone, vaccine
	Anticancer medicine, antibiotic medicine
Bio-health	Sanitizing microbes
	Bioremediations
Life electronics	Bio chips
	Bio computers
	Bio mecatronics
Life agriculture	GMO corns, beans, potatoes
	Plasma Modified (converted) livings
Life information	Bio informatics
	DNA interpreting S/W

Biotechnology is considered to have the best growth potential: 22.1% over the period 1995-2005, compared to semiconductors at 9.4%, new materials at 6.9%, cars at 3.5% and aviation at only 1.4%. The report continues to outline the current trends in the biotechnology industry, stressing the importance of IT and the rapid development of the market.

Comparison of time and cost to develop new medicines

Classification	Traditional way	Research with BIT
Possibility of Success	1/1 million–1/10 million	1/10–1/100
Average development period	10–15 years	5–7 years
Cost of R/D	10–120 billion won**	1–3 billion won

***Source: Symposium of national science technology and knowledge information**
**** The won is the currency unit of South Korea. US $ 1 = won 1,190**

Korea Bio-Vision 2010

With the publication of the report *Korea Bio-Vision 2010* the South Korean government demonstrates its determination to launch a new phase in the economic development of the country. The Ministry of Commerce, Industry and Energy shows in this rather comprehensive report how the government in close collaboration with existing biotechnology firms plans the development of the sector until 2010.

The report is comprehensive in the sense that it covers most of the issues involved in the development of biotechnology in South Korea. It starts with an overview of its various applications.

Leading countries in biotechnology industry

In order to determine the current place of South Korea, the report first presents some details on the leading countries in the biotechnology industry. The United

States is leading the industry. A special US target is the development and commercialization of new medicines, centred on the *National Institute of Health* (NIH). Results of the *Human Genome Project* play an important role. Special attention is paid to the supporting role of the US government through the NIH budget, the *Small Business Innovation Research* program (for small and medium sized firms) and the funding and support to 114 *Biotechnology Centres* by the state governments.

According to the report, there are limitations for the local and national policies within the European Union. It mentions the *Life Science & Biotechnology – A Strategy for Europe* as an attempt to develop a unified policy on the EU level.

The Japanese government is actively promoting biotechnology industry. They support national projects such as the *Helix Plan* (1999) and the *Millennium Project* (2000) in order to create a US $ 220 billion market by 2010. In 2001 they allocated US $ 640 million to biotechnology, and in 2002 almost US $ 800 million. The size of the Japanese market is considerable, as is its growth: from US $ 9.6 billion in 1997 to almost US $ 12 billion in 1999.

South Korea only started to establish a research base for biotechnology in the 1980s. The *Genetic Engineering Research Centre* was founded in 1982 followed a year later by the enactment of the genetic engineering development law. During that decade the state started to support R&D research in fields like genetic engineering technologies on a modest scale. In the 1990s the first steps towards biotechnology industrialization has been made resulting in the establishment of bio ventures like *Macrogene* in 1998. But only since 2000 have large-scale projects in biotechnology started, with the South Korean government playing an active role by protecting and subsidizing this sector. *The Ministry of Science and Technology* launched the *21st Century Frontier R&D project*, and the *Ministry of Commerce, Industry, and Energy* presented 'the industry and technology development project for mid-term key positions and next generations.'

Under the guidance of the president, a scheme for the development of biotechnology industry has been promulgated with ministries and private business involved. Biotechnology is to be better promoted by a 'committee for biotechnology and industry', a law is to be adopted about the movement of genetically manipulated organisms between countries, and all parties involved are to focus more on R&D and the formation of a proper infrastructure for the promotion of industrial appliance. Despite all these initiatives and some promising results in the fields of the technique of plasma transfer between animals and plants, fermentation processes, and genetic segregation, in which South Korea has reached the level of advanced countries, the report concludes that in terms of technological competitiveness, the country only ranks fourteenth in the world, just below China.

Level of life engineering technology in comparison with advanced countries

	Factor Skill	Domestic level (advanced countries = 100)
Base technology	Genetic manipulation	85
	Cell fusion	80
	Protein engineering	70
Manufacturing technology	Fermentation	90
	Cell cultivation	65
	Bioprocessing	65
	Life engineering	35
New material creation technology	New material invention	25
	Safety measurement	30
Total		60

As a second indication for the position of South Korea, the report compares the patent enrolment in the biotechnology industry and concludes that also in this field the country is lagging behind.

Patent enrolment in biotechnology by country (1991-2001)

Nation	1991-1995 (4,828 in total)			1996-2000 (11,677 in total)			2001 (2,782 in total)		
	Cases	Against total (%)	Against US (%)	Cases	Against total (%)	Against US (%)	Cases	Against total (%)	Against US (%)
US	2,993	62.0	100	9,274	79.4	100	2,131	77.0	100
Japan	741	15.3	24.8	1,056	9.0	11.3	207	7.4	9.6
UK	27	0.6	0.9	329	2.8	3.5	150	5.4	7.0
Australia	39	0.8	1.3	126	1.1	1.4	45	1.6	2.1
S. Korea	20	0.4	0.7	67	0.57	0.7	26	0.9	1.2

The South Korean government has increased finance to the sector over the past 4 years by 400%. In relation to government R&D funding of other sectors, the biotechnology industry received 5% of the total budget in 1998 and 8% in 2001.

Budget increases 1994 – 2002

Year	1994	1996	1998	1999	2000	2001	2002
100 million won*	536	1,234	1,115	1,608	2,462	3,238	4,500

* At the end of 1997, the Won was devalued by more than 40% against the US dollar

But the report concludes that the total government funding for R&D in biotechnology does not reach that of American firms like *Amgen Inc.* (US$ 850 million/year), or *Genetech Inc.* (US$ 490 million/year).

Looking at the market size of the domestic biotechnology industry, the growth figures are remarkable.

Market size of domestic biotechnology industry

	1997	1998	1999	2000
Domestic demand (billion won)	4,246	5,085	6,701	9,000
Exports (billion won)	3,018	4,815	4,543	6,101
Imports (billion won)	1,385	1,702	2,114	3,306

*** Source: Association of Biotechnology Industries, Survey about current situation of the domestic biotechnology industry 1998-2001**

With the growth of the industry, the number of ventures in the sector has also increased. This increase is partly due to the supportive attitude of the government.

The annual progress of starting bio-ventures

	'95	'96	'97	'98	'99	'00	'01	Total end 2001 (provisional)
Number of new firms	19	14	27	36	71	233	200	600

In spite of the rapid growth in such a short time span, the base for development is still weak.

Comparison of South Korea, US and Japan by main index

Classification	US	Japan	S. Korea	Remarks
Market size (1999, US$ 100m)	134	120	5.6	*1.2% in the international market
State budget (2000, US$ 100m)	200	54	1.8	*the central government level
Number of companies (2000)	1,283 (1999)	About 1,000	350	*(Korea is) 25% of US
Research labour (persons)	305,000 (1998)	130,000 (1998)	9,392	*(Korea is) 3.1% of US

Looking at the market and the growth potential of the industry in South Korea, the sector is still weak. Most firms do not posses key source technologies and are too small. They cannot present visible results like the 'star companies'. So far, there is no coherent globalization strategy for the development of the Korean industry.

The best chances for South Korea to catch up with the advanced biotechnology economies are offered by the potential of the number of highly educated people and the creativeness demonstrated by Koreans in the past. The country should make optimal use of these circumstances. Based on the above comparison with the United States and Japan, the government is already targeting (higher) education as a field that needs extra funding. In the year 2000, the experts in biotechnology numbered 5,224 at Korean universities, 2,701 in firms and 1,467 in research centres. 47% of all experts had a PhD.

If the government does not take drastic measures, the biotechnology sector will face serious shortages in manpower within 3 years: the predicted demand until 2005 is about 9,470, but without state interference the supply will be only 3,080. Therefore the predicted shortage of high-skilled labourers will be 6,390.

Strategies and tasks

Based on a SWOT (Strength, Weakness, Opportunity, Threat) analysis, five strategies with related tasks have been formulated in order to strengthen the competitiveness of the biotechnology industry in South Korea.
The first strategic step will be the establishment of a system on the level of that in advanced countries that effectively supports R&D, technology transfer and expansion, and biotechnology industrialization. Diverse capabilities of private and public sectors should be properly combined to create synergy. After several conferences and meetings attended by ministers, bureaucrats, and technocrats of the relevant ministries (even President Kim Dae Jung participated in one of these conferences – a clear sign

of the importance of the project) and participants from the private sector, a detailed *Action Plan* has been made including the tasks, targets and financing for the coming years.

A *Biotechnology Industry Round Table* meets regularly to monitor the progress and achievements of the *Action Plan*. Among its members are the *Minister of Commerce, Industry, and Energy*, a chairmen group from the *Federation of Korean Industries*, and the chairmen of all related committees and associations. In this phase, special committees concerning biotechnology are solidifying the relationship between R&D (*Ministry of Science and Technology*) and industrial application (*Ministry of Commerce, Industry, and Energy*). Annually a bio-CEO forum, with universities, research centres and bio venture companies as participants, discusses strategic cooperation and partnership.

The second strategy emphasizes the support for early industrialization in biotechnology and the expansion of the infrastructure. The parties involved will increase the facilities for R&D and production to meet international standards. The report explicitly mentions government funding and tax measures to promote the increase of the industrial base. It also outlines a regional division in the establishment of bio-clusters and detailed funding for the period 2002-2006: 70% from central government, 26% from local government, and 4% private capital. Priority has been given to the funding of small and medium-sized firms and the establishment of an industrial technology valley. A nationwide network has been constructed to promote common cooperation projects and to prevent overlaps in research. Mutual connections between the different bio-clusters should deliver the necessary synergy and prevent stiff competition. At the same time private business and the central government are collaborating in the creation of demand in the industry. To this end they will work closely together on gradual certification, the creation of an industry development law, the opening of bio product internet cyber markets (an internet shopping mall will be opened exclusively for the sale of high-quality domestic bio products). The establishment of a firm legal and organizational base is one of the main tasks in the second strategy.

The third strategy stresses capabilities in the development of key technologies. Two phases are indicated: the selection of competitive areas for future key technologies, followed by intensive investment in these areas. Step by step a few technologies should be strategically developed and the spread of investment over too many entities should be avoided. The competitiveness of key technology sectors needs to be upgraded by more than 85% to reach the world's top level by 2010.

The fourth strategy concerns the availability and good use of human resources. The report mentions in the short run the (re)education of highly skilled labourers, improvements in working conditions to prevent the flight of intellectuals and to create favourable conditions for those who studied abroad to return, and efforts to solve problems of unbalanced supply and demand on the quality side. Until 2005 the government will pay the cost of solidifying the base for human resources. From 2006 onward this will be a task for the private sector.

Finally, a global network should be established to conquer overseas markets and to attract foreign companies and foreign investment. International cooperation in research projects and business is one of the cornerstones of the fifth strategy. To achieve this goal the report explicitly mentions American companies and research centres to make successful inroads in the American market.

Conclusion

For some years, economists and political scientists have claimed that the *developmental state* in South Korea has ended. When we consider the master plan for the development of biotechnology as proposed in *Korea Bio-Vision 2010* this claim cannot be maintained. It is true to say that the Korean government cannot dictate industrial policy as it did in the 1960s and 1970s. At present the state can better be characterized as facilitating the private sector to achieve a prominent position in biotechnology. But the state and private enterprise in South Korea are both convinced that industrial policy with strong support from the government is pivotal for the country to play a leading role in the global market. ◁▶

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Tailor-made biotechnologies for endogenous developments and the creation of new networks and knowledge means

For a Jubilee issue it would seem wise to reflect on the information the Monitor covers. Since the 1980s the Monitor has informed the reader about biotechnological developments and related issues (such as intellectual property rights), and their impacts on development. Concerning agro- and food biotechnological developments, gradually more attention has been paid to initiatives that aim to establish a new development paradigm.
This article discusses the changeover from an exogenous to an endogenous development paradigm and the related changeover from agroindustrial gentechnologies to tailor-made biotechnologies – one that may also have implications for information the Monitor includes in future.

Despite many successes in the development and application of various food technologies (for example plant breeding), over 800 million people are still chronically undernourished and 180 million children are severely underweight for their age, while in the same world people are overfed and food stores are overflowing. This reality shows that attuning the potential of new technologies to issues of equity and sustainability is the crucial challenge. Modern biotechnology illustrates that challenge. In principle, it offers wide technical possibilities for increasing food security, but many doubts exist whether biotechnological applications will benefit the people that have been bypassed by the *Green Revolution*, or actually reach them at all. Indeed, scientific analysis has shown that primarily those biotechnological applications are pursued which only make sense in the narrow social frame of industrial agriculture. This narrow context in which biotechnology is evolving creates a heated pro-anti debate between advocates and opponents on the benefits and risks of 'modern' biotechnology. Less attention is paid to the much more important question *if and how the potential of modern and traditional biotechnologies can be negotiated, modified and related to issues of food security, equity, and sustainability.* Nevertheless some civil society, public and private organizations do attempt to link biotechnologies to sustainable and endogenous developments.

From exogenous to endogenous rural developments

Critical reflections on the concepts of development, industrialized agriculture and global food chains have given space to new paradigms in which concrete possibilities are searched for reinforcing the local potentialities of agriculture and food production through a tailored use of new technologies. The analysis of agrarian developments has made clear that the industrialization of agriculture, leading to an enormous improvement in productivity and wellbeing in many areas, has increasingly been originating from and driven by actors and research institutions, *external to the producers in the agricultural sector* itself. The concept of an 'exogenous development', however, refers not only to the *external origin* of agrarian development, but also to the fact that the industrialization or modernization of agriculture takes place by *disconnecting agriculture from those locally specific elements* (local ecosystem, local knowledge, local consumption patterns) that initially introduced specificity and heterogeneity into agriculture. The concept of exogenous agrarian development stresses that the external institutions (including public research institutions) apply a concept of modernizing agriculture in which an essential *rupture* with existing practices in farming and countryside take place. Correspondingly, those farmers who were more able than others to participate in the modernization projects are classified as those most 'open' to outside information and innovations (the vanguard farming style). This approach of 'getting agriculture moving' fitted well with mainstream economics, which perceived agricultural development as essentially *an adaptation of farming practices to changes in global markets and technologies.* The analysis of the introduction of biotechnology in the agroindustrial chain of production has made clear that biotechnology reinforces the ruptures with local farming practices and separates local food consumption from its agricultural produce (Ruivenkamp 1984-1989). This close interrelationship between biotechnology and the exogenous agrarian development model implies that biotechnology reinforces the development towards a homogenized agricultural production system with an enormous improvement in productivity and wellbeing for the vanguard farmers and consumers in urban centres, but also with an increased social differentiation in rural (and urban) areas. 800 million people who are not reached by modern, industrialized agriculture and food production; the main question is how to reach them and how to 'go beyond modernization'. An answer may lie in the endogenous development paradigm, in which development patterns are *founded mainly on locally available resources*, such as the potentialities of the local ecology, labour force, knowledge and patterns for linking production to consumption. Endogenous developments *revitalize and dynamize* these local resources, which otherwise might decline or become superfluous. Furthermore, endogenous development practices tend to materialize as self-centred processes of economic growth: relatively large parts of the total value generated through this type of development are relocated within the locality itself.

Advocates on either side of the current pro-anti debate seek either to accept biotechnological developments by participating in their developments without changing them or to protect themselves against the biotechnological developments by refusing them completely. However, the real challenge today is to answer the question whether biotechnology, as an ensemble of social-technical dimensions developed from within the context of agroindustrial developments, can be *relocated and modified* within the context of sustainable, endogenous developments. Several organizations in different regions are dealing with this challenge and are constructing other specific forms of biotechnologies within various interdisciplinary, national networks. These networks are aiming to connect the development and use of biological agents such as microorganisms, plants and plant parts to the existing local practices in agriculture and countryside. They are also trying to connect these biological agents with the local potentialities of agriculture, not only as a modern economic activity but as part of a local culture of development.

In view of the various experiences in different regions, an international network has been formed to exchange information about these attempts to tailor biotechnologies for endogenous developments.

The TMBT Network

The general aim of the TMBT Network is: *To explore whether biotechnology as an exogenous instrument can be appropriated by local initiatives and become a catalyst for endogenous rural developments.* Consequently, the programme's goal is to overcome the pro-anti stage in the public debates on biotechnology and identify concrete research and training programmes to support the ongoing attempts to tailor traditional and modern biotechnologies to sustainable and endogenous paths in various regions of the world.

This objective implies that the international TMBT Network should facilitate the intellectual and practical support of location-specific actor networks orientated towards:

- Applying appropriate elements of biotechnological developments,
- Modifying biotechnology into catalysts for endogenous developments, and
- Reinforcing the local potentialities in agriculture and food production.

In order to achieve the overarching objectives, the programme is organized according to the following five, highly interrelated, specific targets.

- To facilitate through the establishment of *regional and international networks* the exchange of information about possibilities of empowering endogenous developments by applying tailor-made biotechnological developments.
- To identify crucial *research issues* and support the implementation of specific research projects that empower the possibilities for linking biotechnological developments to location-specific potentialities in agriculture and food production.
- To develop curricula for *transdisciplinary education and distant learning* on tailor-made biotechnologies.
- To support and facilitate *constructive contributions to public debates* in the South, the North and at a global level by indicating concrete experiences of disconnecting biotechnology from the industrial transformation of agriculture and reconnecting it to sustainable and endogenous developments.
- To strengthen the *capacity and professionalism* of staff members of those organizations that are trying to tailor biotechnologies to the needs of resource-poor households.

Composition of the TMBT Network

In cooperation with various partners, the chairgroup *Technology and Agrarian Development* (TAO) of Wageningen University has set up this TMBT Network to support the initiatives of tailoring biotechnologies to the needs of resource-poor households. The current preparatory phase of the programme started in 2001 and will continue until August 2003, followed by an implementation phase ending in 2008. During the preparatory phase, the complete TMBT network with several founding partners and associated members is to be established. Moreover, some *Advanced Biotechnological Research and Educational Centres* will be invited to join the TMBT partnership. Presently, the TMBT Network has the following six founding partners:

- Brazil: Nucleo de Estudos em Agrobiodiversidade (NEABio)
- Cuba: Instituto Nacional de Investigaciones Fundamentales en Agricultura Tropical (INIFAT)
- Ghana: Science Technology and Policy Research Institute (STEPRI)
- India: Andhra Pradesh Netherlands Biotechnology Programme (APNLBP)
- Kenya: Biotechnology Trust Africa (BTA)
- Netherlands: Wageningen UR TMBT Group

In collaboration with these partners the TAO chairgroup is constructing a website on which the partners will share their reflections on their TMBT experiences with the aim of formulating generalizable ideas and strategies for reconstructing biotechnologies to the needs of the 'unreached'. They will also formulate new research and training programmes that will be set up jointly during the implementation phase of the TMBT programme. Moreover, they will indicate how other organizations can become associated to this network.

The website is divided into different rooms (network partners, case studies, research, training, debates, capacity building). In these rooms everybody can comment on and add information about the possibilities and constraints for tailoring biotechnologies to the needs of resource-poor households. On the basis of this discussion on the case studies, the TMBT partnership will indicate which new research, training and debate issues need to be more fully elaborated during the implementation phase of the programme. The website will be universally accessible from the beginning of March 2003.

Every tool needs a hand to use it

Twelve years ago the Monitor was established to inform the reader about biotechnological developments and to warn organizations about potential shifts in trade, cultivation practices and power relations. Biotechnology was seen as another modern tool that could have important socioeconomic impacts on development, especially in developing countries. However, every tool needs a hand to use it, and gradually it has become clear that there are different ways of using the tool of biotechnology. Awareness has grown that the use of biotechnology to reinforce the industrial transformation of agriculture is not inevitable. On the contrary, increasingly attempts have been made to relate biotechnology to endogenous developments and to the needs of resource-poor households. Instead of taking a top-down approach, the aim is to develop biotechnology using a participatory approach. This means not obliging farmers to carry out certain activities through the specific social/technical properties of seeds and biocatalysts, but revaluing their knowledge and craftsmanship to use local resources in location-specific agricultural developments.

Transferring the tool of biotechnology to other hands will of course lead to new forms of the tool. In future the Monitor may pay attention to the *relocation* of biotechnology from the context of an industrializing agriculture towards the context of sustainable, endogenous developments, and inform the reader about the new social/technical properties of the tailor-made biotechnological developments. However, it is important to note that the reappropriation of the tool through local initiatives does not take place in a political vacuum. On the contrary, this shift will take place within a context of intensive, social and political contradictions that will even be reinforced by agroindustrial biotechnological developments. Therefore, the TMBT Network makes a plea for the Monitor to reorganize itself as a network journal and in future to include the three kinds of information described below.

The Monitor as network journal

Firstly, to continue informing the reader about biotechnological developments in different sectors, such as pharmaceuticals, energy, water, policy, and intellectual property rights.

Secondly, to continue to analyse critically the interwovenness of agroindustrial biotechnology with the industrial transformation of agriculture. It may indicate how agroindustrial gentechnological developments lead to new social relations, new international relationships and new forms of political identities within the social organization of global food chains. Here the objective should be to inform the reader about these developments as well as provide the reader with analytical tools for its own critical reflection on these developments.

Thirdly, the Monitor could inform the reader about experiences in tailoring biotechnologies to the needs of resource-poor households and indicate how local initiatives reappropriate and modify specific forms of biotechnological developments and transform them into catalysts for endogenous developments.

In view of these three objectives it may be necessary for the Monitor to establish itself within networks of information flows. General articles about biotechnological developments and related issues may be written by various authors, commissioned by the editorial board of the Monitor. However, the second category of information about the agro- and food-biotechnological developments may be approached differently. In view of the appearance of many other journals that publish articles about these issues, the Monitor may consider informing its reader where these articles can be found. Instead of rewriting, the Monitor may lead the reader to the sources of information. However, it may still be worthwhile for the Monitor not only to refer to other articles but also to present some new analytical tools that the reader can use for its own critical reflection on these developments. Therefore, the TMBT Network suggests that the Monitor should not only establish agreements with other journals for referring to their articles but also with various research centres for the formation of biotechnological development *dossiers* to be used as background information.

Finally, the Monitor may aim to inform the reader about local attempts to appropriate and modify biotechnologies and to identify lessons learnt from these experiences. The authors of these TMBT articles will be asked to go beyond the location-specificity of their experiences and to indicate *generalizable strategies* of tailoring biotechnologies. This requires that a constant confrontation with other experiences take place and that there is a willingness to search collectively for these lessons and generalizable strategies. This can only be realized by a new dynamizing, bottom-up, participatory journal. Indeed, the big challenge for a new Monitor will be to reorganize itself from a journal that informs and warns the reader about future agroindustrial gentechnological developments into a journal that becomes part of different national networks in which attempts are made to reconstruct these biotechnological developments.

This changeover from an 'exogenous, monitoring journal' to an 'endogenous network journal' implies that the Monitor itself needs to be reorganized, so it is able to stimulate the development of new means of disseminating knowledge that facilitate the generation of attuned transdisciplinary knowledge systems. Therefore, the TMBT Network suggests that the Monitor as a network journal could be related to other activities, such as the organization of *regional workshops*, the formulation of *digital dossiers*, the cooperative selection of specific *research issues* by different national networks, the development of *curricula* for participatory and people-based biotechnological developments and so on and so forth. In particular, attention should be paid to determining how the network journal may also contribute to the development of *transdisiciplinary training* activities and *distant learning programmes* to strengthen the professional capacity of the staff members to reappropriate and modify biotechnological developments. And finally it should be determined how such a new network journal could contribute to facilitating the identification and development of concrete emancipator TMBT products by the national networks. In collaboration with the *Advisory Board* of the Monitor it should be discussed further how this changeover from an early warning system to a proactive network magazine can be realized. ◁▶

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Monitoring biotechnology for development: Lessons learnt

Biotechnology is recognized as a technology that might serve to improve livelihood in developing countries. Provided it is managed and handled well, it opens the door to a new era of development cooperation. By analysing earlier approaches in harnessing biotechnology for sustainable development, lessons could be learnt.

The Human Development Report 2001 (HDR) states that new technologies provide opportunities for healthier lives, greater social freedoms, increased knowledge and more productive livelihoods. In particular, modern biotechnology is mentioned as a tool that can increase food quality and food production through new breeding methods and prevent disease through new possibilities to create vaccines and trace illnesses. At the same time, however, the Report states that these same new technologies might affect developing countries and poor people negatively. Furthermore, the needs of the poor could remain neglected, and new global risks could be left unmanaged.
Given the prominence of public opinion in the European debate on the use of genetic modification, especially in food and feed, the HDR makes an appeal for developing countries to be given the opportunity to decide for themselves. Hence, the development community should allow developing countries the choice to develop, adapt and manage biotechnologies, including genetic modification in agriculture, for their own needs. Since these needs will vary depending on local circumstances, the HDR cannot provide a biotechnology development manual. Donors might wonder how they can actively support the formulation and implementation of Southern research agendas on biotechnology aiming at sustainable development and improved food security.

The European policy arena

In the late 1980s, European public opinion was relatively optimistic about the potential benefits of all kinds of biotechnologies (including GM). In various European countries, policies supported biotechnology R&D in order to spur economic growth, become more competitive with Japan and the USA and expand employment. Recently, European public support of GM agriculture has decreased, which has complicated the process of finding a consensus on European and national policies.
In line with the spirit of the 1980s, the Netherlands took a pioneering role by setting up a policy and programme related to biotechnology research in and for developing countries. As a tool, genetic modification was not excluded, provided it was used to meet the needs of small-scale farmers within agriculture.
Other European countries have been more reluctant to support the development of GM related applications in agriculture in developing countries. Sweden, for instance, although it supports several programmes on biotechnology, waited until the late 1990s before executing two programmes that support GM end-products (Ulmanen, 2001). The *German Agency for Technical Cooperation* (GTZ) gave only limited support to GM related technologies for developing countries. Countries like Norway and Finland do not support GM technology development in developing countries. They only support general academic education in the field of biotechnology through national academic institutes like *Noragric* and *Agrifood Research Finland*. The Swiss agency of development cooperation supports only the development of pharmaceutical biotechnologies.

A comparison between SIDA's and DGIS' biotechnology policy

Various national donors support biotechnology, but few of them actually include support for the development of GMOs. DGIS being one of the forerunners in policy formulation in this field makes quite an interesting case to analyse. SIDA, on the other hand, has a development cooperation approach that is more traditional and therefore similar to other donors. The aim of this article is to compare the experience of the *Swedish International Development Cooperation Agency* (SIDA) and the Dutch *Directorate General for International Cooperation* (DGIS) in supporting biotechnology research in developing countries. Attention will be given to DGIS' Special Programme on Biotechnology and SIDA's East African Regional Programme and Research Network for Biosafety and Biotechnology Policy Development (BIO-EARN), funded by the Department for Research Cooperation. DGIS supports regions in India (Andhra Pradesh), Colombia, Kenya and Zimbabwe. BIO-EARN supports the East African region, including the countries Ethiopia, Kenya, Tanzania and Uganda. The aim of this article rests on the assumption that sharing of information and experience is a prerequisite for sustainable development cooperation in the future.

SIDA and DGIS share the overall aim of reducing poverty in developing countries by increasing the living standards of poor people (see table 1). Provided the technology is handled well, the respective donors share the assumption that biotechnology research is a key to sustainable development. It is interesting to note differences between the two donors with respect to North-South research cooperation and the involvement of Northern researchers in the programmes. In the BIO-EARN programme, SAREC supports capacity enhancement in East Africa through research cooperation with universities and institutions mainly from Sweden. DGIS, on the other hand, supports a participatory and multidisciplinary approach that takes place in the developing

Aims and objectives of the two donors

	SIDA/SAREC – BIO-EARN	DGIS – Special Programme on Biotechnology
Overall aim	Poverty alleviation	Poverty alleviation
Programme aims	To develop a sustainable use of biotechnology in order to help improve livelihoods, ensure food security, and safeguard the environment.	To develop sustainable biotechnology and biotechnology policy that serve the needs of primarily resource-poor farmers and women.
Research objectives	SAREC's policy. To strengthen the research capacity and to promote development development-oriented research through research cooperation with research institutes and universities.	The Special Biotechnology Programme policy. To strengthen the research capacity through a locally established multidisciplinary and participatory Interactive Bottom-Up research approach.
Programme objectives	1. To enable national and regional development of biotechnology and policy according to local needs abilities and opportunities. 2. To promote collaboration in biotechnology, biosafety and biotechnology policy in order to address regional challenges and opportunities through joint action. 3. To foster communication, nationally and regionally, among scientists, policymakers, biosafety regulatory officials and the private sector.	1. To develop sustainable biotechnology and policy in and for the South by means of a participatory research approach including local capacity geared to the needs of resource-poor farmers and women. 2. To improve international coordination and cooperation with regard to biotechnology development for the South. 3. To introduce the dimension of Southern development in Dutch national biotechnology policy.

Needs assessment by respective donor and programme

	SAREC – BIO-EARN	DGIS – Biotechnology Programme
How is the focus defined?	By Southern scientists and policymakers . within the context of SAREC's development policy	By Southern stakeholders within the context of the DGIS Programme
What is the focus?	Cooperation, training and research capacity enhancement in order to enable the developing countries to develop biotechnologies, biosafety and biotechnology policy.	To develop biotechnology for small-scale farmers and related policy by means of the IBU approach.
Biotechnology for whom? Serve what needs?	Local industry and agriculture. Benefiting local food security, improving livelihoods and safeguarding the environment.	Small-scale farmers. Benefiting local food security and improving livelihoods.
Who decides what R&D is necessary?	Local scientists, policymakers and regulatory authority within the framework of SAREC's research and cooperation policy.	Small-scale farmers by means of local NGOs, scientists and policymakers within the framework of DGIS participatory IBU research approach.

country and includes local experts and other local stakeholders, like small-scale farmers.

Another similar assumption is that needs indicated in the South should direct the research development process in order to create sustainable poverty alleviation. Moreover, both programmes stress collaboration and communication on different levels as means to develop sustainable biotechnologies in the South.

Means to fulfil the aims and objectives

DGIS and SAREC share the same assumption that local food security, livelihoods and environment are areas that need research attention, while the end-users for the biotechnology products differ. The Biotechnology Programme focuses on small-scale farmers only, while BIO-EARN gives priority to local farmers as well as industry.

In SAREC's policy, Southern actors define their needs through formal applications. In the case of BIO-EARN, several stakeholders in East Africa requested a regional programme for biotechnology, biosafety and biotechnology policy. This was followed up by a technical inventory study in order to analyse SAREC's possibility to provide for such needs. Local scientists, policymakers and regulatory officials agreed on a joint programme proposal through various workshops, which was granted funding by SAREC.

In the policy of DGIS Biotechnology Programme, the aim to address women's and small-scale farmers' needs was already set. This focus resulted from the basic premise that development cooperation should contribute to poverty reduction, taking on board the fact that small-scale farmers are mainly women and that they feed and constitute the majority of the poor population.

DGIS followed certain criteria to select regions and partners for the programme. Firstly, a minimal 'critical mass' to carry out biotechnology research in relevant areas has to be in place. Secondly, local stakeholders should be found among farmers, NGOs, scientists and policymakers who are committed to using a participatory research approach guided by the needs of local resource-poor farmers. Thirdly, partners should develop their own proposal, to be submitted for funding to DGIS.

The shortcoming of SAREC's demand-led method to identify needs is that only academics and policymakers are stakeholders that can influence which needs are taken into account in the programme. These do not necessarily meet with the needs of the local population. In the DGIS approach it proved essential that the partners found their way in operationalizing and implementing a participatory approach founded on the demands of the poor population. This supposes that these partners participate on an equal footing and that existing power relations and differences are not reflected within the programme. In circumstances where differences in power between the various stakeholders are manifest, this proved to be too optimistic, resulting in the tendency for scientists to dominate the priority-setting and programme-formulating exercise.

Although both BIO-EARN and the Special Programme are demand driven, the methodologies used are no guarantee that the priorities of the poor will be addressed and very much depend on the prevailing socioeconomic context and relations.

Capacity building in the South

In the BIO-EARN programme research capacity is strengthened by means of SAREC's Sandwich Model. Through the Sandwich Model the education of a masters or PhD student from a developing country takes place in a local academic institution, complemented by short periods of training at academic institutes abroad. To avoid domination by the stronger Northern partner, the local institution is given ownership of the project. By these means SAREC aims to avoid brain drain and stimulate the accumulation of a sustainable critical mass in the developing country. Part of this bilateral research capacity building is the transfer of material and instruments to enable biotechnology-related research. Additionally to academic enhancement, policymakers and other regulatory authorities are educated through hands-on courses and workshops in the field of biosafety and biotechnology policy. All education is supported by Swedish and other foreign expert institutes.

Furthermore, in line with the second and third objective (see table 1), collaboration and communication in the region is promoted through a network of local researchers, policymakers and regulatory authorities. The main function of the latter two is to communicate what the national needs are and to cooperate by facilitating the implementation of the research results in national policy. In order to give stability and success to the programme, researchers participating in the network have been selected on their activity in already functional and strong institutions in the region.

The DGIS Biotechnology Programme has three objectives (see table 1), the first of which, to build biotechnology and policy based on small-scale farmers' needs, is carried in the programme countries by means of the *Interactive Bottom-Up Approach* (IBU) (see Commandeur, 1997 for a detailed outline). By following this approach, local stakeholders, including end-users like small-scale farmers in the case of the Biotechnology Programme, set the research agenda and manage the programme and its activities.

In order to avoid a technological fix, relevant actors have to be selected on their commitment to support small-scale farmers. The stakeholders will in turn carry out careful interviews with small-scale farmers in order to find the most urgent needs. When needs have been indicated that can be addressed by biotechnology solutions, a research agenda is set. To ensure that the biotechnology research corresponds with the needs of the small-scale farmer, public debates through workshops are held until consensus is reached.

The second and third objective in the Biotechnology Programme (see table 1) is activities carried out by DGIS in order to strengthen the position of the South, following poor peoples' interests in particular, by promoting international communication and collaboration as well as putting political pressure on international and Dutch policymaking.

Networking is promoted by both programmes as a means to enhance local capacity in order to carry out appropriate research and development in the South. However, the networks are set at different levels. In BIO-EARN the networks are at a national, regional and international level, whereas in the Biotechnology Programme the decision on the nature of the network is left to decision-making at local level. For both programmes it is important that the network partners are committed to carrying out research and development following the aims and objectives. The SAREC policy also stresses the importance of employing high quality research partners from renowned institutes in the North, to allow the programme to progress.

Enhancement of capacity is central to both programmes but in different ways. In the BIO-EARN programme it is brought about by the education of researchers, policy-makers and regulatory authorities, by the mobilization of research capacities through the East African network, and by technology transfer. In the Biotechnology Programme, enhancing capacity to produce appropriate biotechnology and policy is to include knowledge of small-scale farmers and other local actors like NGOs.

What can be concluded from the activities carried out in order to build capacity in biotechnology is that the Biotechnology Programme has a slower process of developing biotechnologies compared to BIO-EARN because of its interactive character and focus on finding solutions to farmers' needs.

Autonomy of local stakeholders to act in the IBU approach of the Biotechnology Programme is of primary importance in order to integrate the needs of the poor and make the programme sustainable. The underlying assumption is that grass roots have knowledge about core problems, and local researchers, being familiar with the local sociocultural setting, are in a better position to communicate with them and provide for tailor made solutions. According to DGIS, the inclusion of Northern

BIO-EARN research priorities defined by country

Key themes	Ethiopia	Kenya	Tanzania	Uganda
Environmental ad Industrial biotechnology				
Waste treatment	X	X	X	X
Biocatalysts for conversion of renewable				
raw materials		X	X	
Agricultural Biotechnology				
Molecular markers for breeding	X		X	X
Tissue culture/ plant transformation		X		X
Biosafety				
Risk assessment research	X	X	X	X
Biosafety capacity building	X	X	X	X
Development and harmonization				
of legislation	X	X	X	X
Biopolicy				
Biotechnology related intellectual				
property protection (IPP) issues	X	X	X	X
Access to and transfer of biotechnology	X	X	X	X
Biotechnology assessment	X	X	X	X

(BAC/BCRI, 1999; p. 23

DGIS-Biotechnology Programme research priorities defined by country

Key themes	Zimbabwe	Kenya	Colombia	India, Andhra Pradesh
Agricultural Biotechnology				
Tissue Culture	X	X	X	
Marker resistant breeding	X	X		
Vermiculture				X
Biosafety	X	X	X	X
Biopolicy	X	X	X	X

(Personal communication: Theo van de Sande, DGIS 06-01-2003)

stakeholders in setting the research agenda makes developing country actors lose interest and responsibility in the project, which is likely to harm its sustainability. Hence, to avoid developing an inappropriate research agenda, Dutch experts are not involved in the development of the programme. Once the programme is established, the stakeholders are free to involve the expertise necessary to provide for the solutions to the needs, coming either from the North or the South.

As already mentioned, the autonomy of Southern actors to set the research agenda is an equally important issue in SAREC's policy. However, this assumption does not hinder SAREC in offering the South the possibility to profit from Swedish technology, expertise and experience. By these means, developing countries do not need to waste time on 'reinventing the wheel'. They can learn from the North and according to Swedish policymakers save a lot of time and energy. Moreover, SAREC's research cooperation with Swedish and other academic institutes is long term and the idea is that the network established will profit from it in the future.

From the perspective of the DGIS policy, the SAREC way of capacity building may result in the transfer of solutions that are not appropriate for the immediate needs of developing countries. SAREC, however, sees risks of making the same mistakes in the developing countries as have been made in the North, not forgetting the delay in results and the additional costs the lengthy research processes create. The Dutch donors, however, claim that the gains in terms of sustainability outweigh the (supposed) extra costs for reinventing the wheel.

Actors building capacity in the South

What different powers do stakeholders have and how could this influence the way the programme is implemented?

The priority that SAREC gives to academics in BIO-EARN is likely to have influenced its focus and priorities. A lot of trust is placed on the ability and willingness of scientists to carry out appropriate, demand driven research. Although communication with civil society is promoted in order to anchor the activities, there is no sign of lay people participation in decision making.

SAREC has tried to tackle the problem of Swedish partner domination in research cooperation by giving the authority of the operation and planning of the project to the actors in the South. However, the South is still the weaker party and is dependent on the new knowledge its Swedish partners give. Moreover, the East African partner institutions also have different levels in development related to biotechnology, which makes it likely that they have similar interest of competition. In order to safeguard all partners' interests, it has become necessary for the programme coordinator to set up special agreements to secure IPRs and other national regulations regarding new materials and processes that are transferred between the Northern and Southern research institutions. This explains that the sharing of knowledge through cooperation and collaboration between the East African and Swedish researchers is problematic. There are a lot of interests involved that may hinder or complicate the process of giving enhanced benefits to all parties, which is the goal of setting up such networks of cooperation.

In the case of the Dutch Biotechnology Programme, actors like NGOs, policymakers, scientists and small-scale farmers are involved in setting the agenda for local biotechnology and biotechnology policy development.

Although the researchers are selected carefully according to their commitment to aiding small-scale farmers, the tremendous need for funding in developing countries as well as the existing power relations are likely to influence the way they research small-scale farmers' needs. For instance, scientists' interest are likely to influence the direction of the research – so it turns towards biotechnology solutions that would result in an article or patent

that could enhance the scientist's academic or economic career.
According to the IBU approach, this kind of development would be hindered by the interests of other stakeholders participating in the process. However, despite the efforts, in most cases it has proven difficult to deviate substantially from existing power relations in decision making in society at large

The implementation of policy

The BIO-EARN programme has completed the first phase (1999-2001) and SAREC has approved support for phase two outlined by the programme stakeholders in East Africa. The focus of the first phase is to establish a basis for the network and to initiate capacity building in the areas of biotechnology, biosafety and biotechnology policy. Three steps have been taken to accomplish this. Firstly, capacity building activities have been launched, such as academic training and research, internships, hands-on training and workshops for policymakers and academics, and the transfer of equipment. Secondly, network activities have been carried out, such as the establishment of material transfer agreements between partners, the formulation of biosafety manuals, the production of articles, newsletters and web pages, and one general assembly meeting with all programme stakeholders. Finally, the transfer of programme coordination responsibilities to East Africa has begun. In this first phase, capacity building has been successful while the programme has run short in collaboration since linkages have not been as extensive as expected. Especially at national level, support for the programme has been weak, which may threaten the future of the programme.
In the second phase of the programme (2002-2004), the task is to work out how biotechnology can benefit society in general. This will be done through continuing mobilization of capacity in biotechnology, biosafety and biotechnology policy dovetailed with increased collaboration and communication especially with end-users such as local small-scale farmers and industries.
In the third and last phase of the programme (2005-2008) the aim is to create sustainability and continuance in both research and network activities. The search for grants will be promoted during this phase (Dagne, 2001).

The DGIS Biotechnology Programme has already been running since 1992. The four phases of the programme follow the logic of the participatory Interactive Bottom Up (IBU) approach (see Commandeur, 1997). It has been difficult to implement the IBU approach for the Zimbabwe and Kenya programme. In Colombia and Andhra Pradesh in India, it was less complicated and hence the outlined approach was followed in a more straightforward way.
According to an evaluation of the programme conducted in 1997, many of the complications were due to problems in implementing the philosophy of the IBU approach by Dutch policymakers. Instead of the IBU approach the Dutch policymakers implemented an approach which very much resembled the standardized institutionalized practices common at DGIS. As a consequence, the different stakeholders in the programme countries gained a limited understanding of the IBU approach. Hence, the implementation of the programme in the developing countries lacked the reflexivity and cultural accountability that the IBU approach requires. For instance, in some cases participants were handpicked on their expertise, not on their commitment. Moreover, the activities in the South were assessed according to standard practices following an assessment checklist. Among other things, the checklist dealt with the way the programme countries take IPRs and biosafety into account, the quality of scientific expertise and the degree to which sound scientific practice has been carried out. Instead of being bottom-up, the practices and methodology of the programme followed a top-down approach.
As a result of the evaluation the institutional setting of the Biotechnology Programme at DGIS was revised in 1997 and more autonomy was transferred to the South. Of the programme team and advisory committee set up at DGIS, only two coordinators were left in office to continue running the programme. Instead of an assessment of the activities to be carried out in the South, the requirement for funding is the formulation of a comprehensive programme proposal indicating the need-based, demand-driven priorities for research and the way a participatory approach is ensured throughout the programme.
All four country programmes have succeeded in establishing multidisciplinary Steering Committees consisting of local stakeholders (NGOs, policymakers and scientists), identifying local problems related to small-scale farmers' needs, and finally around 1996 accomplishing overall programme proposals in each country, all of which have been accepted for funding. Broadly speaking, the research in the programmes aims to provide for disease free, affordable planting material that is well adjusted to local circumstances and has specific traits.
The programmes are currently implementing their agreed proposals. Recently, new programme proposals for activities for the coming five years have been received and some of them have been granted funding by DGIS. Others are still under consideration.
Moreover, many different activities have been undertaken regarding the integration of the development dimension into Dutch national biotechnology policy and international cooperation and coordination. Examples of actions related to international cooperation and coordination are funding for international initiatives to stimulate demand driven agenda-setting in biotechnology research, support for establishing the Biotechnology Development Monitor, and finally, different kinds of political activities to benefit small-scale farming in developing countries have been carried out.

Comparing table 3 and 4 we can see that the Biotechnology Programme focuses on research and development in agricultural application only, while the BIO-

EARN programme supports the development of applications for industry and waste treatment as well. Despite this, the proposal for the second phase of DGIS' Colombia programme, which has recently been approved, is oriented towards the use of biotechnology for improving the environment.

The means that for biotechnology production, tables 3 and 4 reveal that only a part is aimed at producing GM applications. In fact, in the case of the Biotechnology Programme, the participatory approach seeking to meet the needs of small-scale farmers has resulted in research and development of mainly traditional biotechnologies such as classical breeding or tissue culture.
As these programmes have not yet been completed, the BIO-EARN programme has not completed any of its biotechnology products, and because they use such different means to develop biotechnologies, no fair comparison of results can be done at this stage.

Conclusions and recommendations

The respective donors share the assumption that biotechnology research is a key to sustainable development, increased livelihoods and local food security, provided the technology is handled well. However, they use quite different approaches to fulfil this aim.The IBU research approach of the Biotechnology Programme is a more novel and innovative approach compared to that of BIO-EARN. It is assumed to deliver a socially accountable, end-user oriented and sustainable product. The sustainability and quality is ensured by a locally applied, reflexive and transdisciplinary research approach with an organizationally diverse, democratic and flat hierarchy due to the inclusion of all stakeholders' interests in decision-making, lay people included. The pioneering position of DGIS' Biotechnology Programme in using such a novel research approach within development cooperation can help explain some of the bureaucratic complications that followed when it was implemented. However, it is questionable whether all problems can be explained by the novelty of this approach. Even after 1997, when the correct approach was implemented, the problem of stakeholder participation on equal terms in decision-making prevailed. In particular, the ability and power of small-scale farmers to influence decision-making has been limited compared to that of scientists.

In this light SAREC's BIO-EARN programme seems more realistic in its assumptions, though less ambitious. This approach gives first priority to institutional capacity enhancement in renowned institutions in developing countries through a regional and international network of experts and academics, ensuring a necessary foundation and making sure that the quality of activities in developing countries are maintained by peer review. As a second step, end-users will be taken into account in order to produce useful and sustainable technologies. However, at the moment there is no clear indication of how BIO-EARN will accomplish this aim. If they do not manage to take the indigenous knowledge and needs of local end-users into account the products are likely to become less useful and hence less sustainable.
An extensive analysis has been carried out based on an approach outlined by *Gibbons (1994)* and more remains to be said about this in the context of Swedish and Dutch biotechnology development cooperation. Due to limitations of space the choice has been to adopt a descriptive approach, a more analytical approach raising theoretical questions by means of Gibbons and others would say more about the viability of the two approaches. Such an analysis is expected in future publications (Ulmanen, 2003). ◇

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Linking focal points in biotechnology

One of the objectives of the future Monitor programme could be to establish an environment that will make it possible for key biotechnology stakeholders and constituencies to have an explicit and determining role in the future development of biotechnology. This article describes an initiative in an outreach programme designed to meet such an objective. It sketches possible parameters and explores the significance of the *Lusaka Workshop on Agrobiotechnology and Food Security in South Central Africa* for the future of biotechnology.

How should the Monitor as a journal whose mandate is to address issues such as the unequal distribution of biotechnology capacity, competence and understanding define its agenda in a global order characterized by widespread scientific illiteracy and political immaturity and where communities worldwide are struggling with the ethical dimensions of scientific conclusions?

What is the position of the Monitor in an information process that begins with laboratory, university, government and company sources and is elaborated in the projects and work of international, regional and local development agencies? And how accessible is this information to those working to alleviate poverty, chronic agricultural underproduction, and debilitating disease?

Strategies for new constituencies

In this context is there a demand for the Monitor outside the circles of the scientific literati?

The Monitor – the introspective subject of this edition – needs to consider this issue carefully. It can be suggested that the Monitor should develop an organizational structure and programme that makes it possible to meet a growing public demand for a deeper analysis of biotechnology. In this approach the Monitor will have to seek sources able to apply the principals of scientific research to the social and economic dimensions of applied biotechnology. The Monitor should not simply look for new areas of research to record and analyse. It should also be concerned with describing, integrating and examining the reality of those communities whose ways of life are becoming increasingly and inextricably dependent on biotechnology and its agricultural, medical and industrial applications.

The Monitor needs to be proactive in identifying the scale and nature of the demand for the material it specializes in. Future activities therefore may include a focused outreach programme that is not only regionally based but identifies and makes visible strategic groups within the biotech world. At the same time, bringing the constituencies of the biotechnology world together will facilitate the Monitor's core task: sourcing, inventorizing and documenting developments in biotechnology.

Outreach: the Lusaka Workshop,

The workshop *Agrobiotechnology and Food Security in South Central Africa*, held at the University of Zambia, Lusaka at the beginning of October 2002 was a step towards developing an outreach programme. The Lusaka Workshop set out to inventorize and document research and experiences with agrobiotechnologies that could improve the food security of SADC region. It was initiated by the Monitor as part of *The Network University* and was run in cooperation with two regional partners. The first of these was the *Biomedical Research and Training Institute* (BRTI), an organization representing Zambian specialists in human and animal health, agriculture and natural resource management, which coordinated the Zambian side of activities. The second was PELUM (*Participative Ecological Land Use Management*), a network organization with branches in East, Central and Southern Africa primarily concerned with training, communications and advocacy, who took responsibility for media activities. Both the Monitor and PELUM will be publishing material generated in the workshop in their respective magazines later this year.

The Lusaka Workshop was funded by NOVIB (OXFAM), KEPA Zambia (Finnish Development Aid) and the *Technical Centre for Agriculture and Rural Cooperation* (CTA).

The objective of the Lusaka Workshop from the Monitor's point of view was to explore the possible impact on future Monitor activities of an outreach programme that included thematic workshops and focal group activities. Apart from regional stakeholder groups such as those brought together in the Lusaka Workshop, the Monitor also wishes to work with representatives of national and international research institutions, corporate and civil society organizations and those international and national agencies involved in regulation and policy. Focal group activity involving such constituencies will make it possible for the Monitor to source, analyse and document the approach and impact of key stakeholders in biotechnology research and practice. Constituency-specific workshops to inventorize and document issues of local and regional importance will provide a firm basis for the development of a less Eurocentric publishing process.

Constituencies

The Lusaka Workshop made visible a group frequently excluded from national and international conferences and forums: field-level researchers and innovators working with agrobiotechnology in academic, government and civil society organizations. It also brought together representatives of the local media and information services specifically concerned with agricultural and development issues. Establishing learning and working relationships between these two groups was one of the successes of the Lusaka Workshop and, as the articles and radio material produced during the workshop showed, it contributed to improving the quality and flow of information on agrobiotechnology and food security into the public domain. It also complemented the work of such organizations as the National Institute for Scientific and Industrial Research, the Zambian National Farmers Union and PANOS (Africa) who have been running biotech 'sensitization' workshops for the media.

The journalists, broadcasters, web editors and representatives of information services from Kenya, Malawi, Zambia, Zimbabwe, Ghana, South Africa and the UK who attended the workshop used it to source material and clarify the technical complexities they felt inhibited their ability to report on agrobiotechnology. During the workshop, daily media panels provided journalists with an opportunity to discuss the role of their profession in ensuring that information relevant to agricultural recovery and development entered public discourse and became accessible to those concerned with agricultural policy and farmer and extension practice. A media forum at the end of the workshop, attended by the heads of Zambia's main information services, drew policy conclusions from these panel discussions and suggested strategies and approaches that could improve the quality and quantity of development-oriented reporting.

A comparative and international dimension to discussions was provided by specialists from Europe, Asia and West Africa. Their contributions served to place the issues raised during the workshop in a larger analytical framework and was in line with one of the objectives of Monitor editorial policy: to make local experiences more relevant and accessible to stakeholders in other regions. The regional composition of the workshop encouraged scientists in particular to explore such issues as the regulation of biotechnologies that have transboundary implications and to discuss ways of working together to increase the capacity and independence of scientific research and decision making in the SADC region.

Agrobiotechnology and food security

The Workshop resulted in a clear definition of the agronomic and political factors underlying chronic food insecurity in SADC countries: the steady erosion of local genetic diversity; incoherent agricultural policies leading to the degradation of natural resources and a fragmentation of development efforts; and a fatal overemphasis on maize production at the expense of traditionally more mixed farming systems capable of delivering nutritionally better and more balanced diets.

Experiences from Zambia, Malawi, Zimbabwe, Ghana and Kenya indicated that biotechnology had an important role to play in conserving local resources, ensuring the supply of clean planting material, strengthening livestock and fish breeding programmes and minimizing post harvest losses. It was in the context of these agrobiotechnologies that the appropriateness of interventions such as the introduction of genetically modified crops were discussed. The issue of whether Zambia should accept US food aid containing GM maize was being urgently debated at the political level at the time of the workshop. This served to focus attention on local and regional experiences with establishing and implementing policies and regulations that could ensure the safe management of GMOs. In a public meeting organized by the Workshop coordinators and held on the University campus, the issue of GM crops was extensively discussed by a public that included students, members of the local farming community and donor and NGO representatives.

Hands-on documentation

Throughout the workshop, journalists and reporters filed articles and recorded interviews. Many of these were either published in the local press or used later as the basis for radio programmes. *The Media Resource Centre*, set up to provide reporters and information officers attending the Workshop with material relating to agrobiotechnology and development, was well used. Magazines, books, reports, videos and material downloaded from internet were supplemented during the week by brochures, reports, local newsletters and other publications brought in by local participants and visitors to the Workshop.

CTA had commissioned *WrenMedia* (UK) to produce a *Rural Radio Resource Package* on the theme of the Workshop, and extensive use was made of local journalists and broadcasters in preparing the material for this project. Another Workshop product was a video prepared by the students of the *University of Zambia's Mass Communication Department* who recorded the weeklong proceedings. Their final montage was subject to critical assessment by the Workshop during the closing session.

Policies and networks

During the workshop the journalists and broadcasters present decided to institutionalize the contacts they had made with national, regional and international media by setting up a network for journalists specializing in the agricultural and environmental aspects of development. NEAJESA (*Network of Environmental and Agricultural Journalists* in East and Southern Africa) is currently consolidating its national and regional organization.

In terms of the Monitor's own objectives the Lusaka Workshop proved to be an effective way of collating information and sourcing material on regional biotechnology initiatives. More importantly, perhaps, it also provided an opportunity to arrive at a better understanding of the context in which agrobiotechnologies were being applied in the region and the factors that determine the appropriateness and impact of individual technologies. The Workshop also enabled the Monitor to identify contacts, authors, potential editors and networks in the SADC region who might be able to work with the Monitor on future information projects. It also made it possible to make a realistic assessment of the infrastructural problems that hinder the flow of development-orientated information locally.

Interfacing information

The Biotechnology and Development Monitor works at the interface of the inventorization and documentation process. In this role the Monitor – both as journal and web-based media – has the potential to strengthen links between information providers and users. In doing so, however, the editorial policy of the Monitor will have to re-examine its constituency and adopt strategies that draw in a new generation of young scientists, politicians, legislators and activists. Involving this constituency in developing and actualizing themes for Monitor publication and communication activities will help ensure that the Monitor will be better used as a source of information by those involved in research educational, the media and policy.

The outreach policy of the Monitor should, therefore, have two objectives: first, to strengthen and extend the sources of information available to the Monitor; and second to increase the number and diversity of constituencies that read and use Monitor material and in particular extend the Monitor readership beyond its present constituency. In this the traditional Monitor ways of generating information will continue to be useful. However, the experience of the Lusaka Workshop has shown that the specificity of workshop and focal group activity both in terms of topic and constituency is a particularly effective first step to monitoring developments in biotechnology and analysing its socioeconomic impacts. It also suggests that not only can such workshops make visible the international, corporate and regional communities that determine the development and application of biotechnology but in well-organized workshops with clear objectives and strong facilitators they can contribute to establishing informative and productive dialogues, source material for further communication activities. In this way the Monitor may be able to facilitate the flow and analysis of information between those at its source and those who need to access it in the interests of development. ◆

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Reference
♦ Workshop Report available at www.biotech-monitor.nl

The stakeholder approach to biotechnology policy

In developing a national policy for biotechnology application and development, the major challenge is to integrate the stakeholders' interests and expectations while still deriving the policy options from the national socioeconomic and political context. Meeting the challenge depends to a large extent on the degree of participation of stakeholders. It was against this background that the *Biotechnology Development Programme* (BDP) was conceptualized for Ghana. This article appraises the programme and discusses the way forward.

BNARI

Ghana committed itself to biotechnology development with the establishment of the *Biotechnology and Nuclear Agriculture Research Institute* (BNARI) in 1992, under the auspices of the *Ghana Atomic Energy Commission*. The institute was set up, inter alia, to:

- develop better varieties of economic crop plants,
- increase and stabilize agricultural production,
- raise the level of nutrition by improving food quality,
- protect crops and livestock against losses through insect attacks and diseases
- preserve food for animal and human consumption.

The establishment of an institution for biotechnology suggests that Ghana acknowledges the importance of biotechnology in national development. There have also been a number of initiatives in biotechnology development focusing on the scientific application of biotechnology such as tissue culture and molecular biology techniques including ELISA, RAPD and PCR applications. Scientists of the five public universities, the research institutes of the *Council for Scientific and Industrial Research* (C.S.I.R.) and other institutions such as the *Noguchi Memorial Institute of Medical Research* use biotechnology in addressing their institutional mandates. However, the explicit policy initiatives for biotechnology development have not moved in tandem with the activities on the ground. More importantly, critical regulatory issues for bio-safety are yet to be addressed.

An explicit biotechnology policy defines the goals and objectives for biotechnology application and development for Ghana, having regard to national needs, availability of resources and priorities for development. It fine-tunes existing mechanisms and institutional activities to bring about synergy. It highlights the thrust of related policies such as the science and technology policy and agricultural policy to focus on areas of biotechnology application. The content of an explicit biotechnology policy includes a statement of intent and purpose of biotechnology development, the definition of framework for public investment, regulation, capacity building, biosafety and bioethics. An explicit biotechnology policy is only facilitative of the process of biotechnology development. It is only one of the means and not the end.

The Biotechnology Development Programme (BDP)

There have been efforts to stimulate policy discussions on biotechnology, particularly in the 1990s. For example, in 1998 the *Institute of Biologists* organized a symposium on biotechnology development in Accra, focusing on issues of regulation. One of the main recommendations called on government to establish the regulatory framework for biotechnology applications.

But perhaps the BDP was the most concerted effort aimed at stimulating policy initiative for a holistic development of biotechnology in Ghana. In 1999, the *Science and Technology Policy Research Institute* (STEPRI) of the C.S.I.R. collaborated with BNARI and the *Graduate School of Environmental Studies* (GSES) of the *University of Strathclyde* to initiate the BDP. *The Department for International Development* (DFID, UK) funded the programme, which had three main objectives:

- policy research to provide inputs for biotechnology policy formulation;
- capacity building to enhance institutional capacity, and
- Technology Assessment to develop a model for assessing technologies appropriate for a developing country context.

The BDP, which ended in December 2000, adopted a methodological framework that centred on stakeholder participation to address the salient issues. Three main activities were carried out in line with the respective objectives.

Policy research

Policy research was aimed at providing inputs from the perspectives of the different categories of stakeholders for policy formulation to direct and catalyse the development of biotechnology in the country. The specific activities were:

- identifying all the stakeholders and categorizing them;
- establishing contacts with them;
- developing linkages among the stakeholder categories.

The climax of the efforts to garner policy inputs was the *National Stakeholders' Conference*, with participants coming from all the identifiable categories of stakeholders. There were the policymakers, the parliamentarians, the researchers, farmers, academics, journalists, industrialists and workers of NGOs. Under the theme *Priority-Setting for Sustainable Biotechnology in Agriculture and Health*, priorities were outlined for biotechnology applications on the basis of the national development agenda.

Institutional capacity building

There were various sides to the efforts at institutional capacity building. For example, the BDP aimed at creating a framework to stimulate biotechnology innovation and enhance existing capacities. The programme began by strengthening the capacity of STEPRI with the necessary logistics to carry out the programme activities. The aim of enhancing institutional capacity was mainly addressed through activities such as:

- using linkages and networks among stakeholder institutions to enhance access to available facilities,
- creating public awareness and public education, and promoting collaborative ventures between the private investors and local scientists.

Technology assessment

To address the objective of technology assessment a survey was conducted in purposively sampled institutions and enterprises cutting across the stakeholder categories. The survey aimed at identifying institutional capacities in respect of human resources, physical facilities, and the systems for the flows of knowledge and innovation. The results gave positive indications of potentials for innovations. The use of modern biotechnology techniques had become integrated routine modes of research and development.

There was also the diversity of high-level human resource in the country, which though inadequate could serve as a core for creating a base for biotechnology applications. As already intimated, there was however a lacunae in the policy and regulatory framework typified by the absence of biosafety guidelines – a source of concern for stakeholders including scientists.

Impact

In considering the positive gains for policy, there was significant impact. The sensitization of policymakers led to some important initiatives. For example, soon after the *National Stakeholders' Conference on Biotechnology*, which saw the participation of some ministers the *National Biosafety Committee* was set up to address the key concern of stakeholders. The year 2000 was declared a Biotechnology Year backed with budgetary allocation for selected institutions. The *Ministry of Environment, Science and Technology* actually allocated 2 billion Ghanaian cedis, equivalent to about US$ 250,000, to the relevant institutions under it including some of the CSIR research institutes and BNARI. Given that this funding was meant for improving and upgrading facilities in these institutions, the amount was inadequate. However, viewed against the national budgetary constraints, it was a significant action. Perhaps the most important gain from the Conference and the BDP in general is the imprinting of biotechnology at the helm of science and technology policy formulation in Ghana. This notwithstanding, there are outstanding issues including the fact that the national biosafety guidelines are yet to pass through parliament. Table 1 summarizes the stakeholder categories, interests and the impact of the BDP.

The BDP did make impact. For example the discussions among the stakeholders helped to place the issues in the socioeconomic context of Ghana and highlighted stakeholders' respective interests and concerns. Scientists were keen on capacity building for biotechnology applications similar to modern technological trends. But they were also anxious to ensure safeguards for life and the environment, as were the other stakeholders. In the varied – not necessarily adversarial – positions of the stakeholders there was a basis for consensus: Ghana needs to utilize and develop biotechnology, but it must be in relation to the country's needs and development priorities such as in agriculture and health. Specifically in agricul-

Summary of Stakeholder Categories, Interests, Programme Impact and Issues

Stakeholder Category	Stakeholder Interest	Programme Impact	Outstanding Issues
Sources of knowledge and innovation e.g. scientists, educators, extension workers	Experimentation for innovations; supply of innovations; linkage between suppliers and users	Facilitation of knowledge flows within category and to other categories	♦ biotechnology policy ♦ biosafety regime ♦ public education and awareness ♦ strengthening national capacity, physical facilities and human fresources ♦ improving organizational framework for coordination and programming
End-users e.g. farmers and industrialists	Biotechnology products for end use	Stimulating linkage between the source and the end in the innovation flows	
Facilitators/ Mediators e.g. policymakers, environmentalists, mass media workers, investors, civil society activists.	Policy formulation, regulation, public information and , education business ventures	Sensitization to the stakeholder roles, stimulating process for biosafety guidelines, facilitating private sector and scientists interaction	

ture, the focus of biotechnology should be on improving the production of the key food and cash crops, which include maize, cassava, cocoa and plantain. In health, applications should focus on malaria, infectious diseases, HIV/AIDS. The creation of public awareness and public education should enhance public understanding of the choices that are made from the range of technological options biotechnology offers.

The publication *Biotech Ghana*, which was aimed at providing a forum for public awareness and education, has fortunately survived. Conceptually cast in the mould of the *Biotechnology and Development Monitor*, it has created a channel to the stakeholders for information on and sensitization to the issues. Currently, the *African Technology Policy Studies Network* (ATPS) is sponsoring the publication through its project in Ghana, *Technological Capacity Building for Biotechnology Development: Stakeholder Linkages and Public Dialogue.*

The way forward

The whole idea of making the BDP a programme relates to the notion that even after the eighteen-month period, project activities would continue. While some of the programme activities are continuing, others have stalled due to systemic factors such as policy defects, bureaucracy and the limitation of resources. But the networking of stakeholders, conferencing, technology assessment surveys, awareness creation and public education are activities that ought to continue.

One major reason why awareness creation and public education must continue is the choice that confronts developing countries such as Ghana with particular reference to genetic engineering. That choice is assuming a degree of urgency these days. For example, in the event of drought and famine, should Ghana accept genetically modified foods given as food aid? Decisions made under duress are decisions that are vulnerable to risks. While Ghana is enjoying its halcyon years – it has a maturing democracy, encouraging agricultural production and a gradually stabilizing macro-economic climate – it may be time to decide on the answers to some of these questions. The decision to accept or reject genetically modified foods should not be taken in times of crisis. It should be situated in the national policy, specifying choices for biotechnology application and development in accordance with the national development agenda. This is best done through a consensus approach with the stakeholders interacting, debating and deliberating on the corollary issues.

Conclusion

The fundamental basis of the BDP is the need to guide the development of a biotechnology policy in Ghana that derives from national needs. There is no such explicit policy yet, but when it is being developed, it must be a policy that opts for choices in line with sound scientific, social and economic criteria formulated through stakeholders' dialogue. It is in this regard that biotechnology application and development will be meaningful and beneficial. ◈

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Innovation capability for agrobiotechnology: Policy issues

Modern agrobiotechnology is developing at a crucial phase in the history of agricultural science. The conventional green revolution paradigm is being forced to shift to a more ecologically just and politically sound paradigm of sustainable agriculture. Within agricultural innovation systems, the decisions in agrobiotechnology, be they on research directions, allocations or release of research products, will now depend on a judicious mix of public opinion, regulatory and political safeguards, new partnerships and organizational formats, social contracts and scientific judgements. This entails changes both in the expectations from science and in the existing policy processes and instruments. Agricultural biotechnology is now marked by new research and development partnerships demanding new capabilities in the social sciences to analyse relationships between science, technology and society.

Agrobiotechnology: From maintenance research to systems intelligence

The green revolution has taught us that a technology in itself can contribute little to agricultural development unless several complementing technologies, institutions and policies are in place. Biotechnology policies and programmes must be integrated within a sectoral framework and located within the range of problems confronted by agricultural research and policy. The institutional and policy changes now in demand are those that will permit the transition from conventional agriculture to sustainable agriculture. The first generation green revolution technologies in the 1960s enhanced productivity. The ecology responded with more focused and virulent strains of pests, pathogens, and weeds, specific forms of soil and water degradation, and losses in the diversity of crops and other flora and fauna. 'Maintenance research' became essential to maintain yields in the face of these second and third generation problems. Biotechnology, despite its immense potential to respond to specific crop-ecosystem requirements, has now been cudgelled into the confines of these marginal or incremental changes in agricultural technology, to maintain existing yield levels in the face of problems such as weeds, pests or diseases. Current research content in and outputs of biotechnology research are part of this research paradigm to 'maintain' pressure on the ecosystem. Modern biotechnology focuses on the identification and expression of one gene or sequence to enhance yield or quality of produce, push resistance to one pest, disease or weed that is manifest now in the ecological response to this unrelenting pressure of knowledge and technology. Biotech research on bollworm resistant Bt cotton, sheath blight resistant rice, or Vitamin A enriched golden rice, fit into this paradigm of 'incremental response'. The 'incremental' approach to knowledge and capacity building entails the loss of an evolutionary systems perspective and is marked by the inability to address issues in biodiversity or sustainable development (Clark and Juma, 1998). Biotechnology can study the genetic expression of organisms and interactions in complex ecological systems, generate solutions for degraded ecosystems, obligate pathogens, and better rural livelihoods (when part of multidisciplinary analyses), and help gain a systems understanding of the diversity of gene pools and ecosystems. This long-term, evolutionary systems perspective, is the niche on which agro-biotechnology can and must focus to enable the transition from the green revolution research paradigm of maintaining pressure on the ecosystem to a paradigm of sustainable agriculture. It is increasingly evident that the future of agriculture and biotechnology in particular depends on R&D capability to discern and delineate systems components, their interdependence, co-evolution, and equifinality. This systems intelligence demands that we explore the rules or institutions that govern the way innovations are generated and utilized in societies, including intellectual property rights, different R&D strategies in the North and South, knowledge hierarchies among different actors in innovation systems, etc. The social and ecological impacts of narrow maintenance research teach us the need to locate biotechnology in the context of a larger systems understanding of agriculture, land use and ecosystems.

Institutional change: new challenges and strategies

It is no coincidence that the marginal and incremental yield enhancements or cost reductions are technologies that can be appropriated, generated and sold in the agricultural technology market for profit. Institutional changes fostering increased collaboration and partnerships between private and public sector R&D are more crucial in the era of agrobiotech than they were during the green revolution. The responsibility for generation of basic or frontier knowledge in biotechnology, as well as accountability to society and to science is no longer the exclusive prerogative of the State and its public sector R&D. The emergence of the 'hybrid firm' in science-based industries, embedded in (legal, scientific and administrative) public sector institutions (Fransman, 2001) is a pointer to the future of agrobiotechnology innovations. Agricultural biotechnology demands new rules, norms or institutions in the conduct and uptake of research processes and results. Institutional reform within the Andhra Pradesh-Netherlands biotechnology programme in India is a case in point. It focuses on socially inclusive processes of technological as well as institutional capabilities (Clark, et al 2002). This programme, embedded in local actor networks, views capacity development as creating disciplinary (frontier) expertise as well as enabling the institutional change that can sustain the participatory research processes and its development impacts. Evolution of private-public partnership in agrobiotech in semi-arid agriculture (led by ICRISAT), with new ideas (a science park to act as an incubator for small agrobiotech firms), emerging research collaborations, new actors, and changing rules or norms of cost-benefit sharing, provides opportunities for institutional learning and policy making. The policy vacuum in these institutional aspects of agrobiotech makes progressive institutional reform slow and difficult (Reddy et al, 2001). Policy makers must be wary of organizational blueprints. It is important to encourage the dynamism and organizational hybridity essential to exploiting biotechnology and enabling effective response to specific agroecosystems and market contexts. Centralized funding and administration of research may not help excellence and relevant results. Monitoring and assessment of agroecological changes and biodiversity, local stakeholder participation, and specific R&D coalitions (public-private, intra-public sector) are important in agbiotech research.The recent controversies about private sector collaboration in biotechnology R&D (MAHYCO), terminator technology, Bt cotton trials and regulatory frameworks point to the need for institutional change in policy and science. Does the State have the authority to burn farmers' Bt cotton fields? Farmers do not recall being consulted in the 1960s or 1970s when conventional cotton breeding in the *National Agricultural Research System* (NARS) shifted from diploid (*desi*) cottons to tetraploid (American) cottons with higher yields, longer staples, and virulent pest incidence, demanding increased inputs, pesticide applications, agricultural credit and debts. Is Bt cotton an answer to historically misconceived policies? R&D capability and policy making in agrobiotechnology needs to be historically informed. It must engage in public debates about technological and social alternatives. Can Indian farmers demand gene characterization studies in diploid cotton, leading to strategic knowledge to improve its staple length and perhaps reduce pest incidence? Who is to conduct the fundamental and strategic research as well as the applied research for such genomics and systems analyses? An important lesson from existing R&D networks in agricultural biotechnology comes from the shared investments (in these hybrid quasi-private/public organizations) and responsibilities. There is ample scope here for increasing stakeholder participation in these partnerships. They are more dynamic and are less prone to both the ruthless profiteering associated with the private sector as well as the complacency characteristic of public sector science sanctified by state patronage and welfare economics.

Investing in and assessing agrobiotech research

The R&D actors in agrobiotech are different from the public sector R&D that contributed to the green revolution in India. *The State Agricultural Universities* (SAUs) especially in Punjab and Haryana, and the *Indian Council of Agricultural Research* (ICAR) led the green revolution (HYV-water-chemicals) research. But now they figure only as marginal players in public sector agro-biotechnology research. Frontier research areas such as basic biology, molecular biology (of rice flowering, rice insects, etc.), gene characterization (submergence tolerant genes), plastid transformation, etc., are handled mostly by research groups in the *Indian Institute of Science*, the *National Centre for Biological Sciences*, *Tata Institute of Fundamental Research*, the *Centre for Cellular and Molecular Biology*, *Jawaharlal Nehru University*, *Delhi University*, and *Tata Energy Research Institute*. In rice biotechnology for instance, research in the SAUs and ICAR ranges from strategic and applied research (gene mapping, transformation, transformation for drought tolerance and pest resistance, MAS, methodology development, tissue culture, gene cloning, and transgenic varieties) in the *Tamil Nadu Agricultural University*, the *Directorate of Rice Research* (ICAR) and *Punjab Agricultural University*, to wide hybridization research at the *Orissa University of Agriculture and Technology*. The Government of India has consciously encouraged research investment in biotechnology. *The Department of Biotechnology* (DBT) expended a total of Rs. 270 million (roughly US$ 6 million) between 1989 and 1997 on research in plant and molecular biology. Some of Indian biotechnology research is at the cutting edge. Yet, most of the public investment has gone into low-end technology development and adaptation (such as tissue culture or micropropagation). Some fundamental questions about levels and allocation of investments need answers. For instance, of the DBT investment within plant biotechnology, roughly Rs. 51 million (1998 – 1999) is allocated to investments in transgenic plant biotechnology research. What are the expectations from this investment? What are the possible uptake pathways for these agbiotech technologies? Such questions point to the need for better *ex-ante* and *ex-post* assessment capabilities both within the government and in civil society, be it for policy making, research decision-making or technology adaptation. Moreover, with new organizational formats and partnerships in agricultural biotechnology, there is scope for different actors to articulate their expectations or reservations and range of accountabilities. The new organizational formats can also enable the transition of biotechnology from conventional maintenance research to its inclusion in wider systems applications. The context-specific knowledge that each partner brings to systems analysis is a crucial input in designing research strategies and policy or regulatory instruments and processes.Given the environmental risks and uncertainties associated with biotechnology, it is imperative that the responsible nation state and science keep open and transparent the evidences, decisions, doubts, or probabilities of main effects and a series of collective 'side effects' over time and across space. The scope in science and in policy, for deliberative and discursive processes that lead to democratic decision-making have never been higher and more fervent. This entails appropriate social science inputs and deliberative democratic decision-making.

Agrobiotechnology: New roles for the social sciences and policy research.

Innovations in agrobiotechnology pose major challenges for the social sciences. These include designing appropriate institutional and organizational changes for participatory research and technology development, deciphering the locational and cultural specificities characteristic of seed markets in most developing countries, examining the historical, political and philosophical basis of regulatory policies or of criteria used for risk assessment, helping research decision-makers see the pros and cons of different decision trajectories, and exploring the shared understandings (of agricultural problems, research goals, or farming communities) and communication gaps among molecular biologists, geneticists, plant breeders and crop physiologists (Damodaran, 1999, Haribabu, 2000). In the hierarchy of the sciences in agricultural innovation systems, the social sciences must be revived from the 'less prestigious' ranks they have been assigned. The social sciences are necessary for policy research, to help us 'learn from' the changes in science-based industries. The environment-agriculture-biotechnology interface and the problems of evaluation within this interface pose new questions. These in turn question many of the assumptions of neoclassical economics used for impact assessment in conventional agricultural research (for instance assumptions about well defined private sector roles, market equilibrium, monetary valuations, or externalities), demanding other theoretical positions (like institutional economics or social construction of technology) to bear upon issue-based research. An important agenda for social and natural science researchers and policy makers is to encourage the challenges posed by these questions and assessment problems. The social sciences can effectively answer the anti-science rhetoric that threatens agrobiotechnology research and engage with these open and ethically contestable questions in equal partnership with science. Democratic values (especially of franchise, scope and authenticity), and social capabilities are important in deciding the policy for and sanction (or otherwise) granted to scientific research and the commercialization of certain research results. Policies in some countries (the USA and China) allow commercialization of agrobiotechnology, while some have prohibitory or cautious policies in this area (India, Brazil, Kenya). It is often argued that this boils down to the deployment of the precautionary principle in different frameworks (Paarlberg, 2000). The difference, say between China and India or Brazil, may be the presence of a democratic polity in the latter.The history of the green revolution tells us that simple and compartmentalized policy making and S&T initiatives will lead to further institutional and organizational confusions and waste precious public resources. More critical would be the damage done to science, in terms of loss of credibility and public faith. Active public participation in agrobiotechnology innovation systems is a necessity. ◈

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Tailor-made biotechnology: Two examples

At present, biotechnology is often rendered socially problematic and less useful. However, there is space for creative biotechnological innovations using non-genetic manipulation techniques in agricultural development strategies. The tailoring of biotechnologies to specific localities is important, especially in an environment that is favourable to the more powerful and resource-rich enterprises and farmers.

In India, the Andhra Pradesh-Netherlands Biotechnology Programme (APNL-BP) has recognized the potential for sustainable agricultural development in a wide array of different biotechnologies and has steered newly developed biotechnologies towards aiding small-scale farmers by ensuring that farmers continuously influence the technology development processes.

Two important APNL-BP projects deal with the propagation of elite lines of several locally important tree species through the use of tissue culture. The true strength of these projects lies in the fact that they were initiated only by making use of the insights and demands of local farmers, who have pinpointed their main agricultural problems and selected species to focus on. These farmers are involved in the complete technology design and production processes, making optimal use of their craftsmanship and knowledge.

In these examples, careful tailoring of biotechnologies to local circumstances has made possible the application of farmers' knowledge and craftsmanship; it also shows that this knowledge and craftsmanship is in fact highly desirable. It is only when this kind of farmer influence in the production processes is sought that it becomes more effective than a purely science-based steering of the process. Farmers can actually reappropriate all or part of the production processes. The characteristics of the carefully tailored biotechnologies described here are:

- Robustness (system is temperature insensitive, product has a long shelf life), cheap production process;
- Possibility to use local resources;
- Attuned to/using local labour capacities and patterns.

Hybridization of modern science-based biotechnologies with more traditional and local agricultural techniques in these projects has thus not been a planned strategy, but is a logical result of the evolutionary line of a technological design process that aims to attune biotechnological developments to a locality.

See next page

A: Speedy propagation and improvement

The first tissue culture project focuses on speedy propagation and improvement of four agriculturally important tree species in Andhra Pradesh, India: amla, tamarind, custard apple and karaya.

For all four species farmers want quicker propagation. For tamarind, custard apple and amla the shelf life needs to be improved and the number of fruits increased. For custard apple and tamarind the fruit size needs to be increased. The fruit size for amla needs to be kept small; small fruits are found to exhibit stronger medicinal properties and contain more vitamin C.
In this project, a hybridization of modern tissue culture technology has taken place. Traditional grafting techniques are combined with modern tissue culture technology.
Speedy propagation (while improving product quality on the basis of the above demands) was chosen as an aim for this project, because all four species are slow growers, especially tamarind. Tissue culture had been the initial strategy for the entire propagation system of the trees; it is carried out by the NARDI institute in Nagarjuna, Andhra Pradesh. A protocol for tissue culture of selected clones of all four species has been developed successfully. For amla, this technology has been improved even further through multiple shoot generation: the first explant is induced to form a branch. The branch is then cut off and placed in a new medium, where it is induced to form several shoots along the branch. This technique speeded up propagation tenfold.

At a local NARDI research station, where scientists constantly work together with farmers, it was recognized that the hardening of the tissue culture plantlets of these four species is a long and tedious process. Farmers had stated that the plants are often too weak to be cultivated and they had been reluctant to wait the length of time required for the plants to get strong enough. Through a series of steps the relative humidity of the air in little greenhouse-like compartments is lowered and plants are prepared for life in full soil. It takes these plants a long time to develop a strong enough root system. To avoid rooting problems and speed up the propagation process even further, a technology hybridization has been developed by the cooperating scientists and farmers. Tissue culture is now combined with grafting technique, which was already known by the farmers. In grafting, the top part (upper graft) of one plant is cut off and placed on the stem and root system (lower graft) of another plant. In this project, upper grafts are cut from tissue culture plants, and are placed on lower grafts with a strong root system (these are not grown through tissue culture). This brings about several advantages: first, the long hardening and root formation period of the tissue culture plants is shortened drastically, and the robustness of fully naturally grown plants is used. Second, the grafted plants carry all the selected traits (because the upper graft comes from tissue culture). And third, through the hybridization of the technology with grafting, the farmers have been able to grab a bigger share in the involved work. This finally gives them more insight into the production process and also more power to steer it. These developments now have to be evaluated by the coordinating body of the APNL-BP. It is planned to extend this working method and to set up different local grafting centres, which could be managed by trained farmers.

B: Propagation of teak and neem

The second project focuses on the propagation of teak and neem, which are also important trees in Andhra Pradesh. This project is the first of the APNL-BP and has gone through a very long period in which scientists have interacted with farmers, farm science centres and NGOs, constantly shaping the technology. It is in this project that it becomes most clear how valuable farmers' knowledge and craftsmanship is, and that this revalidation can lead to their appropriation of production processes.
For farmers to appropriate any production process they have to have an interest in the product and it has to provide them enough advantages. Teak is a valuable hardwood, of which the main advantage is that farmers get a good price for the wood. Clonal material has been selected on the basis of pest resistance (leaf skeletonizer), late branching of the stem and speed of growth. Neem is a medicinal tree (local people chew on a twig and use it as a toothbrush), and azadirachtin (AZA) can be extracted from its seeds. AZA is an oil that has antibacterial properties and can be used in soaps and toothpaste, but is in this project also used as a cheap local biopesticide. Moreover, neem wood is a locally used construction material, and its final advantage is that the residue of the fruit, after the biopesticide has been extracted from the seeds, is an effective nitrogen fertilizer carrier. Clonal neem material was selected on the basis of total number of fruits per tree, AZA content of the fruits, pest resistance against Loranthus, and speed of growth.
Tissue culture of teak and neem has been optimized and carried out by scientists in the research institute CRIDA, Hyderabad and has been passed on to a local farm science centre (KVK) where farmers have learnt the skills to perform tissue culture. It is in this KVK that farmers have come up with a highly useful innovation of the propagation process. They cut auxiliary shoots from teak plants and directly root them in a shade house in a vermiculite-based medium (a vermiculture product) with added growth hormones. The much more expensive tissue culture phase (agar medium, highly pure water, sterile working environment, high-energy light) can in this way be avoided. The shoots are hardened for survival in the field after rooting in the same manner that was devised for tissue culture shoots. Moreover, the auxiliary shoot method speeds up the propagation a few times. The only disadvantage is that it takes up much more space. Tissue culture is therefore still utilized at CRIDA to keep clonal mother material in stock. In this interactive technological design process, modern science-based tissue culture technology is hybridized with traditional vegetative propagation techniques.
Because of the advantages of this innovation, a start was made on the provision of several localities with a shade house. All these localities are now able to perform the same techniques and grow and sell their own teak and neem plants without any further outside funding.
Not only is this technology development experience a clear

example of the importance of the revalidation of local knowledge and craftsmanship, but it is also showing that the new social organization formed around the production process is in fact better attuned to the local situation. The new social organization is attuned to local labour capacity and patterns, and bears local demands (insect resistance and speed of growth, cheap pesticide) and marketing strategies (wood colour and quality, AZA) in mind. Local women farmers do most of the work in the shade houses, providing their families with added income. At the same time, there is constant training of farmers (including local youth) so they can acquire all the skills needed for tissue culture and vegetative propagation. The knowledge gained from the innovation and experience of farmers in the KVK and the shade houses is channelled back to the CRIDA institute and the APNL-BP coordination as well. Good programme coordination together with this locally stimulated feedback makes it possible to combine products from different localities. The vermiculite medium used in the teak and neem propagation, for example, is obtained from other localities (also working with the APNL-BP) where vermiculture is applied.

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Learning and holographic organizations: NGOs versus NARS

In recent decades the increasing competitiveness in agriculture in southern Brazil has made it hard for family farmers to remain on the land. Both N*on-Governmental Organizations* (NGOs) and *National Agricultural Research and Extension Systems* (NARS) in the region are working to ensure the viability of family farming. However, there is little or no cooperation between them in these efforts. Many opportunities for joining efforts in *Agricultural Technology Development* (ATD) are thus lost. With the advent both of biotechnology and its potentially negative impacts on family farming, it has however become necessary to think about new approaches to ATD in which every organization that holds a piece of the ‘agricultural puzzle’ can contribute.

Introduction

A 1999 field study set out to describe the nature of NGO-NARS relations and find ways for improvement. Two cases were observed, one in which NGO-NARS collaboration did take place, and another in which it did not, thus making it possible to identify factors that may hinder or promote collaboration. In describing these cases, metaphors are used following Gareth Morgan’s method of ‘Imaginisation’ (Morgan, 1997), which help in perceiving a situation from an unconventional angle, thus enabling the viewer to see previously unnoticed dimensions and initiate appropriate change.

Passo Fundo: Blocked by psychic prisons

The first case examined in this paper is located in Passo Fundo, a city in Rio Grande do Sul, situated in a region predominantly characterized by large-scale farming, and the location both of the *Wheat Research Centre* of EMBRAPA, Brazil’s federal agricultural research institute, and CETAP, an NGO closely linked to social movements.

Both organizations are to a certain extent caught in ‘psychic prisons’ of their perceptions, EMBRAPA’s being mainly shaped by technology and science, and CETAP’s by political opposition. As a consequence they have little understanding for each other, which – combined with the fact that both have centralised structures and little overlapping interests – leads to the absence of collaboration between them. Specifically, EMBRAPA, being an outcome of the agricultural modernization, tended to view agriculture as a ‘machine’ that has to be ‘engineered’ by producing adequate knowledge for and transferring it to the farmers.

CETAP on the other hand works on the participatory promotion and implementation of alternative technologies for family farmers, perceiving its work as the continuation of a political struggle in the technological field, and aiming at the creation of a new paradigm for agricultural production. In doing so, however, it perceives the NARS as ‘opponents’, whose understanding of agriculture is ideologically directly opposite to theirs.

Obviously, given these perceptions, any dialogue between the organizations is made difficult and further worsened by the fact that both of them are centres limiting their exposure to actors of their own liking. As a consequence, when EMBRAPA and CETAP do meet, it is usually as fierce opponents in the debate on agricultural development.

Chapecó: A supportive context

The city of Chapecó in Western Santa Catarina – a region of family farmers – is also the main location of both an NGO and a NARS, though here collaboration between them could be observed. This was mainly due to the supportive context to collaboration that was generated by the organizations’ structures and ideologies.

The NARS is the regional centre of EPAGRI, the agricultural research and extension company of the state of Santa Catarina. EPAGRI was created in 1992 from a merger of the states' agricultural research and extension services, the merger being seen as a better structure to meet the new challenge of sustainable rural development, especially for the state's numerous family farmers. Due to this merger the company is still busy 'finding itself', and is therefore very open to outside partnerships and inputs. Its relatively decentralized decision-making procedures furthermore give it a greater flexibility in reacting to local impulses.

The NGO, APACO, is a farmers' association which – even though it acknowledges politics as an important area of activity to support family farmers – focuses on finding technological and organizational alternatives for its farmers' groups, leaving political action to the responsibility of the syndicates. It is furthermore characterized by a 'holographic' structure: in addition to its main office with 3.5 permanent staff members, it has 17 municipality-based and financed extension workers whom it trains and with whom it implements and continuously discusses the organization's activities. Thus the 'whole' – the organization's services and knowledge – is reflected in all its 'parts', and due to this decentralized structure it has extensive contacts to state institutions.
Such a context of decentralized structures and open-mindedness has been supportive to the emergence of several initiatives for NGO-NARS collaboration. Following a suggestion by a small group of researchers at EMBRAPA's pig and poultry research centre, APACO has collaborated with this group to improve and adapt an outdoor pig-farming system. Similarly, on the initiative of a small group of researchers at EPAGRI's regional centre in Chapecó, an EPAGRI-APACO collaboration has been initiated to develop and implement small-scale agroindustries for family farmer groups.

Conclusions
The conclusions to be drawn from these cases point

Strengthening the CBDC Network

***The Community Biodiversity Development and Conservation Programme* is an international programme with the objective of strengthening farmers in developing countries in biodiversity management and conservation. The strength of the programme lies in its ability to relate to rural communities and use their initiatives in project implementation. Active collaboration between the fourteen members is achieved through networking that involves communication and regional cooperation between partner projects in South East Asia, Africa, Latin America, Europe and Canada. The CBDC makes use of modern facilities provided by the internet to promote continued close communication links between its members. Further promotion of this networking has led to the development of the project's website, and an online learning module. These are intended to reach a much wider audience both within and outside the folds of the programme.**

The CBDC Network
The CBDC is a global programme that places emphasis on understanding and strengthening the farming systems of rural communities. The general objective is to combine biodiversity management with sustainable development activities at farm community levels. The programme is conducted in a multinational partnership of fourteen groups referred to as partners: four in Africa, three in Asia, four in Latin America, one in Canada and two in Northern Europe (see table). Eleven of the partners come from developing countries, where they implement projects involving field research that links directly with the practices of rural communities. Individual partners may be non-governmental organizations, government research organizations and academic institutions that have extensive experience with the conservation and utilization of plant genetic resources (PGR). Coordination between these partners is conducted through communication that enhances regional and international cooperation in a networking approach.
For maximum impact in rural communities, different conventional approaches have been adapted to research methods based on field experiences with the farmers involved. Research scientists encourage farmer initiatives that enhance local control of plant genetic resources. More direct emphasis is laid on conducting farmer-led research and on encouraging activities that involves *in situ* conservation. Northern partners (Noragric, CGN and the ETC group) for their part contribute to the formulation of policy and provision of funds and logistical support to the implementing partners. The Global Administration of the CBDC, based in Manila, is separated from regional programme coordination spread over three regions: South East Asia (Philippines), Africa (Zimbabwe), Latin America (Chile).

Capability building in research and extension services.
The CBDC programme runs in phases; it is currently halfway through the second phase. Project mandates include research and extension services that involve the improvement of rural farming systems for achieving food security. Locally adapted projects attempt to address the challenge of strengthening farming communities in their agricultural practices. Objectives are directed towards on-farm conservation and the development of the agrobiodiversity that is vital to the food security of the rural population. Furthermore, the programme regards *in situ* conservation as an integral component of such a village-level research and development agenda. Within this context, communities are encouraged to create a link between conservation, management and utilization of their locally developed crops. All attempts are therefore made to create a working relation-

towards a new understanding of ATD as a whole. During agricultural modernization, 'knowledge' was understood as a discrete entity to be 'produced' and 'transferred' from research via extension to the farmer, and innovation was seen as a single event leading to the generation of new knowledge. The successes of the latter, however, are the outcome of social processes taking place between NGOs and NARS, characterized by facilitation and learning. The key to agricultural innovation therefore lies not only in the innovativeness of each single actor, but also in the interactivity between all actors that are potentially relevant to agricultural innovation (Engel, 1997).

ATD, rather than being seen as a 'mechanical process' to be designed and engineered or as an 'arena of political struggle' could therefore better be compared to an 'ecosystem' whose flexibility in adapting to change is guaranteed by the beneficial interactions between its 'organisms', the organizations and actors involved in it.

The key is to create a supportive context in which such interaction can emerge. Individual organizations could contribute to the creation of such a context by following the success models described above: decentralized decision-making, 'holographic' characteristics, and a focus on learning and on facilitation-based approaches to ATD. If enough inter-institutional interaction emerges within such a context, it becomes possible to generate a critical mass of interactive institutions with the potential to significantly and positively influence ATD as a whole. ◈

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ship between farmers and researchers through extension services, and to give farmers a central role in decision-making. This further underscores the commitment of the CBDC to making all activities on farmers' fields led by the farmers themselves.

Local capacity building for regional networking

One of the CBDC's achievements among many involves capacity building within local communities themselves. Though there is a global context to networking, common regional perspectives do underscore the need to identify local objectives that could address immediate identical problems. A good example was demonstrated in Zimbabwe within the African region with an aim of bringing farmers together on a regular basis. It entailed a framework of activities directed towards the implementation of regional farmer networking schemes. A meeting of farmers was incorporated into the mainstream CBDC activities focused on providing an environment for sharing farm materials and experiences. This was conducted through Seed Fares, organized at district levels, and encouraged farmers to bring their wares and products to a community centre for exhibition. Well-organized seed exchange mechanisms were worked out and supervised by CBDC extension staff so as to promote farmer empowerment through the acquisition of good planting materials. It was also used as a platform for introducing modern technologies through posters and field equipment exhibitions. This turned out to be an encouragement for local cooperation among farmers. Some farmers used the opportunity to sell seeds to earn the extra cash they needed for farm support. Within the exchange mechanism, farmers also shared farm-level technologies for on-farm storage and management of biodiversity. Based on the similarity of objectives and the success of the scheme, the other regional partners in the African Network – Sierra Leone, Burkina Faso and Mali – are now assessing the possibility of incorporating seed fares into their mainstream activities. This demonstrates progress being made in terms of learning more about the dynamics of sharing ideas among regional projects in order to understand their strengths and weaknesses and the areas in which other partners have to adopt technical or technological input in pursuit of similar objectives.

Means and approaches to enable global networking

The continued growth of information technology has offered the possibility for close communication links between partners in the CBDC programme. The recent internet revolution, with its implications for communication and collaboration, has provided the greatest single tool from which the globally distributed regional projects have benefited. Based on the ease of communication, geographic distances no longer impede active interaction between distant partners as they did before. As part of the information exchange strategy, a communication link has been created using an e-mail facility (CBDC surfnet) through which partners interact with each other. Members are enabled to stay in e-mail contact and everyone listed on the surfnet receives messages placed on the platform. Below are some of the linkages provided by such interaction:

♦ Realizing that one of the specific points of the CBDC programme lies in the wide diversity of cultures, the CBDC programme has realized exchange of information from various sources, distributed across the surfnet media on a timely basis. In recent months, early-generated project reports from various partners were circulated over the platform. This happens on a regular basis depending on which projects are completed in time. It is aimed at helping other projects that are in the middle of similar activities to initiate changes that may be relevant to their activities. By this, partners have mutually benefited from the successes and challenges of other projects across the globe.
♦ Networking also keeps all partners informed about administrative activities and travel arrangements made by the global and regional coordinating units, and project staff. A recent example follows the visit of the African

Regional coordinator to other African projects. The itinerary for the visit was circulated over the CBDC surfnet and within hours all partners involved were giving suggestions about visit contents, and travel logistics. In another venture, a delegate from the Philippines representing CBDC at the recently convened summit in Johannesburg, South Africa updated partners on a regular basis about the progress of the summit and the activities the CBDC was involved in.

- As part of the network activity, the regional coordinators convene conferences aimed at presenting progress made at local levels, and also at sharing experiences. In order to facilitate such conferences as well as cutting down costs, a recently employed method to strengthen the interaction is the use of a teleconference facility, whereby members discuss issues without physically coming together.
- A project website: www.cbdcprogram.org has been created to meet part of these objectives. Research reports from projects, campaign statements and news items of relevant interest to agrobiodiversity are obtained from global partners and published on this website. Being part of the CBDC commitment, all reports are made available to the global audience, credit being given to the institutions from where they originated.

The CBDC on-line course as part of the network

As an extended programme within the programme network, an on-line training module is at the stage of being developed by the CGN, Netherlands, under the thematic T-Line of mainstreaming. The project is being undertaken in collaboration with *The Network University* (TNU) of Amsterdam. The objective of such training is to develop relevant personnel skills and knowledge background vis-à-vis the management and development of agrobiodiversity. The target audiences are actors interested in genetic resource management in developing countries where on-farm conservation of PGR is still the basic component of agricultural production systems. It is believed that the CBDC will have a wider impact with its campaign if other actors involved in biodiversity and rural development activities (students, NGO staff, government extension agents and other professionals) acquire training in agrobiodiversity management.

Given the nature of the target audience, the on-line teaching/learning course is an interactive module whereby 'students' can follow short presentations of content material through the internet. Practically the approach is different from (though often confused with) long distance learning. While the former emphasizes the elements of active participation of students, the latter involves the posting of large volumes of lecture material on the web, which students are expected to download and read. A demonstration version of the on-line course is now available on the CBDC website, and can be also visited at http://www.netuni.nl/cbdc/. It outlines the possibilities available and presents a partial coverage of the seed systems in the developing world. Through case studies, and drawing on participant's own experiences, the course offers a very practical approach to the two main agricultural systems (formal and traditional) and their seed relations. As well as introducing the key principles of seed management and exchange, the course gives particular attention to the various farming systems and their characteristics.

In an attempt to reduce the constraint of isolated learning with the on-line study programme, an environment has been created within the website for student discussions with one another and with the tutor at any place on the globe. Furthermore, the whole module is presented using a story line. The story in the demonstration concerns an old farmer in a fictitious village who like all others is witnessing the changing phases of agriculture in his community. His views and fears, together with his hopes are a reflection of those of the majority of his compatriots in the village. Attempts are made through the course to address these issues and give modern overviews related to the module content. Other topics that will be covered in the final course structure include Introduction to *Plant Genetic Resources, Farming Systems, Participatory Variety Selection, Participatory Research Methods, and Policies governing Plant Genetic Resources and Agrobiodiversity.*

Conclusion

There is no doubt that amid the gains made through active international network collaboration, there are accompanying challenges and shortfalls. The CBDC has learnt from these shortfalls and is making efforts to overcome them. As most of the project-implementing partners are in the developing world, modern national electronic networks in respect of high-speed communication infrastructure and broad bandwidth connection requirements that support the system are mostly lacking. In these countries, electricity provisions are often suboptimal. Computer and telephone systems may either be of low-grade performance due to prolonged use and lack of maintenance, or are not capable of running the modern systems. During the recently held teleconference, some members could not participate fully because of system failure during the course of the conference. In the near future, there is need for improvement to encourage a more active exchange of field experiences between partners directly involved in similar activities. This may include hardware assembly that could facilitate the direct sharing of results and most likely personnel visits to other projects for experience sharing.

Though the internet-based learning project being undertaken is yet at its early phase of development, there is growing apprehension among partners that such a programme may be of little use to students in developing countries. These fears are justified due to the lack of infrastructural support facilities in these countries as outlined above. However, it is well within consideration that a provision will be made by presenting the course on CD-ROMS for students in rural regions that may lack internet facilities.

The CBDC may be facing enormous challenges in dealing with infrastructural problems inherent in programme implementation in developing countries, but there is always a leeway in the spirit of problem solving within project partners. This stands out as one of the hidden strengths of the global programme, and one of the many reasons for its success. ◈

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Internet enabling partnership

The internet provides new channels for marketing niche products, It forges new networks and alliances, and cuts across traditional boundaries of geography, markets, production chains.

The story of online auctioning of coffee could equally be applicable to tailor-made biotechnologies (as described elsewhere in this issue) and to alternative developments within biotechnology. The example could also be applicable to the Monitor itself and the impact it has in mind when using and developing new tools and means through its alliance with The Network University.

22 October 2002 saw the latest of the annual online Brazilian Cup of Excellence Competition and Auction (CECAA). New online partnerships are established around shared environmental and social values through which public and private parties are collaborating. These partnerships are similar to the Italian consorzi model in which a small number of SMEs, generally from the same sector, jointly form a non-governmental organization (consorzi) to market their products. The consorzi promotes training, improves product quality, invests in expensive machinery to be shared, organizes trade missions to other locations or countries, participates in trade shows all over the world and contracts export services such as customs clearances, translations and transportation (Costa-2001, p. 58).

Changing the production-market chain and speed

Between 13 and16 October 1999, 315 coffees from six different regions in Brazil participated in the 'cupping' (coffee tasting). Internationally recognized coffee experts selected the ten best coffees, which were then offered at the auction.

A US$ 35,000 loan from the overall project-executing agency, ITC – UNCTAD/WTO allowed *the Brazil Gourmet Project* to advance a premium of US$ 0.30 per pound over the Brazil internal market to participating producers. The selected coffees were given the 'Cup of Excellence' seal, a trademarked graphic quality certificate aimed at increasing market transparency and adding value for producers and sellers.

Importers from Europe, Japan and the U.S. signed up to bid. They received samples and farm information about all ten winning lots, along with an application form and rules and procedures documents. 23 applicants qualified as bidders.

The online auction held on 15 December 1999 lasted for 48 hours. Lots opened for bidding, individually and five minutes apart. The auction's exporter was *Cooperativa Regional De Cafeicultures en Guaxupe-Cooxupe* (CRDCGC); many of the bidders already had a relationship with this well-established organization and trusted that the coffees would be handled properly. This trust was instrumental in raising bids, taking away doubts about the validity of the online auction itself.

The 'traditional' speciality coffee production-market chain can be described as follows:

1. *Producer/ Farmer*
2. *Processor*
3. *Exporter*
4. *Trader/Importer*
5. *Roaster*
6. *Retailer.*

The e-consorzi online auction led to the acceleration of the whole process; eliminating significant barriers of distance and time. Eliminating also the exporter and trader/importer, but introduced a so-called intermediator/aggregator. Participants may be large industrialized companies or small family farms, as long as they produce coherently with the characteristics of the region, its climate, soil and topography, and pay above average wages while offering their workers and their families housing, education and social services.

Furthering such developments would need:

- The adaptation of industry-wide standards for communications, data interchange and system development so that processes and systems can be aligned accordingly.
- The expansion of current online trading platforms into a (semi-)private and collaborative for a offering auction and comprehensive catalogue systems, request-for-quote functionalities and information on inventory levels and logistics.
- The application of the e-consorzio model to add extra value by aligning and integrating all (key) information and data sources.
- Expansion of the certification scheme, adopted and respected market- and worldwide, for product quality, sustainability, production and social responsibility, by providing training and information using a best-practices approach throughout the year.

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Reference

This article is a summary of his forthcoming essay on online coffee trading

Re-crafting the Biotechnology and Development Monitor: The use of interactive technologies

In 2002 the *Biotechnology and Development Monitor* developed an integrated strategy for using interactive media to take the organisation into a new chapter. The strategy is based no a vision of the Monitor as a reflective organisation with a strong ability to share existing knowledge, generate new insights and to spread these around a broad range of networks that are interested in the subject of biotechnology and development. This contribution outlines the vision of the Monitor currently under construction by focussing on the electronic building blocks that will also be used to re-craft its future.

Current positioning and new directions

The journal has a well-established scientific and institutional reputation. This has placed the Monitor in a central position between governments, civil society, NGO's and the scientific communities in the international biotechnology and development arena. Within this landscape the journal has built up a large network of readers/authors who submit papers on issues of interest to their constituency. The Monitor wants to broaden and strengthen this network and reach out to all those disseminating knowledge by also using a variety of electronic means. The framework that would facilitate this would be an interactive website providing online tools that help to keep a stronger *finger on the pulse* for the journal. The website would provide new tools to respond to the knowledge needs of readers in a more direct dialogue between itself and the different networks of which the readership is composed. In this way the Monitor aims to provide information that is continuously updated, is based on pro-active delivery; is rooted in a two way dialogue; works within a wider, internationalized editorial team; and can ultimately also be embedded in more networks involved in biotechnology and development.

Of course in the broad international context of the Monitor (its 5000 readers are spread over 130 countries), very disparate access to technology exists. The Monitor is very aware of the issue of access. Its response to this is twofold. Firstly, the question of who has access to what technology will be linked to defining the constituency for a project well before hand and to gearing the project to the technical capacity the target audience could be expected to have at its disposal. Secondly, the Monitor will continue to be provided as a paper journal distributed freely amongst its readership networks.

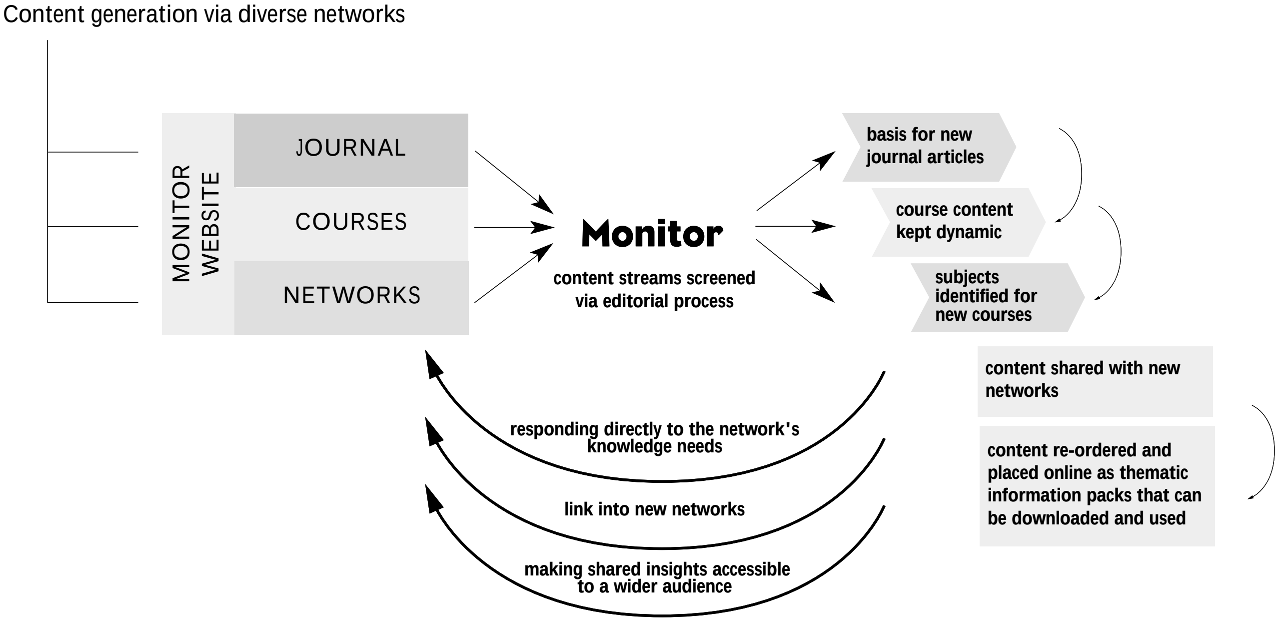
The new Monitor website

The new Monitor site will contain a knowledge base of articles, references to other sites, downloadable information packs on different topics; discussion forums, an agenda of own activities, overview of conferences, book reviews, and other mechanisms for facilitating connections and intersections between the visitors.

Among other provisions, the Monitor will facilitate *tightly moderated discussions*, limited in time and scope that provide an opportunity to develop a pro-active response to

Figure 1: New content creation chains

Figure 2: Recycling, renewing and reviving content



questions that are active in the field and will target advocacy and decision making processes. The journal has experimented with this kind of stakeholder dialogue during the online debate it organized called *Southern Voices*. In this debate 529 readers from more than 69 countries participated over two weeks to come up with 10 proposals for biotechnology policy in the Netherlands of which 4 gained a response from the Dutch parliament. The Monitor will build on this experience (and others) in providing moderated online discussions for interested constituencies in its target audience. The Monitor will also move to providing *interactive online courses* together with other partner organizations (see R. Chakandra in this issue). An integral aspect of these courses will be a direct involvement of participants in both the learning as well as the content generation process. Underlying the new site is an understanding of interactivity as primarily a social process in which both parties have the opportunity to mutually influence the dialogue.

In this way the Monitor will transform its usual reactive process of creating a new issue, into a dynamic process of renewing, reviving and recycling the content it creates. This will be achieved by better linking capacity building and information retrieval approaches into electronic channels. These will facilitate a constructive exchange of experiences and insights on the implications of biotechnologies specifically for developing countries in a way that increases capacity in the South and awareness in the North.

In short, in the future the Monitor would like to:

- Internationalize the editorial team increasingly (with a focus on developing countries), and support this process by special facilities created on the new website. The Monitor will link this process of editorial transformation into the planned southern workshop series thus ensuring that the workshop series are both capacity building exercises as well as a way of embedding the Monitor into new local networks (see M. Minderhoud-Jones in this issue):
- Have a multi-channel approach to reaching into new networks. This includes the concrete experiences of cooperation in regional seminars that contribute to both capacity building as well as to extending the international information network that feeds all Monitor activities;
- Develop a number of online courses (together with other training institutions) in order to contribute to capacity building, while simultaneously building a network of alumni who could contribute to Monitor activities;
- Assure timely information (via the website) for decision makers around relevant international conferences which will help them to prepare for these occasions (the issues; what is at stake; the historical background; and possible scenarios for future development);
- Assist partner policy making bodies in setting up online stakeholder dialogues that increase the potential for impacting on biotechnology policy in various countries;
- Re-arrange its articles into electronic dossiers or downloadable information packs that can be used by journalists and others in developing countries in their work. And provide them with the background information and various lines of argumentation on biotechnology and development;
- Take up a number of new content foci that contribute new dimensions to 'old' discussions on biotechnology and development. ◈

The new website is currently under construction. Some of the above features are already in place, others are still being developed.
We hope you will visit http://www.biotech-monitor.nl soon, and we look forward to hearing from you.

Monitoring the future of biotechnology

An open invitation to consider scenarios as a tool to monitor biotechnology developments

The emergence of biotechnology in the years to come will be shaped by a global context that is both highly unpredictable and significant. Scenario thinking, as a way to anticipate unpredictability and impact of futures that are plausible, will become a widely practised tool for strategy development and cooperation. It may therefore also contribute to the practices of building up, disseminating and exchanging knowledge of biotechnology among its widely dispersed community of researchers, scientists, policy makers, journalists, et cetera. Contextualizing issues of biotechnology against plausible global scenarios of future developments can augment the value of the contributions made in the *Biotechnology and Development Monitor*. This small contribution is meant as an open invitation to consider scenarios as a tool to monitor biotechnology developments.

Questions leading into scenario work

Biotechnology will be undergoing even more dramatic changes in the years to come than it has during the past decade. Each technological revolution remakes the world and societies. At the same time, the conditions of its emergence are determined by the socioeconomic ecology of those societies that bring it forth. Which then will be the societies to shape the new age of biotechnology? What will be the political, economic or cultural conditions they create around the biotechnology complex? How in turn will that determine the characteristics of the biotechnology appliances and economy? And, given biotechnology's expected impact on the 21st century, what new places of influence and power will manifest themselves? Such questions are as unpredictable as the future itself. Which is not to say that we cannot try to imagine plausible answers. The best strategic choice in unpredictable but highly influential situations is to move beyond trend extrapolation and establish alternative scenarios: systematic tales of plausible alternative futures. Scenarios do not predict the future so much as they illuminate it. Ideally, they serve to get us on our feet.

What a scenario is all about

Among scenario facilitators two schools of practice can be distinguished. The first school, with proponents such as the *Shell Scenario Group*, views scenarios as an analytical process to distil predictions and long-term trends. The second school thinks of scenarios as specific kinds of conversations for the ultimate purpose of change management. Nancy Ramsey touches on this second concept when she writes that '*the best scenarios aren't necessarily the ones that come true; they're the ones that subvert expectations, providing deep insights into the changes happening all around us. The better the scenarios are, the more they penetrate to the deepest possible understanding of the present*' (Ramsey 1997).

Both schools would agree that scenario thinking, facilitated by experienced practitioners, can establish '*feedback from the future*'. Usually, the process is kicked off by an exploration of plausible key forces that may drive political, economic, sociocultural, technological and environmental conditions in the future. This is followed by process steps of ranking, entitling, detailing, mapping, and writing.

Moving towards biotechnology scenarios.

If we were to kick off biotechnology scenarios, we'd suggest a pair for now, although four are assumed to be the ideal number. This initial pair summarizes two distinct sets of key driving forces in and around the field of biotechnology today:
A) Fundamentalist World
B) Utilitarian World
Depending on how the above sets of factors play out, the biotech complex will be shaped into a very different gestalt. Keeping track of this emergence and interpreting it in the most accurate way, will be a challenging task for the *Biotechnology and Development Monitor*, its constituency and network.

Two possible worlds of biotechnology: Fundamentalist and Utilitarian

A) Fundamentalist World.
At its core, the US '*war on terrorism*' is not a clash of civilizations, but a clash of fundamentalisms. This clash is increasingly being played out in a global redefinition of security, as seen in the recently restructured US strategy of homeland security. It is plausible that the globally expanded 'homeland' security concerns of the Western hemisphere, led by the US, will become an overwhelming driving force towards a world in which the biotechnology sector in the industrialized nations will become absorbed into the logic of the military sector and the governance of homeland security. Biotechnology in developing countries will be considered on the basis of security stakes. It could lead to restrictions in multilateral funding and development aid, and throttle biotechnology developments in many developing countries. This then may delay solutions to and strategies against deprivation, increase protest and resistance, and in turn cause security concerns to grow even further. In systemic terms, this is called a reinforcing feedback loop. Today we see inspection teams in Iraq. In a high-security world, we will see them in many places. The bombing of a factory in Sudan may well have been a good example of things to come.

Another key factor that is a driving force in this scenario is oil. For instance, the Middle East conflict could create a sustained fossil energy crisis and trigger exponential demand for low-energy technologies such as those found through biotechnology.

Is it possible on the other hand, that biotechnology itself will de-escalate the security spiral? Will the gains of the biotechnology revolution materialize quickly enough to prevent the fundamentalist revolution by effectively ameliorating root causes of poverty? What if Tony Blair puts his money where his mouth is?

B) Utilitarian World.

In the Utilitarian World immense biotechnology revolutions will occur in Asia. Among the candidates are South Korea, which recently announced a $14 billion program to mimic its semiconductor success of the 1990s in the biotechnology sector; and China, which faces high pressure on agricultural productivity while being expected to run an economy as large as that of the US by 2015 or 2020. While Korea may travel down the health route of life sciences, China will definitely invest in agriculture to fulfil its political mission of food autarky.

In a recent Economist article, John Hopkins' Francis Fukuyama echoes the Utilitarian biotechnology scenario. *'The coming years will likely bring ... the growth of an ethical divide between the West and Asia. The Chinese will announce the successful cloning of human embryos. Singapore and South Korea in addition ... will move ahead with stem cell and embryo research, as well as with agricultural biotech, while the UN will debate a Franco-German proposal on a global ban on human reproductive cloning.' As for the issue of bio-terrorism, Fukuyama summarizes, 'it's simply a disaster waiting to happen, ... but [when] this will come ... is something known only to the terrorists themselves.'* (*Economist*, Autumn 2002).

What if ?

So what if the future of biotechnology carries one or more of the key elements described above. What if the Fundamentalist meets the Utilitarian Scenario? What if the two Koreas decide to move ahead on their reunification? Scenario thinking means opening our space of thinking to that which is challenging to think: radical discontinuity and long-term emergence. Monitoring the emergent has long been the vital role of the *Biotechnology and Development Monitor*. As one of its founders, Gerd Junne suggests that in the coming years contextualization and sense-making within a complex global setting will become even more important and valuable. In this scenario, we can plausibly imagine the *Biotechnology and Development Monitor* becoming as important as the *Harvard Business Review*. That should be sufficient a task to keep us on our feet. ◆

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- Prof. Louis van der Merwe, Founding Partner of the Centre for Innovative Leadership (www.cil.net), whom I have to come to know as on of the most explicit and enlightened practitioners of scenarios, also applying them in developing countries such as his home country South Africa.

Monitoring the future 2: A Chinese scenario

What does one Chinese molecular biologist, Dr. Chun-Ming Liu, see as the main characteristics of a possible scenario for the coming 20 years of biotechnology? In agrobiotechnology a few multinationals will have monopolies on the seeds with the desired traits. By then Asian seed companies and Asian farmers will have to pay more for seeds than they would do in a truly free-market system. This will be the almost inescapable consequence of the processes of globalization in which seed companies and farmers cannot compete without owning the basic patents on their products themselves.

China invests quite a lot of money in agricultural biotechnology research. The total investment in biotechnology between 1995 and 2000 was € 1.6 billion channelled through several high tech programmes such as '863' and '973'. The yearly budget for biotechnology is still growing. Thirty per cent of this money goes to agrobiotechnology, as compared to ten per cent for agrobiotechnology in the United States. The Chinese laboratories are well equipped with good facilities and the Chinese researchers are starting to publish in refereed international journals of science. For example, the particulars of the indica rice genome were published this year in *Science* (5 April 2002), by a group of Chinese researchers. There is also an urgent need for high-yielding crops, and drought tolerance, disease and insect resistant traits in China. The Chinese population is growing by 1.2 per cent each year and agricultural production conditions are worsening. Shortage of water is a major problem for the largest part of the country.

But do you expect, on the basis of these facts, a scenario with a strong position for Asian plant biotechnology? No, says Dr. Chun-Ming Liu. According to him and, he says, many of his colleagues, the problem for Asia is a lack of basic patents. In a global free market system, an agrobiotechnology company can not survive without patents. Though most Chinese biotechnology institutions own several patents, this often is not enough to engineer their own varieties with traits such as those mentioned above. They do need licences from Western companies. For example, to engineer one Bt cotton crop, one needs at least a number of basic licences. Even if Chinese institutions or companies are willing to pay for these licences, the patent holder may make prices too high to be affordable for the Chinese. China (or its companies) does not have enough patents for it to gain a strong foothold in possible negotiations. Though the government invests heavily in biotechnology, the position of China in the coming 20 years will not improve substantially, Liu believes. Researchers in China are not keen on patenting their results. They receive funding from the government, and publish the results in scientific journals. There is little or no industrial involvement in the research activities.

According to Chun-Ming Liu a plausible scenario is that in 2020 varieties genetically engineered for desired traits such as drought or salt tolerance will be available from a few multinational companies, such as *Syngenta*, *Dow Chemicals* and *Monsanto*. Many Asian scientists will be involved in developing these technologies for those multinationals, but they will not be involved in developing these technologies directly for Asian farmers and seed companies.

Farmers pay the price

The amount of hectares planted with genetically modified crops in China is growing – from 533 hectares in 1997 to 670.000 hectares in 2001 – and Chinese policy favours of transgene seeds.

The most popular new crop in China is the Bt cotton developed by *Monsanto* and researchers at the *Chinese Academy of Agricultural Sciences* (CAAS). Small cotton farmers (those who have less than one hectare of land) can afford the genetic engineered Bt cotton seeds. They presently pay an amount of money to grow the new crop that is similar to what they paid for the traditional varieties, because less money is needed for insecticides As they no longer spray toxic chemicals, their health is either improving or is no longer deteriorating. Hence, at present farmers are satisfied.

However, Liu doubts if the patent holders such as *Monsanto* will hold down prices in the long run. While they might be willing to give away licences to local small seed companies for reasonable prices, what will happen when the market is saturated to a considerable extent providing the opportunity for these global monopolies to raise their prices? The companies may also decide to increase prices for licences. If no other alternatives are available, farmers might lose their grip on agricultural production.

Monitoring the future 3: An Egyptian scenario

In the Middle East a new generation of young presidents and monarchs is emerging. Environmental scientist Tarek Elmitwalli from Egypt believes, contrary to many of his colleagues, that this will lead to more democracy, less corruption and a better climate for research and innovation. Well-developed, sophisticated reactors for anaerobic treatment of wastewater will supply a growing Arab population with useful water.

In 1999 and 2000 four national leaders died in the Middle East: King Hussein of Jordan, Emir Isa of Bahrain, King Hassan of Morocco and President Havez al-Assad of Syria. Their sons, all in their thirties or forties, have come to power. In Egypt, Yemen and Libya the leaders are in their seventies; soon enough their sons will also take over.

Dr Tarek Elmitwalli is an environmental scientist working at the *Department of Civil Engineering at Benha High Institute of Technology*. Benha is a town about thirty kilometres north of Cairo. Contrary to many of his colleagues working in the field of biotechnology, Elmitwalli is optimistic about the future for research in the Middle East. He believes this region is now at its lowest point with respect to freedom. Things are changing though, and the region is on its way to more freedom and democracy. The younger generation of leaders has been educated in the United Kingdom or the United States. They are eager to prove themselves, as the actions of King Mohammed of Morocco show, and they are open to innovation. The United States and Europe also have immense interests in a peaceful and stable Middle East, so the pressure for democracy to improve is likely to increase. Elmitwalli is optimistic. He expects that more freedom and democracy will lead to a better research climate. At the moment research institutes are severely neglected. Salaries are low and staff are obliged to work outside often carrying out consultancy work for private companies. 'There are enough educated people in the Middle East', he said during a visit to Wageningen University. 'The problem is that they are too busy earning money for their households. The old leaders wanted to keep the intellectuals busy so they don't have time to talk about democracy. The new leaders want innovation, and for innovation they need well-equipped research institutes.'

Anaerobic treatment of wastewater

The population in the Middle East is growing fast. Egypt has 65 million inhabitants and by 2010 the figure will be 96 million. Jordan and Palestine already have a shortage of both drinking and irrigation water. Egypt, dependent on Nile water is worried that it will face the same problem if Ethiopia decides to build dams in the Nile. In addition to the growing demand for drinking water, ground and surface water is likely to become more polluted as a result of the growing amount of wastewater. More than 90% of Egyptian villages have no domestic sewage treatment plants, and the existing wastewater treatment plants (mainly located in the large Egyptian cities) suffer from lack of money for operation and maintenance. The costs of constructing,

Developing alternative scenarios is difficult

One can speculate about alternative scenarios, in which Chinese agriculture disconnects from the world market, which is dominated by the industrial 'Western' seed chains. China could close its borders to genetic engineered seeds from abroad. Chinese researchers and companies could engineer their own crops without the help of Western companies and capital. But this is not a plausible scenario, says Liu, as were it to happen the United States might close its borders to products from China.

Within an open market, local Chinese farmers and farmers' organizations could take the lead and develop, together with government-paid biotechnologists and breeders, their own, locally adapted crops. But according to Chun-Ming Liu this alternative network would have limited success. They would still be dependent on free 'second hand' technology, because they would not be able to afford patented new technology. Sometimes local networks might work, if old technology is useful and well adapted to the local situation. However, often it will not work because these networks will not be able to compete with industrial networks that can afford the new technology. Chun-Ming Liu: 'So the question for the future is: will there be a cooperative and competitive market in agrobiotechnology? With present day monopolies on important technologies and genes, farmers will have to pay more for their seeds, and small companies will find it difficult to survive.' ◈

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Acknowledgement

Dr. Chun-Ming Liu received his PhD in the United Kingdom and worked in China, Singapore, and the United States. Presently he is a senior researcher at Plant Research International (PRI) in the Netherlands, working with an international team on breeding technologies, such as reversible male-sterility for crops and nutrition-improvement in rice.

operating and maintaining aerobic, activated sludge and trickle filter systems are high; the Egyptian government is therefore not able to install sewage treatment plants in villages.

According to Tarek Elmitwalli the solution for cleaning wastewater in the Middle East is high-rate anaerobic wastewater treatment systems. Anaerobic systems don't need electricity or pumps for circulating oxygen. The anaerobically treated wastewater can be used as 'grey' water, for example to irrigate crops or do washing. In Latin America, China and India anaerobic reactors are already very popular because of the low construction, operation and maintenance costs. They also require little space, they do not produce much excess sludge and the biogas they produce is a source of energy. Fundamental and applied research is still needed to adapt anaerobic reactors to local conditions. Each village and industrial plant has its own type of wastewater, climate and social conditions. How can you optimize the reactor in such a way that the bacteria in the wastewater do their job well? And, if you want to use the treated water for irrigation, how can you develop salt tolerant crops?

Democracy and freedom is not a guarantee for less corruption (see India), but Elmitwalli believes that if more freedom is gained in the Middle East, the political climate for anaerobic installations will also improve because corruption will have less chance. At present politicians and bureaucrats tend to prefer aerobic systems because of the expensive and large equipment, machines and pumps that they have to import from the United States and Europe. It is quite normal for them to ask for a percentage on a big order. Anaerobic reactors on the other hand can be made using local materials.

War scenario not plausible

It is possible to imagine an alternative scenario: the sons of the old kings are unable to change the conservative political climate. They do not have power to innovate, nor do they have the power to reduce the influence of the radical fundamentalist groups. They focus national attention on a foreign enemy (Israel, the United States) instead of on their own internal problems, and spend their money on weapons. At the same time, the growing shortage of drinking water and the increasing amounts of wastewater lead to more pollution and civil wars.
'Most of my colleagues expect this black scenario to develop,' says Elmitwalli. 'But I don't. Too many people and countries have an interest in preventing this gloomy scenario from emerging. For example, if the Mediterranean becomes too polluted with wastewater it also becomes a problem for the EU. I think that in one or two decades the environmental problems of wastewater will be solved, and the research climate for environmental biotechnology will have improved. If the leaders want to innovate they will have to invest in the research institutes.' ◈

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The opinion expressed on this page is the author's personal opinion.

Looking forward: Overcoming the genetic divide through information technology

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Soraj Hongladarom

One of the striking characteristics of contemporary technologies is that different types of technology have a way of being dependent on one another, so much so that these different technologies may merge together. Take biotechnology and information technology for example. The two are clearly very different from each other. Biotechnology lies in the hands of life scientists; information technology, on the other hand, emerged from the work of computer scientists and engineers. One field deals with moist living tissues; the other deals with dry and totally lifeless pieces of silicon and abstract logic. However, it is clear that these two fields are merging. The decoding of the genome shows that life itself can be looked at as transmitted information. The building blocks of life consist neatly of four values that are permuted far beyond mere human calculation. The structure underlying the working of the brain, a living organ, is taken as a model for the working of computers.

The analogy does not stop at the level of purely technical considerations. These two technologies are also very powerful as wealth creation engines. One can simply look at giant companies such as Microsoft or Novartis for examples. The power of these technologies to create wealth also carries with it a 'divide' between those who are in the position to enjoy the fruits of these technologies and those who are not so fortunate. There is the digital divide and the genetic divide between those who can benefit from information and life technologies respectively. As these technologies become more and more powerful, these divides are poised to become wider and wider, creating imbalances and insecurity for the whole world. As powers to create wealth and solve problems, these technologies are able, at least in part, to solve the problems facing the poor and the disenfranchised in the world. One merely has to find a way to an effective use of them so that everyone is equally entitled to benefit from them.

One way is to look at yet another area in which biotechnology and information technology can cooperate. The focus here is on how the fruits of biotechnology can be beneficial to a wider sector of the world's population through an effective use of information and communication technologies. My proposal is that, in order for these two types of technologies to be of direct and immediate benefit to the rural poor, in Thailand or elsewhere, the capacities of these remote communities to appropriate the technologies must be built up and enhanced. This can be done through a development of the knowledge system latent in the community so that it becomes more effective in dealing with the contemporary situation through the use of information and communication technologies to link various communities together so that they can learn from one another. The traditional knowledge and skills involved in making rice wine have been around for centuries. Producing and marketing the wine is a very good source of income for the villagers whose lives are always centred on rice planting. Making good rice wine clearly requires skilled knowledge of biotechnology. Modern techniques can be introduced to the villagers in the first place, through education and demonstration. But the main point is not just to transfer the technology, or worse just its products, to the farmers. The point is that the farmers learn how to appropriate the technology, to integrate it into their lives, so that the technology becomes one of the tools within their repertoire in making good rice wine, or any other products and crops according to the locality.

The information and communication technologies can obviously help by disseminating the information needed. Here the role of the technologies in teaching and learning on line is of tremendous importance. But one needs to be reminded that this is not the whole picture. The villagers can also use the information technologies to build up networks of their peers. The idea is that the villagers also learn by trial and error and from one another. They do actually need the help of experts who may come to them from the capital city, but these experts should act more as guides or coaches rather than as ruling administrators, as has been the case in Thailand for the past five or six decades.

This merging of the uses of biotechnology and information technology clearly requires a lot more thinking and fleshing out of details than is available here. However, I am convinced that only through the initiatives and capacity building effort stemming from the villagers themselves can a more equitable and sustainable world be realized. I would like to end by congratulating the *Biotechnology and Development Monitor* for its effort in this regard and wishing that the journal could serve the world better by acting as a node in the network of those who are concerned with the role of biotechnology in development, as well as of those who share the taste for Thai rice wine. ◈

The editors welcome any reaction to the views expressed in this issue.

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