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Guest Editor: Hebe Vessuri

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CONTENTS

Introduction

Innovation Context and Strategy of Scientific Research in Latin America
HEBE VESSURI 201

Articles

Integrating Local and Global Knowledge, Technology and Production Systems: Challenges for Technical Cooperation
JUANA KURAMOTO and FRANCISCO SAGASTI 215

Technological Capabilities of the Chemical Industry in Brazil and Venezuela: A Comparative Taxonomy
ALEXIS MERCADO 249

Rowing Against the Tide: Emergence and Consolidation of Molecular Biology in Argentina, 1960–90
PABLO KREIMER and MANUEL LUGONES 285

The Brazilian Genome Project: A Successful Example of a Research Network
CARMEN LUCIA B. NEGRAES and PAULO CÉSAR G. EGLER 313

Latin American Catalysis: As Seen through the Ibero-American Catalysis Symposia
HEBE VESSURI and MARÍA VICTORIA CANINO 339

Research Notes

Institutions Linking Knowledge Generation with Knowledge Utilisation: The Case of Mexico
JAIME JIMÉNEZ and JUDITH ZUBIETA 365

Book Reviews 379

Abstracts 395

*Integrating Local and Global Knowledge, Technology and Production Systems: Challenges for Technical Cooperation**

JUANA KURAMOTO and FRANCISCO SAGASTI

Countries differ in their economic performance due to the way their respective science, technology and production systems interact. The creation, adoption and transmission of knowledge are at the core of each of these systems. In developing countries knowledge is not uniform, but combines indigenous skills and know-how with modern ones. Policies promoting the prevalence of modern over traditional knowledge have resulted in the dependence on imported knowledge and the incapacity to create an endogenous knowledge base. At the same time these policies have accelerated the loss of valuable indigenous knowledge that would otherwise help improve the capacities and quality of life of vast sectors of the population. Technical cooperation can play a critical role in building an endogenous science and technology base as well as in promoting the integration of indigenous and modern knowledge, technology and production. Three sets of policies are required to fulfil that purpose: those related to the domestic integration of knowledge, technology and production; those that establish links with the global knowledge, technology and production systems; and those that create a favourable policy environment for the other two.

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Introduction

KNOWLEDGE HAS ACQUIRED a crucial relevance at the dawn of the twenty-first century. The acceleration of scientific and technological advances, and their explosive diffusion have changed the way economies and societies work. We do not rely any more on cheap inputs to increase and improve production processes and economic growth. Nowadays we rely on cheap information. Two factors have contributed to the reduced price of information. On the one hand the release of information transforms it into a public good, at least in principle. It is a non-rival good because no matter how much we use a specific piece of information, it will not reduce its amount, so the same information will be available for another person to make use of. Information is also a non-excludable good because two agents can use the same piece of information at the same time. Even when the mechanisms to protect information are tight, for example, patents, information always leaks.

On the other hand the advances in information and communication technologies (ICT) have permitted low-cost storage and widespread access to information in almost all areas of human activities. The OECD refers to ICT as 'a key technology to speeding up the innovation process and reducing cycle times, it has fostered greater networking in the economy, it makes possible faster diffusion of codified knowledge and ideas and it has played an important role in making science more efficient and linking it more closely with business' (Dodgson et al. 2001, citing OECD 2000). Although cheap information creates huge opportunities for economic development, only a few countries are taking advantage of it. A minimum level of capacity is required in educational, research, government and productive institutions to transform information into useful knowledge, and also to discern which pieces of information are useful to solve a country's specific problems.

Knowledge, as opposed to information, is created in a specific context shaped by geographic, economic, social or political aspects. Knowledge creation is not automatic; it requires a process of learning. When individuals learn, they usually build theories and conceptual frameworks that provide coherence to and allow them to reflect on their experiences. Theories are tested in the realm of action, and reflection on the results of these actions leads to additional knowledge to improve theoretical understanding. Thus, knowledge creation requires systematic gathering of information and feedback in response to specific needs (Albu 1997). It is also a cumulative and endogenous process, which continuously builds

up on previous pieces of absorbed and adapted information. This is why it is so difficult to successfully transfer knowledge from one location to another.

Knowledge contributes to economic development by giving people the capacities to solve the specific problems they face, satisfy their needs and further increase their capabilities. In particular, knowledge contributes to generate the technologies that are used in the production of goods and services that improve the quality of life. A country's capacity to devise effective solutions is supported by an institutional setting that promotes the creation, absorption, adoption and diffusion of knowledge, and that also matches such knowledge with the needs and preferences of the population. In developing countries this problem-solving ability and the supporting institutional arrangements must take into account the solutions that have been devised in local settings and in response to rather specific problems. This implies paying attention to indigenous knowledge and technologies, which usually have been accumulating slowly for a rather long time through trial and error.

The recognition that knowledge plays and important role in development has led, particularly during the last half-century, to a variety of initiatives for development cooperation and for transferring knowledge from developed to developing countries (Sagasti and Alcalde 1999). To a large extent, many of these initiatives were inspired by the Marshall Plan, which provided financial and technical assistance to Europe after World War II. Between 1947 and 1951 the United States injected the 1997 equivalent of US$ 88 billion in balance of payments support and soft loans to most countries in Western Europe, and also provided technical assistance and access to US managerial and manufacturing know-how. Five decades later the Marshall Plan's key feature makes it highly regarded as a model for international cooperation programmes. These include, among others, the cooperative and multilateral nature of the plan, involving both donor and recipients in its design and implementation, and the incorporation of training programmes for European business people, transferring valuable technical and management know-how to the private sector. The limited and temporary nature of the plan has also been considered as a desirable feature, which has been seen as the most successful international cooperation programme in history (Holt 1997; Jenkins 1997; Rostow 1997).[1]

However, the international cooperation and technical assistance schemes devised and put in practice to help developing countries have had, for the most part, a rather limited impact. To a large extent, this is because they have relied in the transference of generic information without addressing the organisational, economic, financial and political constraints that shape and condition its use in the recipient countries. As a result, conventional technical assistance programmes have often eroded the ownership, commitment and independent action at the national and local levels in developing countries (Morgan 2001). In many cases countries became dependent on such programmes to support a significant part of their productive systems, and faced the loss of their own indigenous knowledge in their efforts to adopt the foreign one. As a result, developing countries have not been able to create an endogenous knowledge base. This paper presents a conceptual framework to examine the way knowledge and technology creation contributes to economic development. It then explores ways in which indigenous and local knowledge can be integrated into production systems. The paper concludes with some suggestions on the way technical cooperation could help in making better use of traditional knowledge and technologies.

Knowledge, Technology and Production: A Conceptual Framework

The concept of development has changed over time. According to the largely economic view of this concept that prevailed for a good part of the twentieth century, development was practically synonymous with economic growth (Arndt 1987; Bezanson and Sagasti 2000). Developed countries were defined as those that achieved high per capita income, which allowed their populations to purchase a large amount of goods and services. Therefore, the implicit objective of development was to become wealthy and even opulent societies. One of the conditions to achieve this was to improve productivity levels, which in turn implied structural transformations in the economy and the reassignment of production factors from low productivity sectors to those with higher productivity levels.

Partly because the cumulative character of productivity gains, which accrue disproportionately to those countries that have already achieved high levels, the outcome of the race for higher productivity during most of the second half of the twentieth century was an increase of income disparities. Not only did rich countries became richer than poor ones, but also high-income regions—and even wealthy individuals within a region—became richer and wealthier. As a reaction, during the 1980s improvements in the level and distribution of income began to be seen

as crucial to attaining development with equity, and poverty reduction programmes as one of the main tools to achieve this. A more equitable income distribution was associated with successful development, particularly in European countries and Japan, while those countries that were considered far from success in almost any measure—for example, many African and Latin American countries—had much greater levels of income inequality.

One of the perverse effects of poverty and deprivation is the undermining of people's self-esteem and capacities, which in turn lead to further poverty and deprivation. Partly as a result of the contributions of Mahbub Ul Haq (1976), the ILO (1976) and especially Amartya Sen (1981, 1984), during the 1980s there was a shift in the focus of development thinking that led to place human beings at the centre. For example, according to Sen, the important question is what goods and services can do for people's life rather than how many of them people can produce during their lifetime. This was illustrated by comparing life expectancy with income levels. In 1985 China, with an annual income per capita of US$ 310, had a life expectancy of 69 years, while in Mexico the figures were US$ 2,080 and 67 years, and in Oman they were US$ 6,700 and 54 years respectively (Sen 1989). From this perspective the goal of development becomes the enrichment of human life and the expansion of capabilities, and this requires not only access to the goods and services to satisfy basic needs, but also recognition in society and self-actualisation, all of which provide freedom to choose individual life options.[2]

Thus, it is possible to identify three approaches to development, each with its own strategy implications for the road that developing countries should follow. In the approach that focused primarily on *productivity gains*, countries were supposed to replicate patterns of industrialisation traversed by the more advanced economies, which implied a process of major economic transformation from traditional agriculture, crafts and self-subsistence activities to modern sectors, and to industry in particular. These modern sectors had to take the lead in the economy because their higher productivity would increase people's income and allow them buy more goods and services. This also required the use of modern imported knowledge and technologies.

In the *development with equity* approach, the government plays a key redistribution of income role, seeking to provide equal opportunities for improvement to all the population (CEPAL 1990) and to balance growth with social justice. Although it was often argued by proponents of the productivity gains approach that governments should first foster economic growth and then redistribute wealth, for otherwise they would be just redistributing poverty, it has been clear for a long time that redistribution and growth are not incompatible (Chenery et al. 1974). For example, the World Bank pointed out that to increase Latin American poor people's income to a level above the poverty threshold would only require 0.7 per cent of the regional GDP or to levy an income tax of 2 per cent to the populations richest quintile (World Bank, 1990). In any case, whether growth is fostered before or after redistribution, the fact is that sustainable economic growth depends on productivity increases, which in turn requires access to foreign knowledge and technology.

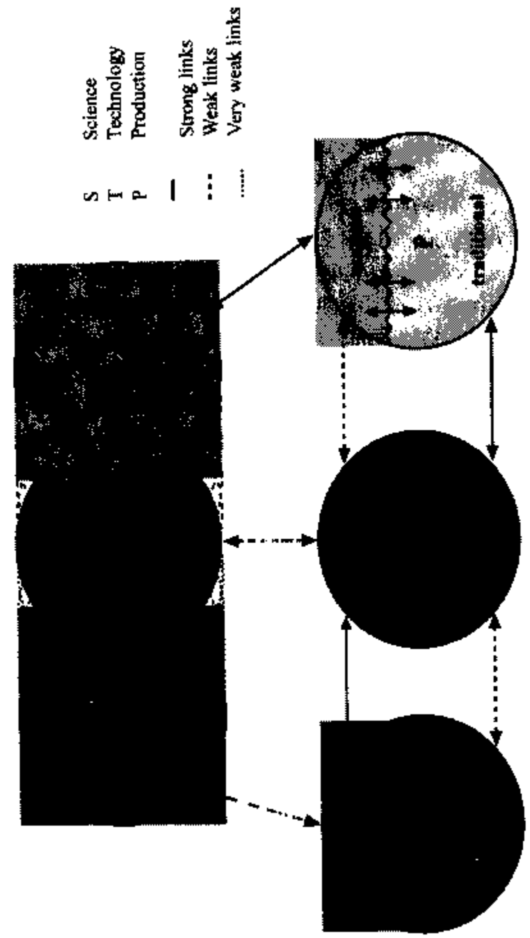
Sen's *capabilities and freedoms* approach views education as a key factor in the process of development, but an education that is specifically oriented towards enhancing the capacities of human beings to thrive in the context where their lives unfold. Productivity is also important, but primarily to the extent that helps increase the production of goods and services required by specific populations to enhance their capabilities, for not everybody needs or wants mass consumption goods. In consequence, among other things, this approach leads to a revaluation of indigenous knowledge and technology, insofar that they satisfy the needs and conform to the preferences of specific segments to the population that are not fully integrated into the markets for mass consumption goods.

These approaches envisage different roles for knowledge and for the way in which it interacts with production systems. Sagasti (1979) provides a conceptual framework to examine the interactions of science, technology and production systems that are at the core of the different economic performance of countries (Figure 1). While this framework was devised at a time when productivity gains were seen as the key to development, it has stood the test of time in part because it allows to incorporate a variety of issues that have been—and still are— relevant to the design of development policies and strategies, such as the role that indigenous knowledge plays in local production systems, and the various ways in which science, technology and production in the developing world interact with their counterparts in developed countries.

According to this conceptual framework, science seeks to generate knowledge to understand natural and social phenomena, and to provide explanations that give sense to human existence. Technology can be considered a set of organised responses to confront the challenges posed by the physical and social environment. Production provides goods and services to satisfy the needs of a community and of the individuals that

FIGURE 1

Relations between Science, Technology and Production in Developed and Developing Countries



Source: Sagasti (1979).

compose it. These three components, considered in a dynamic fashion as currents in constant change, are structured and linked to each other through a set of institutional arrangements, and are immersed with the broader social, cultural and political context of human societies. Figure 1 indicates that a close interaction between science and technology in developed countries nurtured the evolution of productive activities. Without the capacity to generate scientific knowledge, to transform it into technologies that are then used in the production of new and better goods and services, these countries could have not achieved their high rates of economic growth. The close and continuous interaction between science, technology and production led to the creation of an *endogenous scientific and technological base*. This consists of the accumulation of scientific research and technological development capabilities that make it possible to generate new knowledge, and also to modify, adapt and recombine existing knowledge, which is then deployed to produce goods and services. In turn, through learning-by-doing and learning-by-using processes, the utilisation of knowledge and technologies in the productive sector leads to incremental technical innovations and to the further accumulation of technological capabilities.

Although the interactions between science, technology and production are presented in a linear pattern, they usually do not take place in this way. There are substantive overlaps between these three spheres, to the extent that in some highly advanced economic sectors scientific research, technological development and productive activities are tightly bound, mutually reinforcing and cannot be considered separately. The linear model of innovation, which stated that scientific advances pushed technological innovations and these derive in new products or processes, is no longer valid—if it ever was. In developed countries it is more frequent to find that firms finance basic research to obtain direct access to scientific advances, and also to inform researchers about their requirements and needs. Conversely, research performed by universities and scientific institutions increasingly reaches industrial application through the establishment of spin-off companies.

These modifications in the innovation process in developed countries have given rise to new innovation models such as the 'innovation journey' approach of Van de Ven et al. (1999), which views innovation as a non-linear dynamic system, and incorporates managerial and organisational factors and external collaborative activity; the 'innovation systems approach' of Lundvall (1992) and Nelson (1993), which focus its attention on the interrelationships among the wide variety of agents engaged in

technical change and innovation processes market economies; and the 'triple helix' approach proposed by Etzkowitz and Leydesdorff (2000), which highlights the role that institutions have especially in a knowledge-based economy.[3] One of the implications of the evolution of these conceptualisations of the innovation process in advanced nations is that the distinction between the various 'capacities' associated with the generation and utilisation of knowledge becomes fuzzy. Since innovation can occur in the shop floor, production capacities also include the modification of the technology in use. Furthermore, the extended notion of technology, including 'soft' components such as work organisation and supervision, adds more complexity to the delimitation of capacities.

In contrast, and for a variety of reasons, developing countries have not been successful in generating such an endogenous scientific and technological base. Their world-views differed widely from that of Western society, where science superseded religion and myth as a means to explain and understand natural phenomena. The widespread use of the scientific method—a set of procedures that link the manipulation of abstract concepts and symbols to observations and experiments—increased the stock of systematised and codified knowledge in Western societies. In other parts of the world religion and myth continued to codify knowledge under the assumption that god's will and divine interventions, or even mysterious and mystical forces, structured the relationship between society and its physical environment (Jamieson 1994). Furthermore, in some cases the absence of writing and the low levels of literacy added to the constraints that limited the creation and diffusion of modern knowledge. Thus, science as we understand it was mostly absent in these regions.

In addition, the evolution of the stock of technologies was largely a result of localised trial-and-error processes, and the transformations experienced by the production system were also the result of slow changes made to adapt to local conditions and demand (Herrera 1975). To the extent that developing countries interacted with their Western counterparts during the last four centuries, they acquired—if at all— a very thin layer of imported modern scientific, technological and productive activities that usually remained isolated from each other. Therefore, with practically no interactions between modern science, and both indigenous and modern technologies, and with very little relation between the modern technological activities and the productive system, it became virtually impossible to create an endogenous scientific and technological base. Production systems were largely traditional and remained highly localised, relying mostly on traditional technologies (Sagasti 1980).

Paradoxically, the overlap of traditional knowledge, technology and production in developing countries mirrors the close interactions that have emerged in their modern developed country counterparts as they built their endogenous science and technology bases.

The engagement of most developing countries in the dynamics of international markets, intensified by the globalisation process of the last two decades, has created direct relationships that link each one of these national science, technology and production spheres in the developing world with their counterparts in the developed countries. Foreign direct investment has become an important mechanism to connect production systems in developed and developing countries; goods and processes designed in the former were imported or incorporated into local production activities of the latter, thus allowing for an expansion of the consumption options of high-income consumers in developing countries. The requirements of foreign subsidiaries and of more advanced local firms led to technical knowledge flows from developed to developing countries, and helped to establish incipient technology markets where solutions devised in rich countries became available to satisfy domestic production needs, either foı local consumption or export. The increase in information flows associated with the worldwide expansion of modern science helped replicate in developing countries—but in a rather stunted and diminished way—some of the scientific institutions that had evolved in the Western countries over long periods. As a consequence, developing country scientists established rather strong links with the scientific excellence centres in the North, but largely lost sight of the research needs of their own countries.

While modern science, technology and production systems in developing countries forged strong links with their counterparts in advanced countries, they had little or not interaction between themselves at the domestic level. In contrast to what happened in developed countries, this led to the creation of an *exogenous scientific and technological base* whose precarious and disjointed character limited the capacity to provide appropriate scientific and technological responses to the needs of the productive system and of the population. Even in those cases where some capacity was accumulated in the scientific, technological and productive systems considering each on its own, the institutional settings and incentive systems privileged links with their developed country counterparts, and did not lead to the convergence—but rather to the divergence—of science, technology and production in the developing world.

For example, the national science and technology councils in Latin America, as well as government agencies that promote scientific and technological research in specific productive sectors, had little or no interaction with firms, financial agencies, educational centres and technology service providers (Vessuri 1994). The main technological tasks performed by the region's productive agents were limited to the adaptation of imported innovations without establishing tight and permanent links with local research and development entities. Thus, during the last several decades the region has not been able to create innovation systems that work. Even in countries with a higher degree of institutional development in the area of science and technology, such as Mexico, Brazil and Argentina, the relationships among science, technology and production systems still remains wishful thinking rather than reality (Erber 1999).

The task of building an endogenous scientific and technological base requires three sets of policies: (*a*) those that promote the growth and integration of domestic scientific, technological and productive activities, considering both their indigenous and modern components; (*b*) those that create linkages between a developing country's modern and indigenous knowledge, technology and productive activities on the one hand, and the global science, technology and production systems on the other; and (*c*) those that create favourable framework conditions for an efficient functioning of markets conducive to innovation, and for the selective upgrading and use of indigenous knowledge and technology. The integration of knowledge, technology and production in developing countries requires, first, measures to establish, consolidate and guide the growth of institutions involved in the performance of scientific and technological programmes and projects, orienting them towards the needs of the productive sector. Second, it requires measures to promote the demand and application of locally generated knowledge by the productive system, so as to avoid the divorce between science and technology capabilities, and production and service activities. Third, there is a need for explicit measures oriented towards the identification of opportunities for selectively upgrading and utilising indigenous technologies. Some of the policy instruments available for these purposes are institution building, science and technology planning, financing of scientific and technological research, venture capital funds for innovation, the use of state purchasing power to generate demand for local knowledge, tax credits to promote innovation, technical norms and standards, measures to encourage the creation of clusters of innovative firms, information systems regarding indigenous technologies, sector-specific policies to encourage the efficient use of indigenous technologies (for example, in agriculture, small-scale industry, crafts and housing), and incentives to promote the blending of modern with indigenous technologies.

Policies to link with the external sources of knowledge systems aim at forging working relations between science, technology and production in developing countries with their counterparts in developed countries. The idea is to take advantage of and benefit from more advanced sources of knowledge, while at the same time strengthening local institutions. The effective use of imported knowledge requires a certain degree of autonomy and self-reliance on the part of domestic research organisations, technology agencies, and productive enterprises and agents, particularly with regard to decisions about the knowledge to be acquired and the way in which it is to be used. Some of the policy instruments available for these purposes include measures to increase imports of technology- and knowledge-intensive goods, promote exports of progressively more complex goods and services, encourage direct foreign investment, make effective use of licensing and related means of technology transfer, and promote international scientific cooperation. Initiatives to take advantage of technical assistance should be included in this second group of policies aimed at building endogenous science and technology capabilities although, as the articles in this volume argue, this requires major changes in the conception and practice of technical assistance.

The establishment of an appropriate framework to promote innovation and the efficient utilisation of indigenous technologies requires a host of complementary or 'implicit' policies, most of which are not exclusively or directly related to science and technology, but are made with other objectives in mind (Sagasti 1976). Nevertheless, their influence can be decisive in terms of facilitating the creation and consolidation of an endogenous science and technology base, the establishment of effective links with external sources of knowledge, and the articulation of innovation systems. Figure 2 indicates some of the measures that are involved in the creation of such an appropriate framework.

Integration of Indigenous Knowledge with Production Systems

According to the conceptual framework presented earlier (Figure 1), the design of strategies and policies to build an endogenous science and technology base in developing countries must take into account the coexistence of modern and indigenous knowledge, technology and

Figure 2

Policies that Create Favourable Conditions for Innovation: Some Examples

- Maintaining a stable macro-economic environment that encourages long-term investments by productive agents.
- Competition policies to increase innovation-driving competitive pressures, but also facilitating collaborative research.
- Regulatory reform policies to lessen administrative burdens and institutional rigidities.
- Financial, fiscal and administrative measures to facilitate the flow of capital to small and medium firms.
- Labour market policies to increase the mobility of personnel and strengthen tacit knowledge flows.
- Communications policies to maximise the dissemination of information and enable the growth of electronic networks.
- Regional development policies to improve complementarities between government initiatives at different levels.
- Protection of intellectual property, but with mechanisms and safeguards for preserving local and traditional knowledge, and for allowing the use of foreign knowledge in emergency situations.
- Development and maintenance of an efficient transport and communications infrastructure.
- Education and training policies to develop human capital, with emphasis on science and technology.
- Creation of information centres where domestic firms can get information on foreign technology markets and providers, thus reducing information disadvantages in technology transfer negotiations.

Source: Casabonne and Sagasti (2000).

production. In these countries large segments of the population subsist with incomes that are below the poverty line and cannot access products and goods offered in modern markets. In fact, 80 per cent of the world's population depends on indigenous knowledge to meet their medicinal needs, and at least half relies on indigenous knowledge and crops for food supplies. The knowledge about these indigenous goods and services is embedded in the community and has usually been developed outside the formal educational system. The latter does not mean that indigenous knowledge creation rests on an informal or disorganised innovation system; on the contrary, it rests on what may be called a 'cooperative innovation system' that operates in the setting and at the pace of daily living associated with the immediate agro-ecological context of indigenous populations (RAFI/UNDP 1995).

Indigenous knowledge provides a basis for local-level decision making in matters of food security, human and animal health, education, natural resource management and various other community-based activities. Thus, it is closely related to different aspects of survival and subsistence, thus generating a vast body of knowledge and, for that reason, it is extremely valuable (MOST and CIRAN 1999). Given that indigenous knowledge is crucial for survival and often contributes to improving the quality of life of poor populations, there is a strong need to register, upgrade and disseminate such knowledge. Indigenous knowledge is rarely codified and systematised—or codified in highly idiosyncratic manners, which makes it difficult to transmit (at least according to scientific and technical standards). It therefore depends on its depositaries or users for diffusion, which usually takes place by imitation, exchanges of goods and the recounting of oral traditions. In many cases indigenous knowledge has been lost because there are no reliable mechanisms to store it, and because the dominance and presumed superiority of Western ways have led to situations in which traditions were ignored, neglected and discarded. See Appendix 1 for a study conducted in Peru regarding indigenous and modern world-views.

The local specificity of traditional and indigenous knowledge has also become a constraint for its application on a wider basis. Indigenous technologies and products are found in specific regions and, even when they might be suitable for others, technologies are applied and goods are produced in limited amounts. This happens in part because people who use this kind of knowledge follow the rationale of a pre-capitalist system in which artisan work and custom-made production are the rule.

Nevertheless, as the Rural Advancement Foundation International (RAFI) has pointed out, the role of indigenous knowledge has made and continues to make important contributions to modern science, especially in the agriculture, pharmaceutical and biotechnology industries. These improvements have not been the result of passive accumulation, but the result of a cooperative innovation system in which the community as a whole is involved and works with a holistic approach. The recognition and understanding of this cooperative innovation system makes it complementary with the modern or institutional innovation system. According to RAFI, the latter

> tends to produce highly specific 'micro' improvements that then have broad application in such fields as molecular biology or micro-electronics. The cooperative system on the other hand tends to produce macro system innovations that can only be applied at the local level (for example, because they involve a complex mix of plants, insects and soil). (RAFI/UNDP 1995)

The growing needs of low-income populations, together with the limitations of domestic economies to provide the means to satisfy these people's needs, require innovative solutions to promote the wider dissemination of efficient indigenous production and services. The key here lies in the word 'efficient', which must be interpreted in the wider sense of contributing to create capabilities and freedoms, and of improving equity, not just in terms of narrow technical criteria that focus just on productivity increases. For this purpose, it is first necessary to make an inventory of indigenous techniques and of the situations in which they have been successfully applied. Rajasekaran (1993) proposed a method for recording indigenous knowledge systems that involve the participation of key people such as local extension agents, local school headmasters, credit cooperative officials and workers, among others. These observers are usually immersed in the local settings where production and service activities take place, and can therefore observe, document and evaluate indigenous technologies and practices. They should also become thoroughly familiar with, and even embedded in, the local cultural and social environment in order to grasp people's beliefs, values and customs, which will allow observers to understand the decision-making processes regarding the selection and use of indigenous technologies and practices. The accounts and recordings of indigenous knowledge and techniques provided by these observers should not contain just technical descriptions, but also include information about the wider social, cultural, political and ecosystems context in order to facilitate their diffusion and to make them more useful for policy making and planning purposes (MOST and CIRAN 1999).

Second, it is also necessary to evaluate, modify and further develop these technologies and practices, partly by injecting into them modern knowledge and technology components through what has been referred to as 'technology blending' (Bhalla 1994). Local populations in developing countries face problems that require practical and effective solutions in their localities, a task to which indigenous knowledge can make a contribution. For this to happen, it is necessary to devise strategies, create institutions and adopt policies to foster a sustained interaction between the depositories of indigenous knowledge, techniques and practices on the one hand, and scientific researchers and engineers on the other. In doing so it is necessary to always keep in mind the local and specific character of these solutions, so that the new technology options that emerge from this process will be useful and acceptable to local populations.

These two steps amount to a selective *screening and upgrading* strategy to identify and improve indigenous technologies, but maintaining the essential characteristics that appeal to those who use and benefit from them. The design and implementation of such a strategy requires committed, forward looking and culturally sensitive political leadership, a rather unusual combination in most developing countries. Appendix 2 provides an illustration of what can be done in this regard.

Technical Cooperation and the Integration of Indigenous Knowledge with Production Systems

The development cooperation experiment in general, and technical assistance programmes in particular, were devised and put in practice at a time when the productivity increase approach—embedded within the larger paradigm of modernisation—dominated development thinking and practice. The institutional and programmatic arrangements that emerged during the 1950s and 1960s for this purpose conformed to this approach, placed emphasis on the unidirectional flow of knowledge from rich to poor countries, and to a large extent disregarded whatever was available locally. Traditional ways, knowledge and beliefs were generally seen as a hindrance to modernisation and economic growth.

It is time for a reappraisal of the way in which international cooperation for development, and technical assistance in particular, are conceptualised and delivered.[4] Changes in the approaches to development and the poor performance of conventional technical assistance programmes have gradually led to a revaluation of indigenous knowledge, technology and production. From the perspective of this paper, this makes it necessary to examine the role that technical assistance can play in the process of building an endogenous science and technology base, and in the integration of indigenous and modern knowledge, technology and production. The three sets of policies mentioned at the end of the second section of this paper—those related to the domestic integration of knowledge technology and production; those that establish links with the global knowledge, technology and production system; and those that create a favourable policy environment for the first two—provide an entry point to deal with these issues and will be addressed in turn.

Integration of Knowledge, Technology and Production at the Local Level

The first set of policies are geared to the integration of domestic science, technology and production, considering both their traditional and modern components, and comprise several routes to create endogenous science and technology capacities that make full use of traditional knowledge. A first route involves the selective screening and upgrading strategy described in the preceding section, which focuses on the identification of indigenous knowledge and technologies that could be improved before incorporating them into productive activities.

A second route consists in focusing on the complex interactions that take place within indigenous productive systems, attempting to understand their logic and functioning before seeking to inject modern or upgraded indigenous technologies and knowledge components. For example, biological and social scientists have pointed out the complexity and sophistication of indigenous natural resource management systems, and indigenous communities have nurtured and used many species of plants that have therapeutic uses (Warren 1992). The idea that there are indigenous innovation systems, which evolve and change in response to challenges and stimuli, and are different from those of market-based innovation systems, has superseding the notion that indigenous production systems are passive and static. In this regard Gupta (1990) has identified four factors that influence farmer experimentation in local settings: *ecology*, because innovations result from the interactions between crops, soil and climate; *history*, because the memory of major events such as crop failure conditions the willingness to assume risk; *serendipity*, which refers to improved practices that are discovered accidentally; and *economics*, which refers to the incentives, needs and efficiency considerations that induce farmers to innovate and adopt new practices.

Efforts to revalidate indigenous knowledge systems in farming using the 'selective screening and upgrading' and the 'indigenous innovation systems' routes (which overlap to a certain extent and may be considered complementary) make use of a participatory approach to knowledge generation, in which the research agenda is defined by identifying the problems faced by farmers, rather by responding to the concerns of policy makers or the interests of scientific researchers. This has facilitated the interaction of traditional and modern knowledge, technology and production practices, and has proven to be quite effective in tasks such as germplasm screening—particularly because farmers have extensive empirical knowledge about the ecological factors that affect variety selection (Haugerud and Collinson 1991). The participatory approach keeps the indigenous knowledge system of farmers as a base, facilitates farmer participation from the beginning and their acceptance of research results, and also enables scientific researchers to get direct and feedback from the farmers (Rajasekaran 1993).

A third route to the integration of modern and indigenous knowledge, technology and production focuses on the specific problems faced by local populations in developing countries to satisfy their needs and enable them to live with dignity, bringing the full arsenal of modern science and technology to help devise production systems appropriate to these objectives, and incorporating elements of indigenous knowledge and techniques as they appear relevant. An example of this approach is the work of the group Development Alternatives in India, which has focused for more than a decade on the creation of economically, socially and ecologically sustainable livelihoods by developing and marketing technologies and production systems that are appropriate to local conditions.

Development Alternatives and its commercial arm, the firm TARA, have established research, development and testing facilities for the design of technologies geared to the production of goods for local consumption and to generation employment at the local level. These technologies are designed keeping in mind economic, technical and ecological efficiency criteria, and also the need to make them convenient and acceptable to their users. Development Alternatives and TARA have adapted a 'franchise' distribution system, in which technologies and business methods are generated in their central laboratories and offices; local partners are identified, recruited, trained and given technical support through licensing agreements; and the local partners provide the limited amounts of investment capital required (which is sometimes raised with the help of Development Alternatives and with government support) to establish local production and distribution facilities. The technologies and products that have been developed and marketed through this system include highly efficient wood- and coal-based domestic cooking stoves, machinery to manufacture paper and cardboard, water pumps, multiple-use presses, machinery to manufacture stabilised mud bricks, looms and knitting machines, appliances for processing and storing food, and integrated energy systems for rural villages (Koshla 1997).

The role that conventional technical assistance can play to support the integration of modern and indigenous knowledge and technology into production systems through these routes is quite limited. Instead, what is required are programmes to spread best practices, which involve

exchanges of information and knowledge between developing countries, and capacity development initiatives that create the local conditions for such integration.[5]

Establishing Linkages with the Global Knowledge, Technology and Production System

The second set of policies—those geared to the creation of linkages between developing countries and the global knowledge, technology and production systems—includes a variety of measures related to scientific cooperation, technology transfer and the expansion of production facilities from developed to developing countries. However, for the most part, these linkages do not relate to indigenous knowledge or traditional technologies. The main and most visible exception refers to the pharmaceutical, agricultural, biological products and biotechnology industries, which have shown significant interest in indigenous products and native plants that have valuable genetic and therapeutic properties. This has led to a multiplicity of initiatives from research institutions and businesses in developed countries to obtain access to local knowledge and products associated with the rich biodiversity of many developing countries.

Indigenous communities have made important contributions to agriculture, and to the pharmaceutical and biotechnology industries (for an example see Appendix 3). For this reason, a growing global network of institutions, mostly in universities and research centres in developed countries, is making efforts to systematically record and store indigenous knowledge. Warren (1992) reported at least ten centres around the world devoted to the collection of indigenous knowledge. In the early 1990s the value of developing country germplasm to the pharmaceutical industry was estimated at at least US$ 32 billion per year, although developing countries received only a fraction of this amount for the biological materials and knowledge they contributed (RAFI/UNDP 1995).

There are also cooperative ventures geared to mobilise local and global knowledge to make better use of biodiversity resources in developing countries. For example, there is a project aimed at harnessing indigenous South African knowledge about biodiversity (Centre for International Development 2001). The project involves a consortium composed of a team of South African biochemists, indigenous healers and plant experts, professionals from public research institutions and local universities, as well as foreign research partners. The mix of people, ideas, cultures and interests involved in the project is helping to pull together indigenous and modern knowledge systems. Their interactions have also led to questions related not just to technology and knowledge, but also to issues such as how to share benefits and risks between the various partners, how to deal with asymmetric power relations in the conduct of the project, and how to build trust to facilitate the flow of ideas and information between the partners.

The interest in preserving the genetic resources associated with biodiversity has led to the establishment of facilities for the ex situ conservation of indigenous germplasm, usually in well-established institutions in developed countries. The most notable exceptions are the centres associated with the Consultative Group on International Agricultural Research (CGIAR), which has established several facilities developing countries (Lima for potatoes, Manila for rice, Mexico for wheat and corn, among others). More recently, there has been a move to promote in situ conservation, primarily by encouraging indigenous communities to take an active role as stewards of the genetic resources in their own communities. This approach has the advantage of being more cost effective. For example, the cost of germplasm storage in gene bank conditions was estimated to be around US$ 128 million during 1993–2000, but this amount could have been cut in half through the active participation of indigenous communities in conserving biodiversity in their own local settings (RAFI/UNDP 1995). In addition, in situ conservation provides intellectual recognition to the native communities and opens the opportunity to interact with modern innovation systems on a more equal basis.

The linkages between indigenous knowledge regarding biodiversity and the global science, technology and production system raise the thorny issue of the distribution of short- and long-term benefits, which in turn are related to international agreements on intellectual property rights. These agreements are biased towards developed country governments and corporations, and do not recognise the right of indigenous communities to enjoy part of the economic benefits obtained by private firms when they are granted patents based on indigenous resources.

According to Posey and Dutfield (1996: 75):

> Traditional communities may have their own concepts of intellectual property and resource rights. However, industrializing countries are under pressure to adopt the European and North American concepts of intellectual property, which, by guaranteeing the right of legal individuals to profit from their innovations, are widely believed to promote development. Intellectual property rights have usually been inimical to the interests of indigenous communities, but there are ways in which these laws can serve the interests of these communities.

These two authors indicate that acquiring and defending intellectual property rights pose a daunting challenge to most indigenous communities, for this requires good legal advice, financial resources and access to information, all of which are usually beyond the reach of those communities. They review the current international agreements regarding patents, petty patents, copyright, trademarks, trade secrets and breeders' rights, and conclude that they are generally inappropriate and inadequate for defending the rights and resources of local communities. Among other reasons, this is because their protection is purely economic, while the interests of indigenous peoples are only partly economic and linked to self-determination. According to them, 'cultural incompatibilities exist in that traditional knowledge is generally shared and, even when it is not, the holders of restricted knowledge probably do not have the right to commercialise it for personal gain' (ibid.: 92). Nevertheless, they suggest that under certain circumstances, intellectual property rights might be beneficial, but argue that it is more important to develop alternative methods of protection, compensation and self-determination, and therefore advocate a system of 'traditional resource rights'.[6]

There have been other suggestions to modify the existing system of intellectual property rights, which was initially designed in the era of the Industrial Revolution to protect factory machinery, which focused on 'novel' products rather than on the discovery of something that naturally occurs, and which grants patent rights to individuals firms but not to communities. For example, to protect indigenous knowledge it would be possible to devise some sort of 'passport' containing all the available information about the origin of the genetic material so as to clearly identify where it comes from at the time of recording it in gene banks or cell libraries, and when filing a patent application. If the patent claimers fail to disclose this information, they could lose the rights granted by any patents emanating from the material.

To overcome the limitations of the patent system, RAFI has suggested the adoption of special forms of intellectual property protection designed specifically for biodiversity. Among them are the inventors' certificates that would not necessarily grant monopoly control or financial compensation, but would provide non-monetary awards and non-exclusive licensing arrangements. These certificates could, in addition, vary the period of protection, define conditions of transfer of technology and establish compulsory licensing arrangements. Another suggestion is to create the position of a world 'Intellectual Property Rights Ombudsperson', who would investigate complaints from indigenous communities, and governments and organisations acting in consultation with indigenous communities (RAFI/UNDP 1995).

Other alternative mechanisms to protect indigenous knowledge are related to benefit-sharing approaches through contracts and agreements signed by enterprises and indigenous communities. For example, the International Cooperative Biodiversity Groups (ICBGs) provide the framework for establishing contractual arrangements. This initiative rests on an integrated conservation and development programme, in which countries and communities that are stewards of genetic resources share the benefits of research results and of any future drug discoveries, thus providing incentives for further conservation efforts (Davis 1998). A similar scheme was devised and put in practice by the National Biodiversity Institute (INBio) of Costa Rica, which pioneered an integrated approach to biodiversity mapping and prospective (Appendix 4).

Most of the proposals mentioned above to make the intellectual property rights regime less hostile to indigenous knowledge are still under evolution, but provide an idea of what could be done to recognise its importance, and also to protect the rights of indigenous communities when linking their knowledge and technologies with modern productive systems. Technical assistance can play a role assisting local communities in their intellectual property rights negotiations with private corporations and research institutes from developed countries. Several international governmental agencies and non-governmental organisations have established programmes along these lines, and have also promoted the exchange of information and the sharing of best practices among indigenous communities. In addition, some of these international institutions have also played an advocacy role in arguing for changes in the existing intellectual property rights regimes.

Creating a Favourable Policy Framework

The third set of measures to create endogenous science and technology capabilities—those geared to the establishment of a policy environment conducive to innovation, and to the selective upgrading and use of indigenous knowledge and technology—covers a wide variety of topics, most of which are not directly related to knowledge and technology issues. Nevertheless, some of these, notably trade, financial, fiscal and credit policies, can hinder efforts to revalue indigenous knowledge, technology and production.

The main characteristics of a policy environment that is conducive to innovation in a modern market economy are well known. Figure 2 listed some of the measures required to create an environment that stimulates firms and other productive agents to exhibit innovative behaviour. For example, macro-economic stability is essential to encourage forward-looking attitudes by entrepreneurs and managers, and this in turn leads to investment in research and development, whose results are often seen in the medium and long term. In addition, a well-functioning financial system, competition policies that spur efficiency, sensible regulatory policies that protect the public without placing an excessive burden on business, and a fair and effective tax system are among the requirements for an environment that promotes innovation. However, it is essential to avoid rigidities and ideological excesses in the application of those policies. Instead, it is necessary to adopt a pragmatic stance that takes fully into account local conditions, a task in which some international financial institutions, such as the International Monetary Fund, have not excelled in their dealings with developing countries.

The policy frameworks and conditions that promote the integration of indigenous and modern knowledge and technology into the productive system are less well known and accepted. For example, designing and putting in practice the 'selective screening and upgrading' and 'technology blending' strategies described earlier in this paper requires the preservation of reasonably efficient indigenous technologies and productive activities, where efficiency is understood in a broad sense, and not just in technical and economic terms, and the interactions with local setting are fully taken into consideration. Unless this is the case, indigenous knowledge and technologies are likely to erode and disappear. However, this requires a policy framework that allows for, and even encourages, the coexistence of modern and indigenous technologies with different productivity levels. At the very least, such policies—which may include government subsidies, free extension services, access to credit, and temporary protection for local farming, crafts and small-scale industries—should be in effect during a transition period to allow the selective technology screening and upgrading, and the technology blending strategies to work. However, this runs against the dominant common sense in macro-economic policy, which propounds a 'level playing field' of uniform policies for all economic activities and firms, regardless of their size or ownership (but which should probably be better described as a 'level playing minefield' stacked against traditional and indigenous production!).

Moreover, many policy reforms advocated by international financial institutions and academic experts from developed nations (and adopted by many developing countries during the heyday of structural adjustment programmes) work against the possibility of preserving and integrating indigenous and modern knowledge and technology in the productive system. For example, an accelerated process of trade liberalisation and tariff reductions, implemented without temporary measures to assist local producers, may wipe them out with a flood of cheap imports; the privatisation of public financial institutions and financial liberalisation measures may reduce the availability of credit to peasant farmers and small traditional firms; and fiscal reform measures can lead to the elimination of price support schemes for farmers, limit access to affordable agricultural inputs and do away with free public extension services. While care should be taken to avoid that temporary support measures are maintained beyond their usefulness (as was the case with the high tariffs associated with import substitution in Latin America), without a policy framework geared to what Sachs (1980, 1987) has called the active 'management of technological pluralism'—which would facilitate the coexistence of technologies with different productivity levels—it would be very difficult to incorporate modern and indigenous knowledge and technology in the productive systems of developing countries.

Technical assistance can play a useful role in helping to establish appropriate policy frameworks, primarily by distilling and transmitting best practices gleaned from the experience of developing countries, but taking care to reinterpret them anew in each different case. The concern about ignoring the diversity of specific situations, and of basing policy prescriptions on the prevailing conventional wisdom, was clearly articulated by Jacques Lesourne more than a decade ago in his concluding remarks at a symposium to celebrate the twenty-fifth Anniversary of the OECD Development Centre:

> We...have to be wary of the latest fads in the development field. They are frequently transformed into simplistic and extremist ideologies which often cruelly mark the life of nations. The current welcome emphasis on markets is no reason for disregarding their shortcomings, and highlighting the weakness of the State as a producer must not lead us to overlook the contributions government policies have made to development in certain countries. Conversely, the failure of many attempts to foist doctrinaire socialism irrespective of realities on societies with their own long-standing structures must be acknowledged. There is not just one possible development model, although this does not mean that all models can work (Lesourne 1989: 298).

This warning applies with particular force to the variation of technical assistance that goes under the name of 'policy advice' by international financial institutions and academic advisors from developed countries. In the former case, this advice is usually buttressed with conditions for developing country access to the resources at the disposal of these institutions, and therefore carries significant weight. As the policy frameworks to facilitate the integration of modern and indigenous knowledge and technology in productive systems do not register on the screens of international financial institutions, it will take much research, exchange of experiences and persuasion to transform technical assistance, and policy advice in particular, into positive forces for the revaluing of indigenous knowledge, technology and production.

Concluding Remarks

Taking into account the knowledge explosion that took place during the last five decades, the creation of an endogenous science and technology base must figure prominently in the design of development strategies and policies in the twenty-first century. Most developing countries rely to a significant extent on traditional knowledge, technology and production activities, which have evolved over a long time through trial and error, in response to local conditions, and which cater to the needs of the poorer segments of their population. In consequence, development strategies must open spaces and create opportunities for the integration of modern and indigenous knowledge and technology into their productive systems. Such integration should lead to improvements in the efficiency of traditional practices, but at the same time maintain the characteristics that render them useful and attractive to the poor and to indigenous people.

This requires efforts to understand the logic and functioning of indigenous production systems, and also to identify, select and upgrade traditional knowledge and technologies. Although several possible routes are available to do this, much more research and analysis are needed before a well-established body of knowledge emerges on how to integrate local (traditional, indigenous) and global (modern) knowledge, technology and production. These should be complemented with efforts to learn from the experience of other developing countries that have explored ways of preserving and revitalising indigenous knowledge and technology.

The current set of technical assistance concepts, practice and institutions emerged, in large measure, at a time when the productivity increases and economic growth approaches to development—which in turn were embedded in the broader paradigm of modernisation—were prevalent and informed strategy design and policy making. They were based on the transmission of supposedly superior knowledge from developed to developing countries, and paid little attention to traditional and indigenous knowledge and technology. The latter are being revalued as approaches to development have evolved over time, and now focus on human capabilities and freedoms, as well as on equity considerations.

The criticisms of development cooperation and of technical assistance levelled during the last two decades are forcing a reappraisal of these concepts and practices. At present there appears to be little room for applying conventional technical assistance schemes to promote the integration of traditional and modern knowledge and technology into the productive systems of developing countries. Perhaps such reappraisals, many of which are focusing on local 'capacity building' and 'capacity development', may lead to new conceptions of international cooperation and new ways of putting them in practice. As yet, there are very few institutions that have ventured to face this complex and potentially rewarding challenge. The most notable and successful of these has been the International Development Research Centre (IDRC) of Canada, which for over three decades has supported the development of local science and technology capabilities in developing countries, and which has sponsored many projects that revitalised traditional technologies.[7] Building an endogenous science and technology base and revaluing traditional knowledge and technology will require many more institutions like the IDRC.

Appendix 1

The World-view of the Andean Peasant Farmer

Maria Angelica Salas's (1996) study of systems of knowledge in the Peruvian Andes raises important issues regarding indigenous visions of the future. As part of this study, a number of peasant farmers were asked to make drawings that expressed their vision of a desirable future, depicting themselves, their social relations and their relationships with nature.

One drawing that showed the countryside looking very much like an urban or industrial landscape prompted a reaction from other peasant farmers who, somewhat disconcertedly, observed that the bare hills and the absence of crops could not be associated with better a future. Furthermore, they could not imagine a future without their homes, their relatives, the sun, the moon or animals. This expressed their reaction against the tendency to deny their Andean identity, replacing it with a vision of modernity in which the rural world is rendered in non-Andean terms. By contrast, the elements that appeared most frequently in the drawings were associated with the specific environment in which the peasants lived. The drawings contained elements symbolic of Andean culture (the mountains, the crop parcel, the Andean community, the family) and other that expressed cultural interaction (roads, trucks, school).

By examining the symbolic meaning of the more common elements depicted, Salas was able to identify the outlines of a vision of society that differs from the urban and industrial model. The peasant farmer has a relationship with nature in which sacred and economic elements are closely intertwined; furthermore, they feel that their ties with nature are built on reciprocal relationships. This same principle reinforces the strong family and community ties that shape the identity of Andean mean and women. Also, the participatory and direct democracy mechanisms that organise community life make it possible to address the tensions that exist between individual and collective initiative in the solution of problems. These ties are protected from the threat of dispersion by their respect for the history and knowledge embedded in their oral traditions, rituals, songs, dances and other forms of expression of Andean cultural diversity.

As part of her study Salas also organised a workshop for elder peasants knowledgeable in potato farming with scientists from the International Potato Research Centre based in Lima. She was able to contrast their alternative world-views with regard to the cultivation of potatoes, but found that the technical solutions devised by farmers and researchers did not differ much in their fundamental aspects.

Appendix 2

Support and Preservation of Indigenous Knowledge and Technology: The Case of India

India provides a good example of how governments could support the preservation and promotion of indigenous technologies.

First, India has an Indigenous Knowledge Systems National Programme that is led by a highly respected scientist. This programme has the aim of auditing, documenting and supporting research associated with indigenous knowledge. In addition, there are other more specific programmes to promote and popularise these knowledge systems, and India has developed a large database on indigenous knowledge and biodiversity heritage.

Second, although India does not have formal laws to prevent anyone from appropriating knowledge from the indigenous community, it has made various efforts to protect indigenous knowledge. Through an amendment of its Patent Act of 1970, India does not grant patents to subject matter that is available to the public by means of use, written description or in any manner in any country, or that is used by local and indigenous communities prior to the date of filing the application for patents. India is also screening patents to engage in 'precedent setting' by challenging those that are based on 'prior' knowledge and to which India can lay claim.

Third, India has wide institutional platforms to screen, preserve and promote research on indigenous knowledge. These platforms include the National Botanical Research Institute, the National Institute of Immunology, the Toxicology Research Institute, the Central Institute of Medicinal and Aromatic Plants, and the Council for Scientific and Industrial Research, among others.

Fourth, India has managed to provide a market to indigenous knowledge via the validation of alternative medicinal and health care systems, and the accreditation of hospitals and clinics that applied these alternative methods. Finally, although there is no formal mechanism for integrating indigenous knowledge and innovations at university or school level, different initiatives are aimed at training people and at promoting research. (DACST 2000; RAFI/UNDP 1995)

Appendix 3

Indigenous Knowledge and Therapeutic Plants in Australia

The smoke bush (*Conospermum*) is a plant that is widespread in Western Australia, and indigenous people used it for a variety of therapeutic purposes. During the 1960s the US National Cancer Institute, under licence from the Western Australian government, collected and screened the smoke bush for scientific purposes. In 1981 some specimens were sent to the United States to be tested for possible anti-cancer chemicals, but no cancer resistant properties were found. In the late 1980s the smoke bush was tested again for potential substances that could cure AIDS. In the early 1990s the Western Australian government granted a licence to an Australian multinational pharmaceutical company to develop a substance named Conocurvone, which was able to destroy the HIV virus in low concentrations. Some estimates stated that the Western Australia government could receive royalties exceeding US$ 100 million by year 2002 if the substance was successfully commercialised, but there are no clear provisions for the indigenous people who had first identified the plant for its therapeutic and healing properties.

Source: Davis (1998).

Appendix 4

The National Biodiversity Institute (INBio) of Costa Rica

Costa Rica's National Biodiversity Institute (INBio) was set up in 1989 as a public interest non-profit civil association, and is an example of what can be done to acquire knowledge of, conserve and utilise biodiversity in a rational and sustainable manner. It is financed primarily through contracts for the sale of services and from grants made by foundations and international organisations. Its main activities are:

1. **Biodiversity inventory:** INBio is in charge of the national biodiversity inventory, compiled on the basis of material and information gathered by a group of men and women living in the communities close to the national parks. They are known as 'para-taxonomists' and receive intensive practical training in the fundamentals of biology, ecology and taxonomy; specimen collection and preservation techniques; data management and information processing; and administration and management of technical equipment. The para-taxonomists gather specimens and process them in twenty-three stations set up all over the country, and the information is subsequently sent to INBio headquarters.
2. **Search and promotion of sustainable uses of biodiversity:** This takes place through 'biodiversity prospecting', which consists of the systematic search for new sources of chemical compounds, genetic material, proteins, microorganisms and other products of potential economic value to the pharmaceutical, cosmetic, agro-industrial and biotechnology industries. The process begins with the location, detailed description and collection of specimens. The compounds contained in these specimens are then identified in a preliminary manner and those with economic potential are then handed over to firms and institutions associated with INBio. If any of these compounds reach the stage of commercial exploitation, the firm or institution pays a royalty to INBio, which has developed research agreements for bioprospecting with academic centres such as the University of Costa Rica, Strathclyde University and Cornell University, and with private companies like Bristol Myers Squibb, Merck and Co., Givaudan Roure and Diversa. These generate over US$ 1 million per year to support INBio's activities, as well as other conservation initiatives.
3. **Generation and dissemination of knowledge and information:** INBio processes and publishes information about biodiversity. It has developed several multimedia products, and maintains and continuously updates a large Web site with more than 10,000 pages of free information. It conducts workshops and training programmes on biodiversity and develops educational materials for schools, and also provides consultancy and advisory services. In 2000 it inaugurated INBiopark, a large educational facility with three or

four types of ecosystems and installations specially designed to house permanent and temporary exhibits on biodiversity in Costa Rica and the rest of the world.

Source: Agenda: PERÚ (2001).

NOTES

1. The Marshall Plan's success owed much to the specific historical and geographical context in which it was carried out, because it involved the industrial reconstruction of countries that had decades or even centuries of manufacturing experience, a well-educated labour force and the institutions needed to support a modern economy.
2. This approach was central in the development of the 'Human Development Index' by Mahbub Ul Haq and his collaborators, which issued the first *Human Development Report* in 1990, now published annually by UNDP.
3. This approach can be considered as an update of 'Sabato's triangle' that was widely used in the 1970s to examine the interactions between government, industry and scientific institutions (Sábato and Botana 1968, Sagasti 1982).
4. For an attempt to suggest new directions for development cooperation, see the 1999 Hopper Lecture delivered by one of the authors of this paper (Sagasti 1999).
5. On this matter see Rath and Lealess (2000).
6. For an African perspective on how to deal with intellectual property rights see: Mugabe et al. (1997), and for a Latin American view see Perkoff and Ruiz Muller (2001).
7. See the IDRC website at http://www.idrc.ca.

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