A SOUTH-NORTH-RELEVANT KNOWLEDGE NETWORKING TREND: PHARMACOGNOSIS AND BIODIVERSITY INTERLINKS INTO THE USA-MEXICO RELATIONSHIPS

Silvia Almanza
International Relations PhD Candidate
Universidad Nacional de Educación a Distancia, Madrid, Spain

Address: Un iversidad Nacional Autónoma de México
Grupo de Estudios Sobre Innovación Tecnológica
Instituto de IngenieríaG
Edificio Uno, 1er Piso
Ciudad Universitaria
México D.F. C.P. 045035 MEXICO
E-mail: silviaa@servidor.unam.mx

SUMMARY

The international interchange of knowledge for technological innovation involves a complex, dynamic and asymmetric set of flows and relationships, mainly from North to North. However, the issue of the movement of knowledge, and the asymmetries that these movements produce between North and South is an important issue. In this paper we address a rather complex converging trend: that one embracing several types of knowledge movements (formal and informal, refered here as *relevant knowledge*) between the South and the North, closely linked to the local availability of natural resources and its concomitant knowledge of the former. These movements are-closely linked to the advancement of the new technologies at the industrialised countries. The increasingly interest of the North to be connected with some selected semiperipheral economies is closely related to the need to access to these new" iputs as fast as possible in order to create or sustain –directly or indirectly- the competitive advantages of the firms. Within this logic, countries mainly of semiperiphery, with an endowment of biodiversity, indigenous knowledge and a minimal scientific infrastructure are being strategically selected. At a broader dimension, this may have to do with the rivalry among the great central economies, as stated in the modern world economic system. Both the position of the included or excluded peripheral and semiperipheral countries within the new international division of labour, and some kind of asymmetric integrating processes -we argue here-, seems to be closely linked, trhough this way, to the technological change.

On the other hand, while information flows can be viewed as a confused mess within a whole network, mobilisation of knowledge has to have in mind its attributes, of historical, transnational, transdisciplinary and asymmetric nature. At a microlevel, we argue here, mobilisation of knowledge has to be highly selective, cloistered around precise goals. However, asymmetries has to be shortened to be successful. To visualise the knowledge flows we suggest and test in this paper the concept of *knowledge international circuits (KIC*), which are viewed here as a dynamic aspect of a broader information network. The limits of the whole information network may appear undefined within the economic world system, because of its very expansive nature. However, at the microlevel, through detected interactions, the sope and constrains of the system to mobilise knowledge between countries may become clear. The KIC could be a representation of this dynamics.

We have taken, as a general framework, the integrating process of a variety of relevant knowledge circuits between the South and the North. This emergent trend arises from the increasing demand of medicinal plants located in specific south geographical zones, by the pharmaceutical firms of the North. We view all of them linked in one or another way, to the biotechnological burst in this industrial sector. Here, the precise goal would be the [phyto]pharmacognosy, within the drug discovery process. In this context, the *knowledge international circuit* involves, on one side, the knowledge required in the USA to communicate, translate, understand and get the concomitant indigenous knowledge associated to the medicinal plants of Mexico. On the other side, is involved the local knowledge in Mexico to deliver both the physical inputs (plants, extracts, etc) and their associated knowledge, to their counterparts in the USA.

INTRODUCTION

An important input for the innovation process is the suitable, relevant knowledge. Its generation and acquisition, however, is not an easy task. To get it, is required to have the suitable channels through which the knowledge could be mobilised. This is particularly true if the required knowledge has to be transferred between countries with relatively sharp different grades of development. On the other side, today it is used to study the interactions as a way of networks. While their structures have attracted the attention of scholars, the dynamic aspects of the networks remain at the row of issues to be studied. In this paper, we suggest and test a simple tool as a first approach to the study of the international dynamics of networks, through the study of knowledge channels and flows, the *Knowledge International Circuit (KIC).* Given the aim of the paper, we are not going to discuss here other important issues with regard to the asymmetries of knowledge international transference, like ethical, property rights or power aspects.

Building channels to mobilise knowledge is quite a complicated task: there are different types of knowledge, actors, aims, contexts, etc. The knowledge may be required or supplied by a developed or an undeveloped country, by a private firm or by a public research centre. Therefore, the strategies to build them have to take into account the *from where, to whom, who, how and what for.* Finally, to design the instruments and mechanisms, the inherent asymmetries and complementary aspects between the parts have to be taken into account. In case of large asymmetries, like international projects among developed and underdeveloped countries, a kind of special "bridges" must have to be designed to speed up the knowledge flow. Asymmetries, in this context, means, among other things, that there will be some "selectors" and other(s), the "selected" -countries, institutions-, which have that peculiar expertise required to speed the access to the precious resources. Therefore, the KICs are, by nature, power relationships.

These circuits may arise from a diversity of selective interactions among the economic, academic and other knowledge provider and receiver agents at the microlevel. At the macrolevel, however, orchestrated policies and instruments should be in charge to lubricate the knowledge machinery (governments, IOs). While we leave out from the KIC the macrolevel institutions and instrument, we include them into the consolidated analysis, since both levels are deeply linked.

Currently, there are many examples in the world around relevant indigenous knowledge mobilisation for drug discovery. To test the KIC model we have taken just two examples. The first is a KIC to mobilise knowledge from the Maya zone, at he south of Mexico; the second is a KIC to mobilise knowledge from the drylands, at the center-north of Mexico. Both of them were picked out from a broader North-South knowledge network named *International Conservation Biodiversity Groups* (ICBG). This is an instrument of the USA governmental strategy to build a new kind of bridges and channel flows to the USA from some important biodiversity zones of the world, mainly of Latin America, within a new vision of this country to sustain it as a world leader –in this case- of biotechnology. .

The paper is divided in three parts. A brief background is presented in the First Part. It includes the recent conceptual changes of knowledge, from *valid* to *relevant*, that allow us to include the indigenous knowledge as a part of the Knowledge Era.*;* a brief description of the phytopharmacognosy process, for whom the indigenous knowledge is mobilised; the resurgence of the Occidental interests about medicinal plants and indigenous knowledge for drug discovery; the types of knowledge required to get/give the information contained into the concept "medicinal plants"; finally, we present the concept of *knowledge international circuit (KIC).* In the Second Part, we test the KIC as an analytical tool with two examples. Finally, in the Third Part, we briefly discuss some preliminary results, on one side, about the dynamics of knowledge channels, and , on the other, about the KIC itself as an analytical tool.

1. BACKGROUND

Knowledge Production in the modern economic world system

A key feature of the modern world economic system is the incessant search of profit and, therefore, an unceasing need to create and sustain competitive advantages. In turn, this mean a continuous requeriment to innovate and expand the knoweldge base in each activity of the industrial production. Each knowledge base differ in terms of the properties of knowledge from whom shall be based the innovative activites of the firms. By its own nature, the technical knowledge can be specific or generic, tacit or codified, to have high or low complexity, independent or interdependent. Far from being a freely flow of knowledge through space, the relevant knowledge shows several difficulty grades, according to its nature, codification and availabitiy of transmission and communication channels, some of which are strongly institutionaly dependent (Lundvall, 1988). It is different the knowledge and skills required at the very beginning of the pharmacognosy process than that at the end. However, the concomitant knowledge of medicinal herbolary from Mexico –as all indigenous knowledge may be-, is tacit and decodified, but it is conextual –it belongs to a different vision of the world-, so many bridges have to be constructed, to be "translated" to become useful. Also, given its recent acceptance as relevant knowledge for the drug discovery process, it has yet to be properly legitimised, institutionalised and dignified, mainly by its own home countries.

With regard to the mode of knowledge production much can be said. By limits of space, we would point out here just the most important features for our purposes: the conceptual change from valid knowledge to relevant knowledge (or hybridization); the international division of knowledge labour; and knowledge with regard to North-South relationships.

From Valid Knowledge to Relevant Knowledge

The frontiers of knowledge are never finished. As they are broadening or forced in one direction, new specialized workers shall be produced or absorbed by the system; disciplinary barriers will be throwed down and traditional skills will have to be recycled to be connected into the modernity. On the other side, much of our scientifically based technologies work well enough not because they were rationally designed from the very basic principles and a real and full understanding of what was happening, but simply because they were probed in practice by old, traditional methods of probe and error (Zimman, 1980).

V*alid knowledge* is defined as a knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through the scientific method. However, the acquisition of knowledge is a social activity. The consensual accumulated knowledge gives the intellectual framework for future research by individual scientists. This is, precisely, from where the power and authority of scientific knowledge comes from.

For the time being, however, and closely related to the technological change, the production and communication of knowledge has changed, to give rise to a new hybrid science, where boundaries between theory and practice are blurring and the cognitive and non cognitive elements are being mixed up in novel and creative ways and means (Gibbons, 1999). In this context, the feeding process of the scientific knowledge may well come from various sources, rooted to the environment.. Thus, the dynamics of convergence and expansion of the knowledge base within a technological system has its fineness, no matter how sophisticated the technology could be. What it really matters now, is the *relevance* of such types of knowledge, for a given purpose. No matter from where comes from. The change today is just the recognition that scientific knowledge can be feeded by other types or sources of knowledge, as far as they were *relevan*t and pass the probe of the scientific method to be validated. What science does, in this sense, is utilize or legitimize the relevant knowledge -that owe more to the experimentation of probe and error than to a deep conceptual analysis (Zimman, 1980)- to, eventually, diffuse it to assure its own expansion. To accelerate the incorporation of knowledge into the productive sphere, sometimes is needed to build bridges to link it with the scientific technological activity, to mobilize it to the scientific machinery, to capitalize it.. In other words, the relevant knowledge has to become more scientific, to be validated and thus, accepted.

For this paper we use the concept of *relevant knowledge* as a set of several types of knowledge directed to a practical or social applicability. Here, the efficient use of knowledge has to do with the capability –say, ingenuity - to retrieve timely every kind of knowledge –scientific or any other type, including indigenous knowledge-, managed so as to get even more than the conventional limits of scientific knowledge, in order to satisfy the needs (of the project), for a precise goal. In this context, "relevant"means to have a real or a potential utility. Therefore, it is undetachable from the selectivity process.

Finally, *indigenous knowledge* refers to that type of knowledge having originated in and being produced naturally in a particular region or environment. In this sense, it could be a synonimous of local or traditional knowledge, and nor limited to a particular ethnic group.

In sum, in real life there is a convergence of fortunate and unfortunate facts and dificulties (concomitants to the scientific and technological activities; the pressures of a system that requires incessantly and increasingly more products in less time, etc.) in a context of urgent efficiency. Thus, the old mental scheme used to only accept as "valid" that knowledge classified as scientific, has changed, to accept -on the name of *relevance*-, another kind of still alive skills –indigenous among them. Then, the point seems to be just to build the proper bridges to understand it, in an orchestrated way between the macro and micro levels. However, don't forget that the motivation of this openess is derived as a function of relevance and so, to achieve precise goals. And, in a broader sense, the goal usually is to get profits: biotechnology is a business.

Throwing bridges

Viewed from the perspective of knowledge, the biotechnology is a typical product of our time: it takes the very basic information of life (at a molecular level, from the DNA), closely links scientific and technological knowledge to manipulate it; involves indigenous knowledge to feed up itself. The very core of the life technology is knowledge and knowledge manangement. Thus, biotechnology involves a broad interdependent set of activities, bringing togheter many sources of knowledge to achieve a lots of purposes.

To get the indigenous knolwedge, an interdisicplinary approach is needed. For that aim, ethnobiology seems to be a good instrument to build those bridges between traditional and scientific knowledge at the micro level. In such a way, the research machine tends to be horizontally connected at its very base of knowledge and, vertically, through communicating channels in such a way to allow the free movement of people from one level to anotherbetween the several fields of knowledge.

International Division of Knowledge Labour

The process of knowledge creation, being a complex production means and a commodity, necesarily entangle a social and technical division of labour, either at local, national or international levels. Within the globalization of economy, this process imply an increasingly interrelation of interests, capacities and capabilities, skills and availability of natural resources from everywhere, that result in a complex knowledge networks whose shape is determined by its dynamics. From here, myriads of continuum KICs switching-on and off emerge. As precise goals and technologies change with time, the shape of the networks could be modified. While many circuits could emerge on the same directions, others will change or simply, dissapear. In this way, the division of labour can be viewed in its two dimensions, micro and macro.

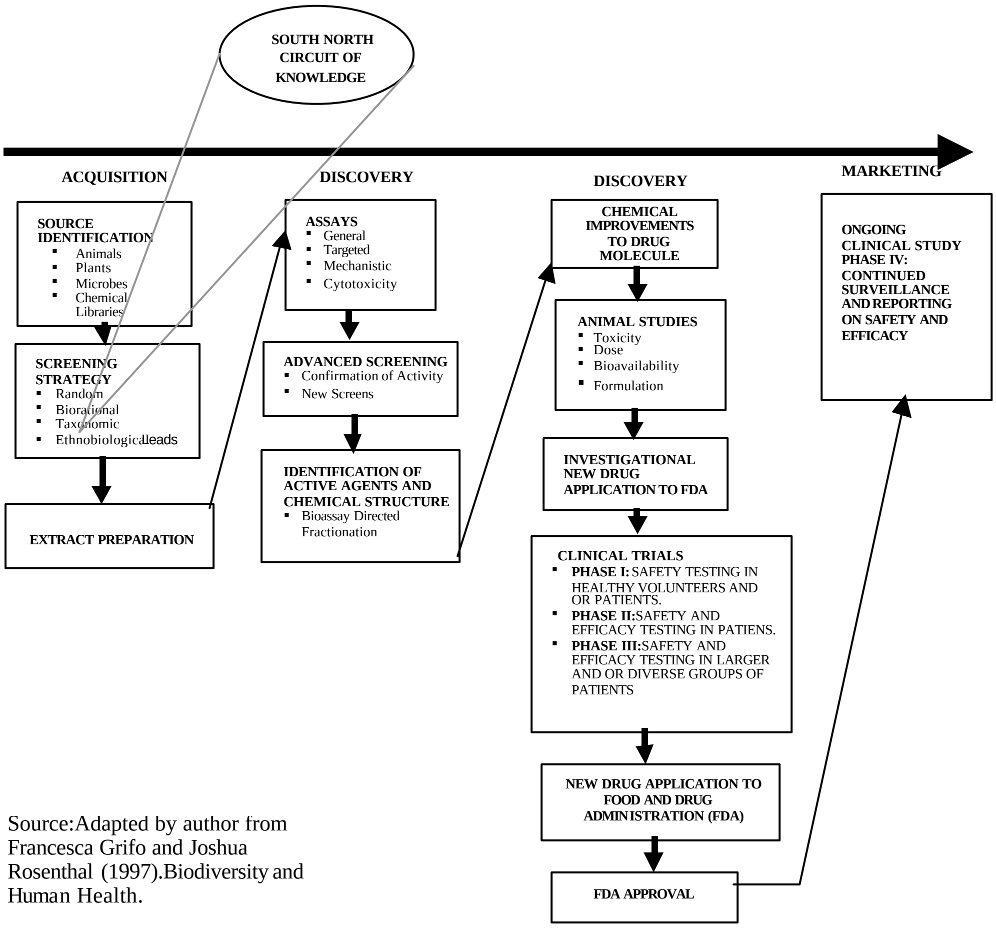
Knowledge and North-South relationships

As a rule, technical change and innovation proceed through the interaction of many and different actors, involving always some type of knowledge communication , crossed fertilization of ideas and interchange of technical and market information among individuals and organizations (Lundvall, 1993; Malerba and Orsenigo 1993, Nelson, 1993). Within the global trend for privatization of knowledge, in past years interchanges around knowledge tended to be concentrated among the most advanced countries, excluding apparently the less advanced countries. However, even if such interactions with the periphery and semiperiphery were oriented more to the formation and/or eventual recruitment of qualified human resources and sales of equipment, with time the generated links have been consolidating through a number of useful activities subordinated to conception and innovation in the center.Within the same capitalist logic, however, due the technological change as stated before, visions have changed and new interests have emerged. This is the moment where we are with regard to the knowledge relations between North and South.

The Drug Discovery Process

The general process of drug discovery and development as is currently done in the United States is shown in Figure 1.

Figure 1
The Drug Discovery Process in the USA



Source: Adapted by author from Francesca Grifo and Joshua Rosenthal (1997). Biodiversity and Human Health.

Figure 1. Magnified is shown the position of knowledge international circuits (KIC)studied in this paper.

As can be seen, at the very beginning of the drug discovery process has to be decided the natural source to be seized: plants, animals, fungui, microbes, etc. Plants naturally produce a variety of chemical defenses against predation or infection. This feature has been a rich source of medicines through history and, in modern times, of juicy economic returns source for the pharmaceutical industry.

Once it has been decided that plants are the choice to discover a drug, the process will be called *phytopharmacognosy.* The whole process encompasses many areas of knowledge such as phytochemistry, botany (including ethnobotany, economic botany, etc.), natural product chemistry, pharmacology, chemical ecology, pharmacy, molecular biology, etc. Therefore, the first step is to decide the best way to get the input from nature, what is the relevant knowledge to use it, who have it, who could transfer it, where is it, and so on. Plants and medicinal herbolary are plentiful in rich biodiversity zones, most of them located in the South. Some semiperipheral countries, have also the minimal required infrastructure for the first step of the phytopharmacognosy. Thus, priorization and selectivity for the initital screening of plants, including the mobilisation of the relevant knowledge from South to North, takes place in the form of programs and projects.

Drug discovery in context

As said before, the irruption of biotecnology intoo the pharmaceutical industry in the North has generated an increasing search of any kind of living source, plants and wild herbs among them, to feed up the drug discovery process. Almost the whole process can be done in the North. However, biological sources are uneven dispersed throughout the world, most of them are localted in the South. The differences or range of variation among some set of living species is known as biological diversity or *biodiversity*. Naturally, as more biodiversity endowment a geographical zone has, the number of possibilities to find the right inputs goes up. The probabilities to find the right candidate, however, is not an easy task: an amount of time, effort and knowledge has to be used to pick out the right inputs. Knowledge, in this context, means any kind of useful knowldge, including the indigenous knowledge. There are some geographical zones in the world particularly rich in biodiversity and indigenous knowledge –like Mexico, that is one of this “metadiversity zones” with a long tradition in medicinal herbolary. To be biodiversity rich, however, is not enough to be included. A minimal scientific infrastructure, historical relationships, legal frameworks, etc. are also accounted in the selectivity process.

The economic value of biodiversity

Till date there is not enough information on the value of the pharmaceutical potential of biodiversity. Just to give a brief idea of the importance of biodiversity as a source of new drugs we include an etimate done by Francesca Grifo (Grifo,1996)). Based on the number of prescriptions filled each year, 57 percent of the top-selling 150 pharmaceutical products in 1993 contained active ingredients that were natural products, derivatives or analogs of natural products. Given that sales of prescription drug products in 1990 were around $147 billion, biologically derived pharmaceuticals could reasonably generate in excess of $100 billion in revenues per year.

Indigenous Knowledge in Drg Discovery

Humans have been using plant materials for health since prehistoric times. In Mexico, for instance, there is a rich history in medicinal herbolary since prehispanic times. Later, since the colonial period, bioprospecting and search for indigenous healings became an important target of the European expeditions to the New World. With time, pure isolated compounds from plants were produced and eventually synthesized, giving rise to what is known today as the pharmaceutical industry. With the advances on chemistry the synthetic approach has been dominating the drug design.Till the mid-1980s most pharmaceutical firms had abandoned exploring folk uses of plants in their search for new drugs. However, in the last few years, the use of active principles from plants as inputs for drug discovery within the pharmaceutical industry has been recovering importance, mainly as a result of the economic possibilities that came to offer the tools of new technologies, like biotechnology.

The Knowledge International Circuit

This analytical tool has been sugested for a dynamic approach of the contemporary international relations (Tomassini 1991). It is a new way to organize the different elements of the structural change of the international system. To identify them, Tomassini proposes the idea of specific scopes of action *or transnational circuits*, to locate such elements within the changing reality. These elements -like knowledge, in our case- tend to cross the national borders and create circuits, according to precise interests. Under this focus, the international context is presented as the background from which, eventually, could be highlighted the circuits as objects of study. The actors involved in a circuit, belonging to different societies, work together according to an agenda. They may be interlinked in multiple fashions, according to specific interests or fields, such as technology, science, energy, food, environment, etc. It is precisely this specificity which defines the phenomenon of the transnational circuits.

Each circuit presents its own grade of specificity. The conditions of access of the actors to each circuit -the selectivity- depend not just of their location within the international hierarchy, but of their role with regard to the interests that in each case, are at stake. The interacting circuits are not rigid or static channels. They are, simply, signs of a selectivity that limits the margins from where the options are going to be fulfilled. From this perspective, the non-state actors belonging to different national societies involved in external relashionships, could bind their activities to get some results within an specific activity. The benefits pursued by the interacting actors within a circuit means a division of labour or a complementarity of efforts that creates a relationship of interdependence. In the South-North circuits it is usually a kind of asymmetric interdependence.

Based in the Tomassini’s idea (Tomassini, 1991), we developed a model to study the dynamics of knowledge international flows within the innovation process, picking out from the whole knolwedge network, specific scopes of borderless activities linked by precise goals..We named this analytical tool *Knowledge International Circuit* (KIC.

Within the term “research center” we mean universities, public research centers, botanic gardens and so on. On the other side, Governmental (G), International Organisations (IOs) and non-governmental (NGOs) institutions are not actors of any a particular KIC. Rather, they are viewed here as “facilitators” or mediators, as they provide the suitable policies and instruments for the actors directly involved in the KICs.), as shown in Figure 2.

Figure 2
The Knowledge International Circuit (KIC): General model

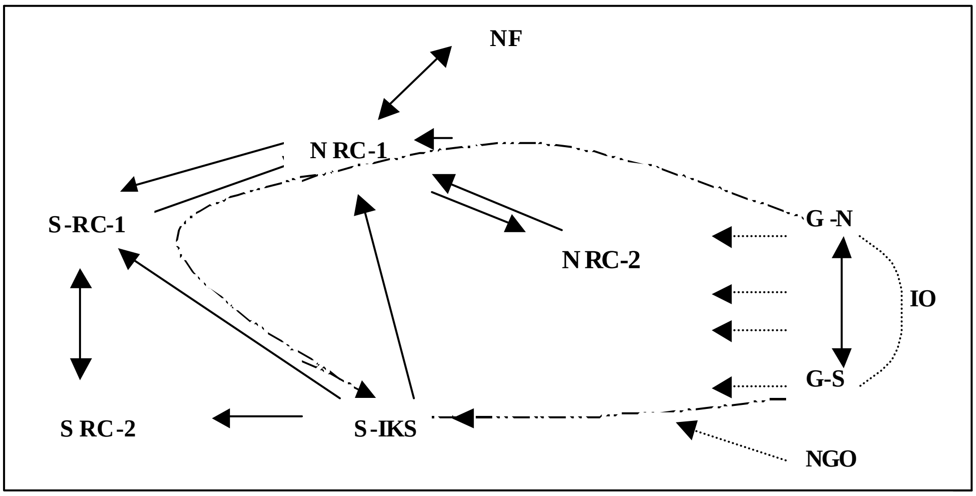


Figure 2: KIC Model: International Mobilisation of Knowledge from South to North
N-F = North Firm¸- N-RC = North Research Center; S-RC = South Research Center; S-IKS = South Indigenous Knowledge Supplier; G = Government; IOG = International Oganization; NGO= NonGovrnmental Organization**.**

3. MOBILISING KNOWLEDGE FROM MEXICO FOR DRUG DISCOVERY IN THE USA

Interacting knowledge actors and facilitators.

For the study case in this paper, we consider four types of directly involved actors in the KICs to mobilise indigenous knowledge: North firms, North researech centers. Mexico research centers; Mexican Indigenous Knowledge Suppliers Facilittors or mediators are govrnments, international organisms (IO) and nongovernmental organisms (NGO).

The Strategies and tactics

As said before, relevant knowledge for innovation may be of many types. In our case, we are concerned with the concomitant knowledge of medicinal plants from Mexico to be utilized –directly or indirectly, soon or later- for drug discovery by firms of the USA. This kind of relevant knowledge, however, is contextual and uncodified. Therefore, to mobilise it in a useful way, it has to be collected, translated, validated and codified. Thus, the channels and strategies from South to North must be different of those from North to South. So atrractive is this vein of knowledge that a variety of innovative strategies, tactics and instruments are emerging to build the bridges to get it. At microlevel, are for intsance, ethnobotany studies; indigenous languages studies (nahuatl, maya, purepecha, etc); Shaman’s knowledge programs; bioprospecting manuals; certificate/degree programs in Traditional Medicine; collaborative links with local scientists; information networks through internet, etc.

At a macrolevel dimension, there are some important USA policy instruments to facilitate the knowledge flows. In general, the international cooperation programs, by means of some conditionalities for grants, translate the governmental priorities to concrete projects. In this way, it is possible to link policies, programs and projects in a coherent form, like those from the ICBG program, like the Maya-ICGB - and Drylands-UNAM projects, taken here as examples of KICs.

Another angle of mediating measures is the regulatory framework. Rules, laws and norms around intellectual property rights, international technology transfer, environmental protection, science, technology, trade , etc., are all instruments used by governments to lead the interactions according to strategies of national interest

At the IOs level, while managed as multilateral treaties, its role as facilitators for precise KICs are mo re in the sense of setting suitable broad framemworks like the Convention of Biological Diversity (CBD) whose mandates, in turn, should be grounded to the national spheres as laws and norms, but also as national institutions to carry out their mandates, like the Comision para le Uso de la Biodiversidad (Conabio), in Mexico. The role of such agencies for a knowledge circuit could be to mediate at the negotiation process, to monitor the projects, to design apropriated instruments, or act as counterpart with similar foreign agencies. On the other side, the role of NGOs, their interests are much wider and contradictories, so they may facilitate or limit the emergence of a particular KIC.

The two KIC examples in this paper belong to an important USA special program named International Collaborative Biodiversity Groups (ICBG), designed to mobilise genetic resources and knolwedge from selected zones of Asia, Africa and LatinAmerica.

The International Cooperative Biodiversity Group Programs (ICBG)

These programs are going to be viewed here as a network to mobilise knolwedge from South to North. This is the immediate reference framework for the two examples that will taken here to test the KIC model. In a broader level, the ICBG is a USA governmental policy instrument to sustain the competitive advantages of their pharmaceutical firms and their leadership as a world power (Albright, 1997). Briefly, the main objective of ICBG is to accelerate the research into drug discovery from natural products. It is also an experimental effort that involves biodiversity conservation and economic development in developing countries (Timmerman 1997).

The ICBG Programs are jointly funded by the National Science Foundation, the U.S.A. Agency for International Development (USAID), several components of the National Institutes of Health (NIH). These programs are coordinated through the Fogarty International Center of the NIH. Reviewers include members from universities, museums, pharmaceutical companies, the World Bank, and environmental non-profit organizations with backgrounds in natural products chemistry, systematics, ethnobiology, ecology, intellectual property right laws, and international development.

According to the CBD, the ICBG principles require that full disclosure and informed consent are carried out, that near- and long-term benefits are shared with scientists, organizations and communities of the genetically rich source countries, that local laws and customs are followed, and that credit be given to local and indigenous or other intellectual contributors where possible. Several principles were established in relation to intellectual property rights through the use of novel contractual agreements between all members of this ICBG to ensure that economic benefits from any discovery are equitably shared. If a new drug is developed and marketed a substantial percentage of any royalties from sales will go to the source country to trust funds for local conservation and development projects.

In all cases, the projects have to be directed from USA institutions.The Latin America ICBG has five Associate Programs, four of which involve or are exclusive to The University of Arizona: *Biodiversity Utilization and Conversation in Tropical America (Suriname), Peruvian Medicinal Plant Sources of New Pharmaceuticals, Chemical Prospecting in a Costa Rican Conservation Area* and *Bioactive Agents from Dryland Plants of Latin America* (Argentina, Chile and Mexico). The University of Georgia is in charge of the fifth Program, the *Maya-ICBG.* Strict confidentiality is observed regarding public knowledge of specific names, location and information on the plants that are being studied, their active chemicals, proprietary bioassays and other details in order to protect potential intellectual property of the ICBG. Based on these constraints, we have taken as KIC examples, the *Drylands Mexico* and the *Maya-IGB.*

The Drylands ICBG Program

While plants from arid lands are well known to produce a variety of secondary metabolites as defensive agents and poisons, they have received much less attention than plants from the rainforests as potential sources of useful pharmaceutical agents. The objectives of this ICBG are to discover and develop pharmaceuticals and crop-protection agents from plants of arid and semi-arid ecosystems in Latin America and to promote sustained economic activity while conserving biological resources in these fragile environments. To meet these objectives, this ICBG is working with The University of Arizona, Pontificia Universidad Catolica de Chile in Santiago, Chile, Institute de Recursos Biologicos (MTA) in Buenos Aires, Argentina, Universidad Nacional de la Patagonia in Comodoro Rivadavia, Argentina, and Universidad Nacional Autonoma de Mexico (UNAM), Mexico City, Mexico (Timmerman, 1997).

Example 1: The KIC University of Arizona-UNAM-Mex (Drylands ICBG)

The University of Arizona, in cooperation with some USA firms, a university of Mexico, UNAM; is looking at plants from arid and semi-arid ecosystems of Mexico as potential sources of new pharmaceuticals and agrochemicals. The bioassays are performed in the USA by the GWL Hansen's Disease Center at Louisiana State University, Purdue University, American Home Products Corporation's Lederle/Wyeth Ayerst Research Laboratory and American Cyanamid Company (Figure 3).

Figure 3
KIC University of Arizona-UNAM

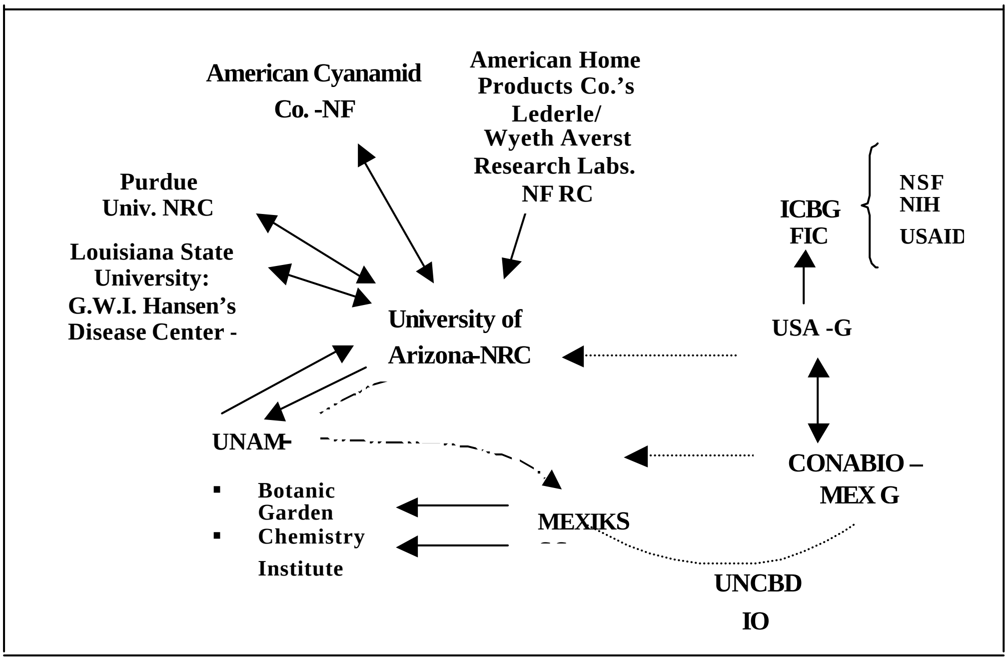


Figure 3: The Drylands-UNAM KIC (Drylands ICBG).

The Drylands–UNAM KIC is a good example to show the North efforts to mobilise knowledge from the South..Through this KIC it is evident the remarkable asymmetry between the South and the North. While in the USA appears a strong interaction between governmental institutions, private firms and research centers to act according to a governmental strategic vision, in Mexico appears a lack of coordination –in fact, a lack of strategic vision-both to take advantage of the international cooperation programs and to design and implement suitable policy instruments. At a governmental level, there are some broader agreements between the USA and Mexico about science and technology, environment, etc. that, naturally, favour this KIC.

Example 2: The Maya ICGB (University of Georgia-ECOSUR)

Within the same framework of the Drylands-UNAM example -ICBG Program), and with same three objectives (search of plants for drug discovery, biodiversity conservation and sustainable development) the Maya-ICBG KIC is internal organization is quite different. The main interacting actors are the University of Georgia and El Colegio de la Frontera Sur (ECOSUR), in the Highland Chiapa, a rainforest zone in the south of Mexico.

The Maya-ICBG project is organized around three Associate Programs, each dealing with the major research goals. The leader group (API1) deals with drug discovery and pharmaceutical development. There are involved the Molecular Biology and Biochemistry Department of UGA, two british biotechnological firms (Xenova Discovery

Ltd. and Molecular Nature Ltd), the Wales Institute for Grassland and Environmental Research, the UGA's Department of Physiology and Toxicology in the College of Veterinary Science.

The second group (API2) is in charge of medical ethnobiology and biodiversity inventory form. It includes Anthropology, UGA, Botany, UGA, Centre for Pharmacognosy and Phytotherapy; School of Pharmacy (London), Social Medicine Program , ECOSUR (Mex) Herbarium, ECOSUR Department of Systematics and Terrestrial Ecology.

The third group (API3) is focused in conservation, sustainable harvest, and economic development. Involved here are the Dept. of Statistics and Informatics, ECOSUR, Dept. of Agricultural Systems and Production, ECOSUR Bromeliad Ecology, ECOSUR Dept. of Horticulture, UGA, and Medicinal Plants Promotion and Development of the Maya ICBG

Other project forces are: PROMAYA, A.C., a Maya civil association still in the process of being fully structured (Fernández-Ugalde, 2000); Although the USA is not part of the Convention on Biological Diversity (CBD), its influence is there,. As in the first example, at a governmental level, there are some broader agreements betwwen the USA and Mexico about science and technology, environment, etc. that also have presence in this KIC. The general dynamics of this KIC is shown in Figure 4..

Figure 3
KIC MAYA-ICBG- ECOSUR

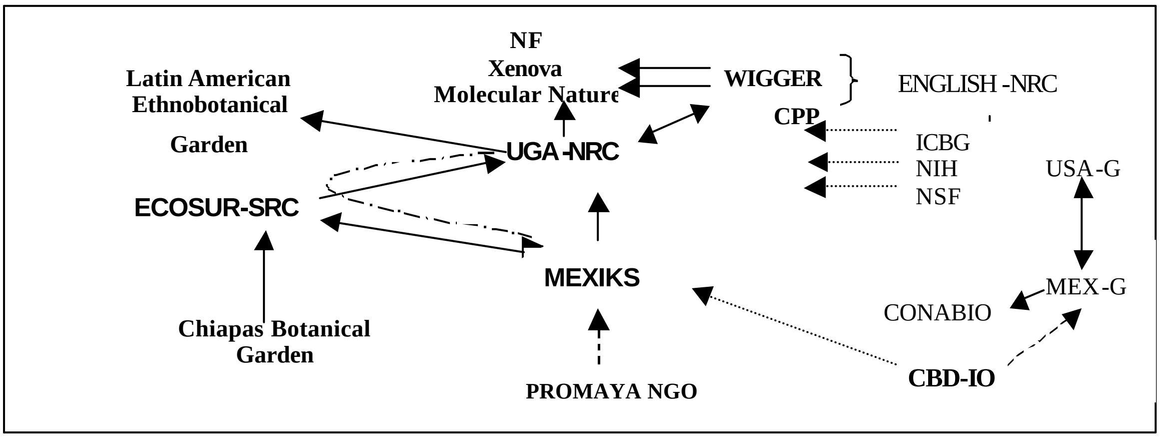


Figure 3: Knowledge International Circuit ICBG-MAYA -ECOSUR
UGA =University of Georgia, USA; WIGGER and CPP = North researhc centers; ECOSUR= Research center at Chiapas, Mex, MEXIKS = Mexican Indigenous Knowledge Supplier; ICBG = International Conservation Biodiversity Groups; NIH = National Institutes of Health; NSF= National Science Foundation; SEMARNAP = Secretaría del Medio Ambiente, Recursos Naturales y Pesca, Mexico; CONACYT = Consejo Nacional de Ciencia y Tecnología. PROMAYA is a NGO, CBD= Convention on Biological Diversity

As can be seen in Figure 4, the Maya-ICBG presents the same asymmetric pattern as in the Drylands-UNAM's example. In both cases, the proactive interacting forces from the North to atract the knowledge and resources are dramatically stronger than the capabilities in the South to equilibrate them. Another interesting feature to observe in these KICs is the international division of labour both at the micro and macro levels. At micro level, is self-evident that the role of the research centers from Mexico is to make easier the field collecting and identification steps, while the rest of the drug discovery process is done at the USA At macrolevel, the weakness of the policy instruments (in the figures, the ausence of suitable governmental institutions) to take advantages from the international cooperation programs is clear.

4. CONCLUSIONS

Two points shall be discussed here. First, the study case. Second, some possibilities that the KIC model could offer to the technological change based in our study case.

A] The study case

With regard to the induction from the USA academics and firms for this sort of South-North knowledge flows around the phytogenetic resources of Mexico is taking many innovative forms and strategies by the northern neighbours. These involves the concurrence of several disciplines and agents, and a serious effort to built the bases of a deeper understanding through a variety of mechanisms, including the use of electronic informa tion, the study of indigenous languages, ethnology, economics, bioprospecting, etc. We provided two examples of knowledge international circuit (KICs) sin the paper. At the macrolevel, there appears a well structured institutional apparatus to favour actions, with one eye to the internal needs and other to the foreign resources and relevant knowledge to feed up their productive machinery.

From the side of Mexico, there appear a reactive attitude within the bridges-building process. The role of the academic agents, with links with their northern counterparts on one side, and with the local indigenous knowledge providers, on the other, is minor within the whole process of drug discovery, as can be seen in the Figure 1. At macrolevel, the policy and the institutional infrastructure of Mexico is clearly weak to face the new international reality with regard to the science and technolgy for industrial development. The international cooperation, the legal framework, the bi-, tri and multilateral agreements have to be viewed within a whole strategy for development that we are not going to discuss here.

However, from what we have seen here, it is important to decide which role we wish to play, based on what we have to offer and what we can construct. A key point -in our view-, is to make an effort to sustain and validate the local knowledge through the reinforcement of the capability of the national science and technology of the providers of natural resources; to stack an efficent policy to sustain the traditional knowledge, oriented to add some value at home. If it is recognised that a *regional knowledge system* is more efficient than a national one, then the division of labour within that system should be orchestrated in such a way that could allow an equitative sustainable development for all.

In sum, iwith regard to our study case, we could say that it is seems to be important for the choosing process in the asymmetric partnerships, the availability of several types of local knowledge, perceived as relevant by the owner of a given new technology, but this situation well could be seen as a window of oportunity for the less developed countries.

B] The Knowledge International Circuit

In the technological change literature two issues have been emphasized for the understanding of the process of technological innovation: the innovation system and the transfer of technology. However, the international relations of science and technology have been almost ausent. Given the transnational nature of these activities; the transnationalisation of civil actors; the shifting of the international agenda to economic issues and the process of globalisation, a new, more transdisciplinary focus –in the sense of Edgar Morin (1997) could be very fruitful for the better understanding of reality. Within this view, we have made a first intent to adapt and integrate a concept of the international theory -the transnational circuit of interactions, renamed here as *knowledge international circuit* (KIC)-- to put in context an emerging trend in the interchange of knowledge between the central and semiperipheral economies, as a result of the technological change.

From the point of view of the international studies, the role of science and technology in the contemporary international economic system has to be included to understand, among other things, the international division of labour, the integration processes, the power relations, etc. From the perspective of the studies of technological change, the study of innovation systems have to take into account the interstate system (Wallerstein, 1992) to understand the dependence and asymmetries among countries in order to describe and explain, for instance, diferences of the national innovation systems –particularly between the developed and underdeveoped countries-and, in general, the dynamics of the technological change.

By using the KIC model we tryied to study the emergent trend of knowledge movements between the center and semiperiphery. Although at this stage is too early to make definitive conclusions, some preliminary results can be highlighted:

1) In the two examples, it becomes clear the selectivity process within the international division of labour. For countries well endowned with real o potential resources for the new technologies, it is unavoidable to improve their national innovations systems with an international perspective.

2) Through the analysis of a precise innovation process and technological change, it is possible to view the very process of capitalization of the common-pool resources (Keohane and Ostrom, 1995), like traditional knowledge and biodiversity.

3) Consistent to the open markets trend, there is an effort by some central economies to build bridges to establish communication channels with the semi-periphery or periphery, according to the interests of capital.. By integrating the analysis of small interacting scopes of activities, at the microlevel, to the national and international policies and these, in turn. to the interestatal system could drive to a better arrangements for development, including the integration processes. Even for competitive reasons, regional innovation systems –if well managed- are more efficients than national innovation systems, as is perceived in th European Union.

4) Given the structural asymmetries between the center and semiperihery with regard to science and technology management, the channels to mobilise resources have to be supported by stronger, strategic, proactive and open-minded policy insGtruments in the semiperipheral countries to better negotiate and take advantages of the international cooperation within the new vision of the central countries to temper their relationships with semiperipheral countires.

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