RAFI

The Conservation and Development of Indigenous Knowledge in the Context of Intellectual Property Systems

In Fulfillment of UNDP Contract
- INT/92/209 -

Pat Roy Mooney
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Introduction

Scoundrels and hypocrites act in the name of the General Good but Art and Science can only be achieved in minutely organized particulars.

William Blake

The I.Q's: In this year of indigenous peoples - and in the wake of the Earth Summit - where the invocation of indigenous peoples became a kind of *mantra* prologue to every statement, stories of the "wisdom" of indigenous persons abound. If the story exposes the depth of knowledge of women - all the better. If the story involves environmental sensitivity laced with a certain earthy reality, it is assured a long shelf life. The sad truth, however, is that indigenous knowledge is still widely dismissed even in the most sympathetic environs. The intellectual contribution of indigenous peoples is quietly regarded as suffering from the three "Q's" - i.e. indigenous knowledge is either *quaint* (with no currency or modern utility); *quackery* (it never worked or is probably carcinogenic); or *quits* (well on its way to extinction).

That this view is held by general society in industrialized countries is dismaying. That it is equally shared by scientists and others in the Institutional Innovation System is disastrous. Although it is true that a growing number of scientists are aware that indigenous communities may well harbour useful information about the properties of biological materials that may one day lead to new breakthroughs in medicine or crop production, almost all scientists and science policy makers perceive this collected information as the result of centuries of passive - even accidental accumulation. Indigenous communities have gathered knowledge in about the same way stones gather moss. Rarely does a scientific institution contemplate the prospect of a dynamic system of investigation and discovery.

The Cooperative Innovation System: The attached report attempts to document the socio-economic importance of an ongoing and dynamic Cooperative Innovation System which continues to work - despite overwhelming pressures to destroy it - and continues to offer humankind an irreplaceable hope for planetary survival. Indigenous knowledge has gone unnoticed by the Institutional Innovation System for so long because it is - not informal or disorganized - but cooperative and conducted within the pace of daily living. Most especially and invisibly, indigenous knowledge systems operate within the context of their immediate agro-ecological environment.

There are many in the international community who continue to believe that the extinction of indigenous knowledge is both inevitable and even desirable. Indigenous knowledge is sometimes regarded as a barrier to the transmittal of new technological tools and information. If indigenous knowledge once had a role, that role has since been overtaken by others.

Reference: UNDPINT92.209, 23 July, 1993

This is an extraordinarily dangerous view. Eighty percent of the world's people continue to rely upon indigenous knowledge for their medical needs. At least half, and possibly two-thirds, of the world's people could still not survive without the foods provided through indigenous knowledge of plants, animals, insects, microbial, and farming systems. To an extent that will astonish most readers, indigenous knowledge continues to be a major source of innovation and development in both agriculture and pharmaceuticals in industrialized countries, and its role in other forms of industrial production can be expected to increase substantially in the decades ahead. Indigenous knowledge fuels a multi-billion dollar range of life (or genetics supply) industries, ranging from food and pharmaceuticals to chemicals, paper products, energy, and other manufactures.

Macros and Micros: The Cooperative Innovation System of indigenous communities can be seen as a mirror image of the Institutional Innovation System. As a fair simplification, the Institutional System offers humanity micro-system developments which find application on a macro-scale. Highly specific improvements in molecular biology or micro-electronics can be capable of vast commercial application. Cooperative innovators offer often broad macro-system innovations that can generally only be applied at the micro-level - within the local environment. Indigenous knowledge often involves the use of complex bio-systems integrating plants, insects, and soil, for example, in a common strategy.

Minutely-Organized Particulars: The vital ongoing necessity of indigenous knowledge comes from this micro/macro mix. The more we come to understand the complexity of the eco-system, the more we recognize that the huge global problems that surround us - atmospheric erosion, soil erosion, species loss, malnutrition, and poverty - will not be resolved either through U.N. resolutions or sweeping new technological "silver bullets" be it nuclear power, cold fusion, or transgenic micro-livestock. As Blake said, art and science work as minutely organized particulars. To the extent that science and technology form part of the solution to major world problems, these solutions will come through millions of integrated experiments conducted by millions of researchers linking their work in each micro-region. Many of these researchers will be indigenous people.

Two Solitudes: Both sides of the mirror are needed. The micro-innovations of the Institutional system are in no way denigrated by recognition of the contribution of the macro-innovations of indigenous communities. The real challenge for science and technology in the decades ahead is to find the mechanisms necessary to allow these two solitudes to work together.

If the two solitudes are to help humanity through some of its most perilous times, the system of cooperation must offer each side integrity and equity. Intellectual property issues quickly rise to the surface.

Intellectual Integrity Framework: The key to cooperation may rest in the development of a framework that will safeguard the intellectual integrity - but not property - of indigenous innovators. That framework involves organization, public information, certain institutional mechanisms, and the development of a new Covenant that could guide the relationship of public and private researchers and of Cooperative and Institutional innovators.

This Report begins with a survey of recent trends in intellectual property rights. The "rules of the game" have shifted in the last few years and the scope of the patent system is becoming limitless. The economic implications of a globalized legal and trade system for IPRs is daunting.

In Section Two, the report emphasizes the economic and social contributions of indigenous rural communities in the nurturing of biological products and processes. The report discusses plants, livestock, microbial, and human genetic materials. There is little discussion of non-living material, in part due to a lack of time, and in part because the real issues and debate will develop around the new life industries.

After a survey of the specific contributions of indigenous peoples, the report summarizes a number of policy options noting that each has some role to play but finally placing highest importance on the development of an Intellectual Integrity Framework.

Each of the five policy options listed in section three could easily be developed much further. It is important, however, that indigenous peoples' organizations join quickly to become active participants in this discussion before much more work is done. Much of the economic information contained in this report is new, and it may well serve to alter the perspective of many readers. Indigenous peoples need to have early access to this kind of information as a prelude to policy formulation.

The struggle of people against power is the struggle of remembering over forgetting.
- Milan Kundera

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I. Current Trends in Intellectual Property Systems

Section One provides an overview of recent developments and trends in intellectual property protection including a discussion of the implications for indigenous communities.

A. Overview:

A.1. History: Intellectual property protection - in its broadest sense - has been a part of most societies throughout most of human history. In the Seventh Century B.C., Sybarites granted their cooks exclusive monopoly use of new recipes for one year. In 480 A.D., Emperor Zeno of Rome opposed a monopoly over fish indicating that such monopolies were common in the Empire. There are approximately 15,000 culturally-distinct ethnic communities in the world today[1]. In most of these cultures, knowledge and the use of medicinal plants is ceded to selected individuals who exercise a form of monopoly over these plants. Some monopolies have been (and continue to be) gender biased affording, for example, a right to women to select seed prior to harvest in order to conduct plant breeding experiments or, more typically, denying women access to certain species (game animals, etc.).

Despite this long history, the first formal patent law, recognized in the dominant western form of intellectual property, was recorded in 1474 in the City State of Venice but the Statute of Monopolies in England in 1623 is generally regarded as the first attempt to institutionalize a system of intellectual property protection. The international recognition of intellectual property is often traced to 1873 and the Patent Congress at the Vienna World's Fair[2]. In the 120 years that have lapsed since Vienna, the form and scope of intellectual property expanded. The pace of change in the last two decades, however, has substantively surpassed all of the developments in this field in the previous century.

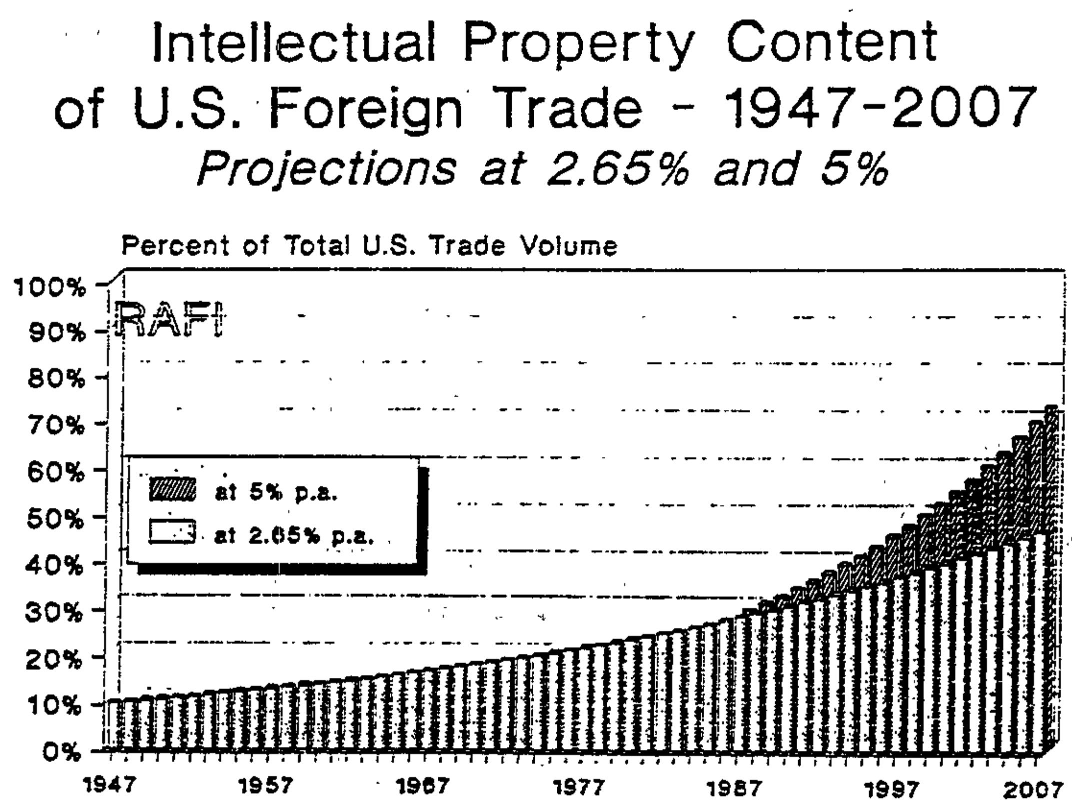
Given the remarkable explosion in science and technology over this same period, a parallel expansion of the system intended to stimulate innovation would not be surprising. Whether there exists a correlation between the development of intellectual property rights systems (IPRs) and the growth of innovation is a matter of long and inconclusive debate. Some contend that IPR systems have trail innovation and others see that, whichever comes first, the pace of innovation would slow if it were not for the prospect of intellectual property protection. During the middle part of the last century - as some European nations sought to join industrial revolution - society and government views on patent law shifted and there was a strong trend against intellectual property protection throughout the European continent. Switzerland, Germany, the United Kingdom and The Netherlands all either rejected, revoked, or restrained patent systems. Many parliaments saw IPRs as a barrier to development restricting the ability of industry to innovate and imitate.

A.2. Trade: There is no doubt, however. that the place of intellectual property in society and in commerce has changed significantly. As an indicator, the share of U.S. goods in international trade having a high intellectual property content (books, chemicals and electronics) rose from barely 10% of all exports to 27% of U.S. export value between 1947 and 1987 (early into the most recent GATT Round). At an annual rate of increase of less than 2.7%, the *brain* content of U.S. trade was projected to rise to just under 50% in the first decade of the 21st Century. However, taking into account the new importance of micro-electronics/informatics industries and the development of new biotechnologies, RAFI projects the share of U.S. traded goods under patent or copyright could leap to 80% or higher by 2007.

The spread of intellectual property rights over pharmaceuticals as well as plant and animal varieties are the major reasons for this upward revision[3].

The incorporation of Trade-related Intellectual Property (TRIPS) within the GATT Uruguay Round gives emphasis to the heightened importance of IPRs in trade. In GATT, U.S. negotiators have maintained that patent and copyright piracy by developing countries loses American industry sales and royalties amounting to between $43 billion and $61 billion per annum[4]. Roughly equal figures are projected for losses for European and Japanese industry.[5] Such enormous calculations have given intellectual property issues a visibility not seen since the Vienna Congress. When intellectual property rights and technology transfer became an issue at the UN Conference on Environment and Development (UNCED) in 1992, the controversy also incorporated the concern for the protection of indigenous knowledge. Agenda 21, in fact, juxtaposes the use of new biotechnologies with the use of indigenous knowledge.

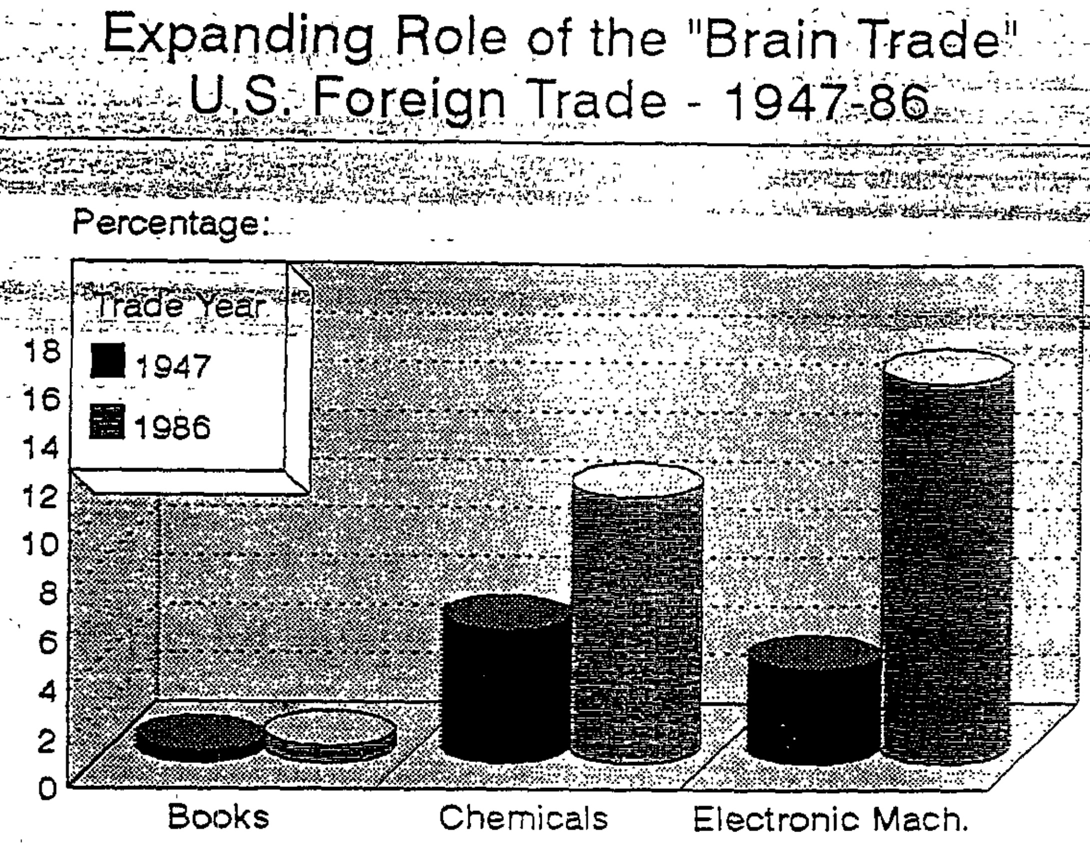
Chart 1 - IPRs and U.S. Foreign Trade



Reference: UNDPINT92.209, 22 July, 1993

From being a relatively modest factor in international trade, intellectual property - and the conventions and regulations that govern its transfer - is becoming a real force in world affairs.

Chart 2



RAFI Estimates

A.3. Vertical Intellectual Integration: Perhaps for the first time, basic or near-basic research is being treated as a marketable commodity. In the arena of new biotechnologies, for example, and in the absence of a traditional product, it is still possible for researchers to buy, sell and profit from basic research in ways heretofore unheard of. Some biotechnology companies have been able to carry out research for many years, financed by other companies and venture capital, without producing a product and without turning a profit. Shamen Pharmaceutical, for example, is a bio-prospecting company that has yet to produce a product but has grown into a profitless company with $120 million in assets[5]. One reason why this has been possible is because of IPRs and the ability of the companies to patent their research (or to use trade secrecy). IPRs are vertically integrating *backward* into basic research.

A.4. The Intellectual Stock Market: Aside from whatever role intellectual property may or may not play in innovation, patents are now regarded as *bargaining chips* or *intellectual legal tender*. Patents are items of trade and barter. It is possible to envision a Futures Market in intellectual property stocks. The value of a company can increase because of the patent claims it might make or the patent scope it might defend.

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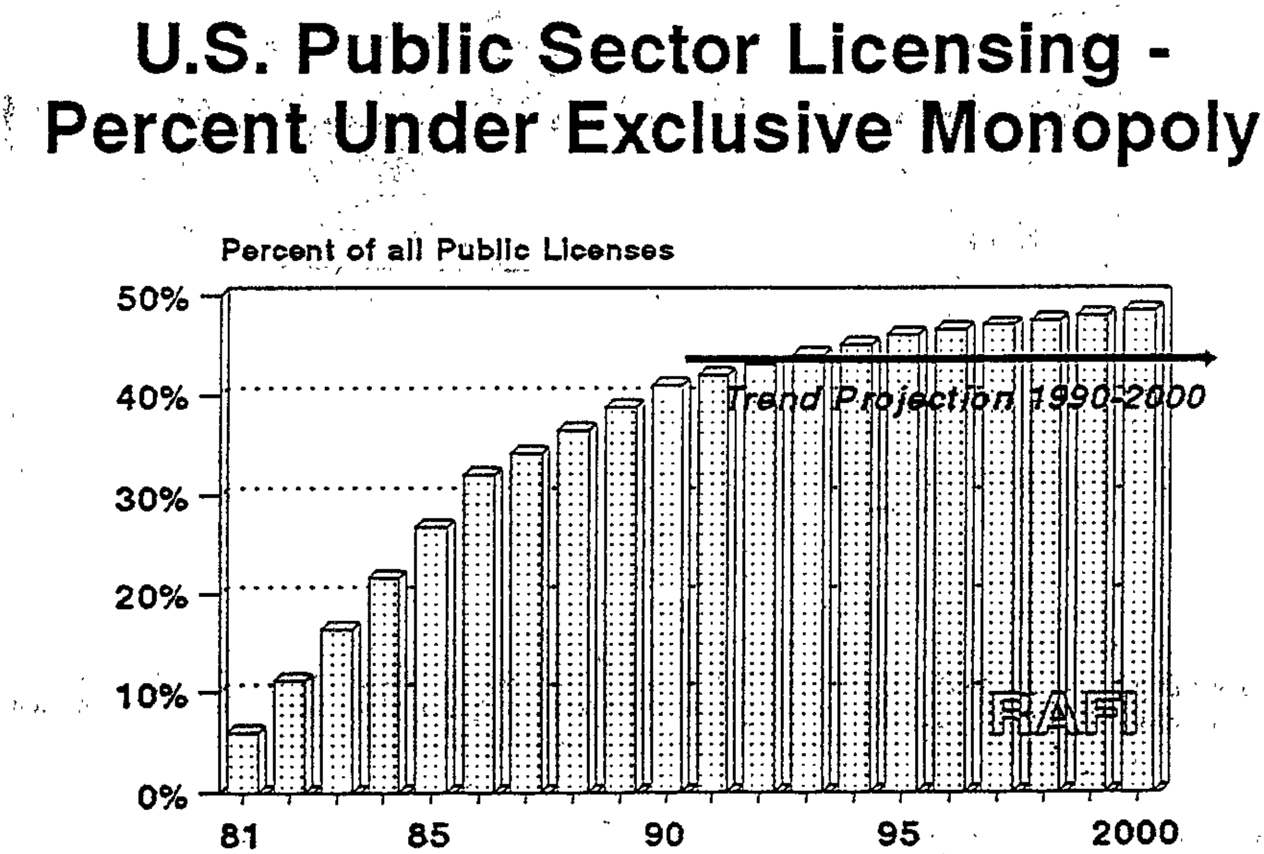
With the scope of scientific investigation moving to biological products and processes, the implications of a genetic stock market in bio-research require consideration. The IPR System now seems to perform a number of complex market functions that were not originally envisioned. The functioning of IPRs is made still more important and more complicated by two other developments - one social and the other scientific.

A.5. Privatized Research: The obvious social change is the new importance assumed by the private sector and the mushrooming influence of the private sector in R&D. The role of the private sector in funding public research is now seen as extremely important to public research survival. Whether the amount of money available for public research has increased - or whether there has only been a shifting in the source of funding from the public purse to private enterprise is unclear. It is clear, at least in the United States, that the private sector now has a dominant influence over the direction of public research. Interestingly, the share of public sector patents that have been sold under exclusive license to the private sector has jumped from less than 6% in 1981 to over 40% in 1990. If present trends continue by the end of century, close to half of all the intellectual property accruing to U.S. universities and government agencies will be controlled by corporations on an exclusive access basis.

Chart 3 - U.S. Public Sector Licensing



Source: Multinational Monitor & RAFI

Reference: UNDPINT92.209, 22 July, 1993

A.6. The Homogenized Life Industry: The scientific change lies in the focus on life forms and the potential to apply fundamental research to a number of diverse commercial activities ranging from human pharmaceutical to veterinary medicines to plant and animal breeding, food processing and a number of energy and environmental purposes. The linkages between these industry segments has increased with research developments in transgenics allowing plants to utilize animal and insect genes and for pharmaceutical enterprises to use livestock as manufacturing plants or to merge medicines and foods into *nutriceuticals*. The result is an emerging *genetics supply* or *life* industry more broadly-based than any that has come before. That this new industrial configuration operates at the centre of life and works with the essentials of human and planetary survival makes its activities all the more important.

Although the trend toward the privatization of research is only partially driven by the potential for exclusive monopoly patents and the trend toward the homogenization of life would take place regardless of intellectual property rights developments, both trends pose new issues and new challenges to the social management of innovation and the transfer of technology. In mid-1993, even though GATT negotiations are not yet completed and many issues concerning IPR and the Convention on Biological Diversity remain unanswered, it is realistic to assume that the move to adopt ever-stronger forms of exclusive monopoly intellectual property over ever-wider fields of innovation will continue and that most developing countries will - over the next decade - adopt IPR legislation in line with both WIPO and UPOV. Indigenous communities - regardless of their views on these developments - should develop policies and strategies with this in mind. This is not to suggest that indigenous peoples need accept or comply with IPR systems they do not welcome. There are socially-viable alternative scenarios available that should be considered.

The box immediately below offers a simplified overview of the major enterprises in the "life" (genetics supply) industry as it is now emerging. The box considers four industrial sectors. The four industries are: biotechnology R&D investment; pharmaceuticals; pesticides; and seeds (plant breeding).

Box 1 - New Life (Genetics Supply) Industry

Enterprise	Biotech	Pharma	Pest	Seed
Ciba-Geigy	1	1	1	1
Hoechst	1	1	1	1
Monsanto	1	2	1	2
Sandoz	3	1	1	1
Upjohn	1	1	3	1
Du Pont	1	2	1	3
Eli Lilly	1	1	1	
ICI	3	2	1	1
Pfizer	1	1		1
Rhone Poulenc	1	2	3	1

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Amer. Cyanamid	1	2		1
Elf Aquitaine	1	3	3	1
Bayer	3	1	1	
Dow	3	2	1	3
LaFarge Coppee	1	2	3	3
BASF	3	2	1	
Schering	3	2	1	
Lubrizol	1		3	3
Merck	3	1	3	
Rohm & Haas	1		3	3
Shell	3		2	3

Notes: 1 = A leading enterprise in this sector;
2 = Active in this sector;
3 = Minor activity in this sector

B. Current Developments in Intellectual Property:

A number of recent patent applications have caused debate within the scientific and legal communities. The following selected examples have implications for the protection of indigenous knowledge and of indigenous peoples themselves.

B.1. The Human DNA Patent Claim: The U.S. National Institute of Health (NIH) has laid claim to at least 2,851 human genes or DNA fragments related to the human brain. The invention is based on a discovery method that allows NIH scientists to identify material and then undertake a computer search to determine whether or not the material has been previously patented or described. If the material is technically unknown, the NIH stakes a patent claim on it. The NIH claims portend the diminution or elimination of the *usefulness* criteria in intellectual property legislation. Essentially, the NIH has argued that because the genes and DNA fragments they seek to patent are related to the workings of the human brain, they must have utility. By extrapolation to agricultural biodiversity then, a claimant could contend that anything found in an ecosystem (plant, animal or microbial) must have utility within that system and be a valid subject for protection. While the NIH applications were turned aside, the public institute has reapplied.

As of December, 1992, the NIH had identified 2,851 DNA sequences ranging in length from 15 to hundreds of nucleotide, in a patent claim 1,015 pages long. The NIH has deposited all the fragments in the American Type Culture Collection at a cost of more than $1,700,000 in deposit fees[6] In addition, each of the 2,851 claims costs $30 ($85,530 in total) plus the enormously greater cost in legal fees. The public expense has also caused an outcry for what has become the most controversial patent case in history. Box 2 below presents a summary of an NIH patent claim.

Box 2 - NIH Human DNA Patent Claim

Publication Number	WO 9300353 A1
Publication Date	1993 01 07
Application Number	U.S. 9205222
Filing Date	1992 06 19
Priority Application	U.S. 716,831 1991 06 20 U.S. 837,195 1992 02 12
Title	SEQUENCES CHARACTERISTIC OF HUMAN GENE TRANSCRIPTION PRODUCT
English Abstract	Partial and complete human cDNA and genomic sequences corresponding to particular expressed sequence tags (ESTs). The ESTs are cDNA sequences that are generally between 150 and 500 base pairs in length, are derived from human brain cDNA libraries, correspond to genes transcribed in human brain, and have base sequences identified herein as SEQ ID NOS: 1-315.
Applicants	THE UNITED STATES OF AMERICA, as represented by THE SECRETARY, DEPARTMENT OF HEALTH AND HUMAN SERVICES;
Inventors	VENTER, J., Craig ADAMS, Mark, D.
IPC Version Number	5
IPC Code(s)	C07H 21/04 C07H 21/02 C12N 15/11 C12N 15/00
Designated States	AU CA JP AT (epo) BE (epo) CH (epo) DE (epo) DK (epo) ES (epo) FR (epo) GB (epo) GR (epo) IT (epo) LU (epo) MC (epo) NL (epo) SE (epo)

B.2. The Cotton Species Claim: The Agrocetus species claim (Agracetus is wholly-owned subsidiary of W.R. Grace, one of the world's largest chemicals companies.) on genetically-engineered cotton argues that any genetic manipulation of cotton -regardless of the germplasm or method of manipulation - would infringe on the holders' patent. Although conventional cotton breeding is uninhibited, the Agracetus claim, if upheld in the courts, would largely surrender the future of global cotton development to a single enterprise and its licensees. While only valid in the United States at present, it is likely that Agracetus could prevent any other country from exporting genetically-manipulated cotton to the United States. It may also be possible for Agracetus to prevent the importation of cotton clothing or other finished products containing engineered cotton. If this is the case, then the implications for 68 developing countries, as major cotton exporters, is substantial. Cotton is produced in 32 African countries (18 of which are LDCs), 21 in Asia (6 are LDCs), and in 16 Latin American states. In the developing countries (including China) some 250 million adults and children are dependent for all or a part of their cash incomes on cotton production or processing.

An indication that the Agracetus claim will survive legal challenge is that both Monsanto and Calgene have applied for and obtained licenses from Agracetus. The company says, however, that it will not license its patents relating to cotton fibre quality. Box 3 below provides a summary of this patent claim.

Reference: UNDPINT92.209, 22 July, 1993

Box 3 - Agracetus Species Patent Claim

Patent Number	5159135
Issue Date	1992 10 27
Appl. Data	575035 1990 08 30
Assignee	Agracetus
Inventor(s)	Umbeck, Paul F.
State/Country	WI
Title	Genetic engineering of cotton plants and lines
Abstract	A method is disclosed to achieve genetic transformation of cotton plants and lines. Immature cotton tissues are genetically transformed in vitro by Agrobacterium-mediated genetic transformation. The resultant cotton tissues are subjected to a selection agent or agents to screen for transformants. The transformed cultures are then induced to commence somatic embryogenesis. One possible regime for regenerating such somatic embryos into whole cotton plants is disclosed.
Exmp. Claim	5. A cotton plant comprising in the genome of at least some of its cells a foreign gene construction including promoter and control sequences effective in cotton cells, said gene construction further including a heterologous coding sequence, the foreign gene construction effective to cause essoin of a detectable cellular product coded by the heterologous coding sequence in the plant cells, the cellular product selected from the group consisting of a foreign protein and a negative strand RNA.
U.S. Class	800/205 435/69.1 435/172.3 800/DIG27 800/DIG63 800/255 935/64 935/67
IPC	A01H 1/04 A01H 5/10 C12N 15/00 C12P 21/00
U.S. Refs	4771002 4940835 5004863

B.3. The Endod, Thaumatin, and Neem Claims: Most relevant to indigenous peoples are a series of relatively recent examples of patent claims made in the United States of bio-materials traditionally used by indigenous communities in developing countries. Still pending in the U.S. Patent and Trademarks Office is a claim on endod (African Soapberry). After one day of experimentation followed by four months of legal and scientific work to verify the initial evidence, the University of Toledo has applied for a patent on the use of endod to kill zebra mussels in North America. The original research - over 19 years - was conducted by Ethiopian scientists in Ethiopia with support from IDRC in Canada. In turn, this scientific research was based upon hundreds of years of innovation and use by Ethiopian communities. Opponents to the claim argue that the discovery that endod kills zebra mussels was obvious and that the real work was done by Ethiopians. Under U.S. patent law, information regarding the details of a patent claim only becomes available when a patent is granted. Under the European Patent Office, only the application is published. As this claim has not yet been processed in the United States and its application in Europe is not known, there is no box summarizing the scope of this application. A copy of the RAFI *Communique* on this issue is appended to this report.

Similarly, a patent granted to Lucky Biotech, a Japanese enterprise, with the University of California for Thaumatin and the Serendipity plant have elicited dismay in West Africa where the sweet plants are local. That the commercial development of these enormously sweet plants in bio-factories in industrialized countries could further undermine the beleaguered sugarcane industry has increased the concern. Lucky Biotech and the U.S. university have also sought patent protection in West African making it possible for the patent-holders to prohibit some uses of the plants in the countries in which they are endemic. Indigenous communities in the region have used and nurtured the plants for many years. A RAFI *Communique* on thaumatin (prepared prior to the patent disclosure) is appended to this report.

Reference: UNDPINT92.209, 22 July, 1993

Box 4 - Thaumatin Patent Claim

Publication Number	WO 9201790 A1
Publication Date	1992 02 06
Application Number	U.S. 9105150
Filing Date	1991 07 22
Priority Application	U.S. 557,222 1990 07 24
Title	ENDOGENOUSLY SWEETENED TRANSGENIC PLANT PRODUCTS
English Abstract	Edible fruit, seed and vegetables of transgenic plants modified to produce a sweetening protein such as monellin or thaumatin are useful in preparing food compositions which have enhanced sweetness improved flavor. Expression systems for the genes encoding sweetening proteins compatible with plant systems and designed to enhance the production of these proteins in the edible portions of plants, and methods for producing sweetened fruit, seeds and vegetables are described.
Applicants	THE REGENTS OF THE UNIVERSITY OF CALIFORNIA LUCKY BIOTECH CORP.
Inventors	FISCHER, Robert KIM, Sung-Hou CHO, Joong, Myung PENARRUBIA, Lola GIOVANNONI, James KIM, Rosalind
IPC Version Number	5
IPC Code(s)	C12N 15/29 C12N 15/66 C12N 15/82 A01H 5/00 A01H 5/08 A01H 5/10
Designated States	AT AT (epo) AU BB BE (epo) BF (oap) BG BJ (oap) BR CA CF (oap) CG (oap) CH CH (epo) CI (oap) CM (oap) CS DE DE (epo) DK DK (epo) ES ES (epo) FI FR (epo) GA (oap) GB GB (epo) GN (oap) GR (epo) HU IT (epo) JP KP KR LK LU LU (epo) MC MG ML (oap) MN MR (oap) MW NL NL (epo) NO PL RO SD SE SE (epo) SN (oap) SU TD (oap) TG (oap)

As noted elsewhere, W.R. Grace (which controls Agracetus - the cotton species patent-holder) also controls two patents related to the Neem tree - the traditional medicinal and pesticidal tree used widely by many indigenous communities in Asia and Africa. The implications for continued local use are not yet a factor but some would argue that the qualities of the Neem tree are not a new discovery and that - if they were - the intellectual property rights should go to indigenous communities and not to a private enterprise.

Reference: UNDPINT92.209, 22 July, 1993

Box 5 - Neem Tree Patent Claims

UNITED STATES PATENT AND TRADEMARK OFFICE CERTIFICATE OF CORRECTION

Patent No.: 4,556,562
Dated: December 3, 1985
Inventor: Robert O. Larson

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below: In the list of OTHER PUBLICATIONS on the cover page, additionally include the following:
Recent Advances in Phytochemistry, Chapter 11 by Koji Nakanishi, 1979, pp. 283, 288, 289.
Chemical Abstracts 102: 41598u, 1985, "Isolation from Neem Oil of Active Principles Evincing Oviposition Deterrent Activity in Insects" Claim 10, line 3 after "3,500" insert - ppm azadirachtin. Claim 16, line 2, "12" should be -15-

Stable Anti-Pest Neem Seed Extract Technical Field

This invention relates to a composition for protecting food and fiber crops from harmful pests, and also to a process for preparing the same.

Background of the Invention

For many years now, several powerful and effective insecticides have been used to protect food and fiber crops. More recently, there has been a great deal of controversy about the effect of these on the environment and some of the insecticides which have been in common use have been banned. Furthermore, other insecticides which are still in use are considered to be potentially harmful to the environment, but are required to be used for lack of other alternatives.

As a result, a search has been going on for "biorational pesticides". These are compositions which would deter insects or other pests but would have no or minimal harmful effect on the environment.

One agent known to protect crops from pests is azadirachtin which is a natural product found in the seeds of the neem tree (*Azadirachta indica A. Juiss*). The neem tree is found in India, Pakistan, Bangladesh, Burma, Thailand, Malaysia, and Africa, for example.

Azadirachtin has been extracted from neem seeds and found to have antifeedant (deters insects from feeding on plants) and growth regulation potency against several pests including Japanese beetles, fall armyworms, locusts, termites, grasshoppers, tobacco hornworms, tobacco budworms, caterpillars, gypsy moths, rice weevils, aphids, cotton boll moths, and many others. It is readily applied by coating seeds or by applying a spray to the crops themselves. See for example, *J. Environ. Sci. Health* A17(1), 57, 1982 by J.B. Stokes and R.E. Redfern of the USDA.

While azadirachtin is a known agent, it has not come into commercial use because it has stability problems. For example, its instability in sunlight has been known and is subject of the aforementioned article by Stokes and Redfern. That article indicates that sunlight degradation is hindered by leaving some neem oil in with the azadirachtin or by adding other plant oil and that further aid is given by including a sunscreen (an ultraviolet absorbing additive). Azadirachtin has also been found to have storage stability problems whereby it deactivates in the container or after application simply on the passage of time. No solution has been suggested in the published literature for these problems.

Reference: UNDPINT92.209, 22 July, 1993

B.4. The Oilseed Quality Claim: Sungene, in the late eighties, laid claim to the high-lycine characteristic it introduced into sunflowers. Sungene argued that its claim applied to the characteristic for any crop. The claim has been challenged because of the breadth and looseness of the interpretation given by Sungene. Opponents argued that it could be interpreted as granting rights to the first parent to produce a nice child so that anyone else parenting a nice offspring would be obliged to pay royalties to the original holder. Box 3 below provides a summary of this patent claim.

Box 6 - Sungene Characteristic Patent Claim

Patent Number	4670391
Issue Date	1987 06 02
Appl. Data	635175 1984 07 27
Assignee	Sungene Technologies Corporation
Inventor(s)	Cooley, Gloria L. Wilcox, Anne S.
Title	Sunflower regeneration through embryogenesis and organogenesis
Abstract	The present invention relates to the regeneration of sunflowers via embryogenesis and organogenesis. The process comprises the steps of: (a) culturing tissue obtained from a sunflower plant on a first medium which comprises mineral salts, vitamins, amino acids, sucrose and a hormone in an amount sufficient to ensure callus formation; (b) optionally subculturing said callus on a maintenance medium which comprises mineral salts, vitamins, amino acids, sucrose and a hormone in an amount sufficient for callus maintenance; (c) subculturing said callus on a second medium which comprises mineral salts, vitamins, amino acids, sucrose and a hormone in an amount sufficient to precondition the callus; (d) subculturing said callus on a third medium which comprises mineral salts, vitamins, sucrose and a hormone in an amount sufficient to ensure shoot formation, and (e) subculturing said shoot on a fourth medium which comprises mineral salts, vitamins, sucrose and a hormone in an amount sufficient to ensure root formation, whereby plants are obtained.
Exmp. Claim	1. A process for regenerating sunflower plants from cell or tissue culture through embryogenesis and organogenesis which comprises the steps of: (a) culturing tissue obtained from a sunflower plant on a first medium which comprises mineral salts, vitamins, amino acids, sucrose and a mixture of abscisic acid (ABA) and 2,4-dichlorophenoxyacetic acid (2,4-D) in an amount sufficient to ensure callus formation; (b) subculturing said callus on a second medium which comprises mineral salts, vitamins, amino acids, sucrose and 6-benzylaminopurine (BA) or a mixture of ABA and BA in an amount sufficient to ensure callus preconditioning; (c) subculturing said preconditioned callus on a third medium which comprises mineral salts, vitamins, sucrose and a mixture of indoleacetic acid (IAA) and kinetin in an amount sufficient to ensure shoot formation, and (d) subculturing said shoot on a fourth medium which comprises mineral salts, vitamins, sucrose and IAA in an amount sufficient to ensure root formation, whereby plants are obtained.
U.S. Class	435/240.49 435/240.54 800/DIG14 800/DIG67 800/200
IPC	C12N 5/00 C12N 5/02

B.5. The Bacillus thuringiensis Claim: Plant Genetic Systems has received a patent covering the introduction of Bacillus thuringiensis (Bt) into most (possibly all) field crops. Any researcher engineering any strain of Bt, by any process, into a crop is in violation of the PGS claims. Bt is, by far, the most commonly used bacillus in biotechnology to develop insect resistance. Box 4 below provides a summary of this patent claim.

Reference: UNDPINT92.209, 22 July, 1993

Box 7 - PGS Insecticide Patent Claim

Publication Number	WO 9309218 A1	
Publication Date	1993 05 13	
Application Number	EP 9202547	
Filing Date	1992 10 30	
Priority Application	FR 91402920.2	1991 10 30
	GB 92400820.4	1992 03 25
Title	MODIFIED GENES AND THEIR EXPRESSION IN PLANT CELLS	
English Abstract	A DNA fragment, preferably encoding all or an insecticidally-effective part of a Bacillus thuringiensis insecticidal crystal protein, is modified by translationally neutral modifications in cryptic promoters and abortive introns.	
Applicants	PLANT GENETIC SYSTEMS, N.V. CORNELISSEN, Marc (U.S. only) SOETAERT, Piet (U.S. only) STAM, Maike (U.S. only) DOCKX, Jan (U.S. only) VAN AARSSEN, Roel (U.S. only)	
Inventors	CORNELISSEN, Marc SOETAERT, Piet STAM, Maike DOCKX, Jan VAN AARSSEN, Roel	
IPC Version Number	5 Code(s) C12N 15/82 C12N 15/32 C12N 5/10 A01H 5/00 A01N 63/00	
Designated States	AT AU BB BG BR CA CH CS DE DK ES FI GB HU JP KP KR LK LU MG MN MW NL NO PL RO RU SD SE US AT (epo) BE (epo) CH (epo) DE (epo) DK (epo) ES (epo) FR (epo) GB (epo) GR (epo) IE (epo) IT (epo) LU (epo) MC (epo) NL (epo) SE (epo) BF (oap) BJ (oap) CF (oap) CG (oap) CI (oap) CM (oap) GA (oap) GN (oap) ML (oap) MR (oap) SN (oap) TD (oap) TG (oap)	

B.6. The Coloured Cotton Claim: Plant Breeders' Rights have been granted to a U.S. breeder (Sally Fox) for strains of traditional Andean coloured cotton which she modified through conventional plant breeding to lengthen the staple for commercial weaving. Two textile companies using the cottons advertise that the varieties come from "the ancient peoples of the Americas". Critics maintain that the genius was not in lengthening the staple but in establishing the colour. The breeder has publicly agreed. No description of the U.S. Plant Variety Rights is available and, thus, the box only contains the basic registration information published by the U.S. Government.

Box 8 - Coloured Cotton Certificates

U.S. PVPA Cert. #: 8900169 "*Coyote*"	9/28/1990, Sally V. Fox, owner
U.S. PVPA Cert. #: 8900170 "*Green*"	9/28/1990, Sally V. Fox, owner

Reference: UNDPINT92.209, 22 July, 1993

C. Intellectual Property Trends:

The examples cited above are transforming the legal environment within which IPRs operate. In a sense, the System has shown greater flexibility than might have been expected. Nowhere is this more the case than with biological products and processes. It is possible to contemplate further changes to IPR law and practice inconceivable short years ago. The following examples arise from current international discussions:

C.1. Research Exemption: Vertical Intellectual Integration now challenges the normal IPR research exemption that allows scientists to use patented inventions for non-commercial investigation. With new biotechnologies, so much of the inventive activity centres upon basic research that some researchers are unwilling to undertake certain kinds of investigation for fear of litigation. The net effect could be a decline in innovative activity.

C.2. Scientific Exchange: Other than in the U.S. (and the U.S. is changing), patents may have a tendency to delay disclosure since publication prior to patent application nullifies the application. Inventors are thus encouraged to hold off on releasing research results until they and their lawyers have determined the most advantageous intellectual property strategy and submitted applications. Most observers concede that the pace of innovation is slowed.

C.3. Product Liability: There is some interest in the notion that a patent holder should be liable for any damages caused by a patent which is proven to perform defectively. (For example, a defective process for inserting a gene causing escapes from cultivated crops to wild relatives of that crop increasing arm costs and environmental damage.) The development of a product liability posture in IPRs could lead to greatly constrained patent claims. This could also serve to deter innovation.

C.4. Reversal of the Burden of Proof: In the field of biological products and processes, some governments and industries are arguing that the onus of proof should be reversed in patent litigation so that the suspected trespasser must prove in court that a patent right has not been violated. While some find the tendency alarming, there could be a theoretical benefit to indigenous communities should some opt to pursue their own patent claims. It could mean that enterprises in industrialized countries would be more accountable to indigenous communities for claims related to farmers' folkseeds and medicinal plants.

C.5. Criminal Law Enforcement: The expanding importance of intellectual property in commerce has further blurred the boundaries between physical private property and intellectual property. Intellectually, it is difficult to understand why criminal law would not be applied to patent or copyright piracy. The implications for innovation could, however, be mixed. A recent bill in the Philippines placed a form of plant breeders' rights under criminal law with the implication that one-third of the nationally-approved plant varieties developed by farm communities could have been patented by the first person to reach the patent office and the community could have been jailed for using their traditional varieties. The bill has been stalled at second reading in the Philippine Senate[7].

C.6. New Wave Patent Rules: Given the sweep of some recent patent claims (some unsuccessful in the patent office and others unsuccessful in the courts), there is discussion that the boundaries of patentability may become limitless. Computer software, the products, processes and parts of all life forms, biological end-products, methods of doing business, mathematical calculations, etc are either now subject to claims or might become so in the future. Requirements such as for an inventive step, non-obviousness and utility are being challenged as are Plant Breeders' Rights (PBR) criteria such as distinctness, uniformity and stability. Given the new kinds of technology coming forward in informatics and biology, it is reasonable that such *old technology* criteria be reviewed in favour of a New Wave IPR System affording new dimensions of protection. This also causes unease and concern among policy-makers.

C.7. Hyper-Intellectual Property Systems: Corporations are increasingly working with combinations of invention protection mechanisms including Trade Secrecy, Materials Transfer Agreements and Patents. There is an argument for the codification of a new level of innovation stimulation/protection that recognizes these combinations or affords different levels of protection for different kinds of technologies. The current range of patent, trademark, design and copyright laws are too crude for the new technologies. Industry now needs the *Big Mac Hypercard* of IPRs.

In a broad sense, as the power and importance of new technologies is recognized, there is increasing uncertainty about the role of intellectual property. Some hold the view that IPRs afford too much power and lend themselves too readily to market manipulation. Others argue that a system that was originally established to provide inventors with protection for sewing machines in the scientific and economic environment of a century ago is not well-suited to meet the needs either of industry or of society today.

Most observers and practitioners agree that - especially with respect to IPRs over life forms - there is a considerable degree of confusion and uncertainty. While some maintain that the existing IPR system and legal processes will be self-correcting and that, after a period of transition, the system will order itself, others believe that the breadth and depth of the new technologies and new IPR claims is such that society must become involved and a new societal dialogue on innovation and protection must emerge. It maybe time to reconvene the Vienna Conference of 120 years ago and seek a new social covenant for the era of Agenda 21.

D. The Implications for the Protection of Indigenous Knowledge:

D.1. Non-living Cultural Products and Processes: Most of the "liberalization" in intellectual systems property relates either to informatics or biology. Nevertheless, the general trend toward relaxed criteria and wider applications probably makes it both more likely that cultural artifacts, etc. can be protected and that others (non-indigenous persons or enterprises) can establish mechanisms to pirate the work of the Cooperative Innovation System. The WIPO/Unesco Model Law on Folklore (to be discussed later in this report) nay offer some protection to indigenous communities in these areas. There is a wide gap, however, between theory and practice and communities must recognize that the intellectual property system does not work as a Human Right in the marketplace but as an expensive and complex market tool.

D.2. Agriculture: In the field of agriculture, the GATT TRIPS initiative and the 1990 changes to the Convention of the Union for the Protection of New Varieties of Plants (UPOV) - concerning the right of farmers to save seed - has led one industry official to speculate that 40% of U.S. farmers will be contract growers within a few years. Others estimate that farmers will, effectively, become renters of germplasm from the same enterprises to whom they are contracted to sell their end products.

The role of science and technology in society - and/or the IPR systems themselves - has stimulated many changes. Many indigenous peoples are farmers and have a direct stake in these developments wherever they are in the world. The same people - and many other indigenous peoples who protect and nurture the wild relatives of cultivated crops also have an interest in these trends.

Reference: UNDPINT92.209, 22 July, 1993

D.3. Medicine: The implications for the indigenous knowledge of medicinal plants is less certain. Certainly, the scope of some recent patent claims should make it more possible for medicinalists and/or their communities to lay claim to patent protection. At the same time, the NIH's so-called *driftnet* patent may make it possible for bio-prospectors from industrialized countries to gather up large quantities of plants and merely patent them as a business speculation that, someday, someone will discover a use for some part of their collection and be obliged to come to them for license access. Confronted with renewed commercial interest, some governments, nongovernmental organizations and indigenous peoples themselves are increasingly pursuing bilateral contractual arrangements with individual enterprises. As is discussed later in this report, the risks involved in strictly bilateral agreements are discussed later in this Report.

E. Summation:

The trends and developments noted above have stimulated new and creative thinking regarding the protection of indigenous knowledge. The sweep of claims such as those by Agracetus and the NIH (if sustained) serve to remove most (or all) of the legal barriers to intellectual property over farmers' varieties and medicinal plants and could afford the informal innovation system some extremely broad patent claims of their own. The removal of legal barriers, of course, does not imply that economic and political barriers dissolve.

As an alternative to the adoption of indigenous intellectual property rights, it is feasible to argue that a pro-active Intellectual Integrity System could establish mechanisms that could help to safeguard the rights of indigenous peoples and farmers. Ombudspersons in patent courts; review and reporting procedures" riles for deposit and nomenclature etc. could place the financial burden for protection on industrialized countries for the benefit of indigenous communities. The following section contains a discussion of the relative bargaining position of indigenous peoples in commerce.

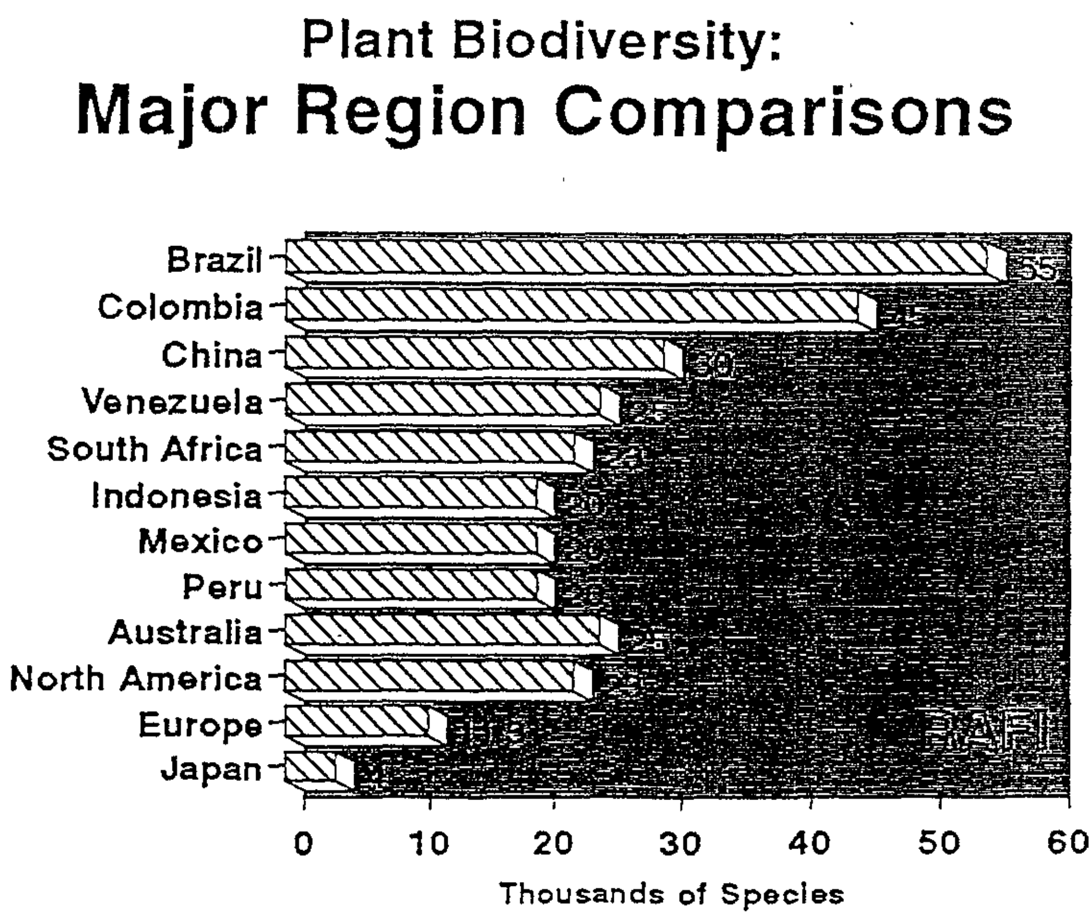
II. Indigenous Knowledge and Biodiversity

Section Two explores the role of indigenous communities in the conservation and development of biological diversity.

A. Overview:

A.1. Location: The overwhelming majority of the earth's remaining land-based biological diversity resides on the traditional lands of indigenous peoples in Africa, Asia, and South America. Seven percent of the earth's surface hosts between half and three-quarters of the world's biological diversity. Well over 90% of all biodiversity is in the tropical and sub-tropical regions of developing countries. There is more biodiversity on a tiny island off the coast of Panama, for example, than there is in the entire British Isles[8]. Panama, in fact, is less than one-third the size of the United Kingdom, yet it has more than five times the vertebrate species. Although it is less than a tenth the size of France, Costa Rica has almost three times more vertebrate kinds[9]. A single hectare near Kuala Lumpur in Malaysia holds half the number of plant species as can be found in all of Denmark[10]. A small volcano next door to the International Rice Research Institute (IRRI) in the Philippines has more tree species than Canada[11], and a 15 hectare plot in Borneo has more woody species than North America[12].

Chart 4 - Plant Biodiversity Comparisons

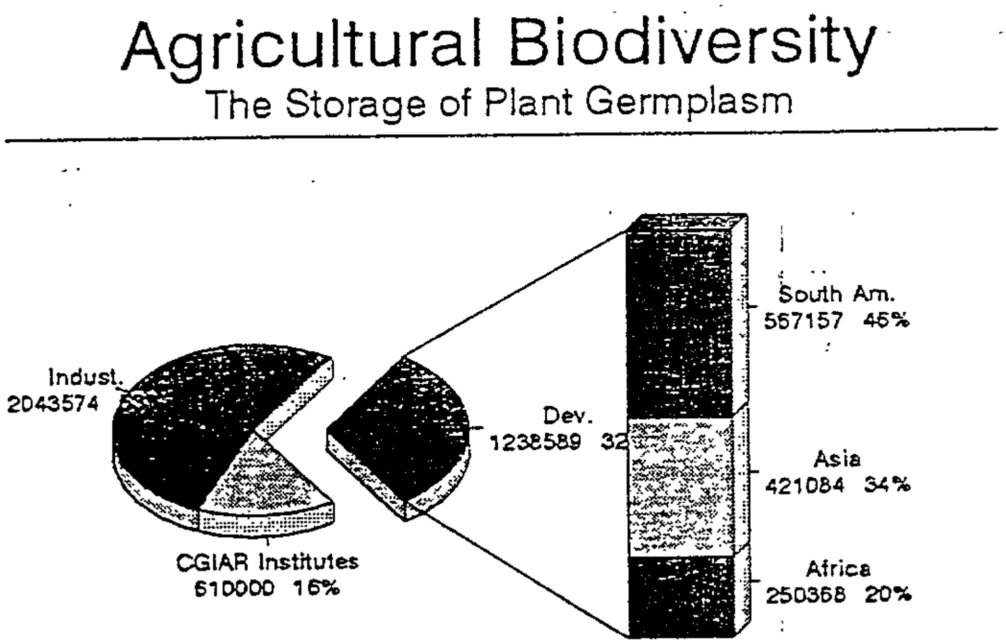


Source: Cunningham and U.S. OT

There are three times more aquatic species in the Amazon River than in the Mississippi system, and ten times more than can be found in Europe[13]. An estimated 40% of freshwater fish in South America have not even been classified. The Indo-West Pacific offers an estimated 1,500 species of fish and at least 6,000 mollusc species in contrast to 280 fish and 500 mollusc in the Eastern Atlantic. Thailand may have as many as 1,000 species of freshwater fish and Brazil claims more than 3,000 species - three times more than any other country[14].

If we divide the known number of species in a country by the number of square kilometers in the country, then Mexico and Indonesia both have more than five times the plant diversity of the United States. Peru has seven times the U.S. plant diversity, and South Africa has nine times the diversity (all figures based on per square kilometer comparisons). Colombia, barely a tenth the area of the United States, scores almost nineteen plant species for every U.S. species per kilometer, yet the southern Africa (Mediterranean climate) region is the most diverse of any similar area in the world, including the Amazon.

Chart 5 - Plant Germplasm Storage



Source: GRAIN, 1993

When it comes to livestock, Asia has 140 breeds of pigs compared to 19 in North America. Similar comparisons can be made for other domesticated animals - virtually all of whom originate in Africa, Asia, or South and Meso-America.

These figures underestimate the true disparity between developing and industrialized countries. By universal consensus, the largest concentration of plant species lies in South America - a region with the least number of ecologists. Whereas, the largest concentration of ecologists lie in North America - a region most notable for its lack of botanical diversity[15]. This leads to some understandable statistical distortions. Swiss ecologists, for example, have logged more plant kinds within their borders (again, per kilometer), than the Amazon but not as many as Luxembourg - where the counting task is easiest. In our highly-scientific world, biodiversity still tends to be found where Northern ecologists like to picnic. By and large, Northerners have not been picnicking much in Africa and they have been distinctly cautious in Asia. Ecologists have been intrepid, however, on Alpine walking paths and in Appalachian trailer parks.

A.2. Species Loss/Erosion: Indigenous communities are losing the biodiversity essential to their survival. Biodiversity is sliding into extinction at 100 species a day[16]. We lose more species now in one week than the world lost in the preceding three centuries[17]. Nowhere is the loss greater than in industrialized countries. In a survey of U.S. vegetable varieties, RAFI has shown that 97% of the varieties of 75 species have become extinct since the turn of the century[18]. In the same survey, 86% of apple and 88% of pear diversity has also disappeared[19]. Roughly similar estimates have been made for pears and apples in Belgium.

What has happened to crop plants has also happened to livestock. Half of all of Europe's domesticated animals have become extinct in this century. A third of the remaining livestock species in both Europe and North America are endangered[20].

The loss of medicinal plants in the industrialized countries is uncalculated. However, the value of medicinals has been estimated. For example, 150 drugs from North American indigenous communities have been taken into the modern U.S. pharmacopoeia[21]. Given the destruction of cultures and agricultures in industrialized countries recently, it is unlikely that these countries will find many more traditional medicines. In the mid-eighties, industry analysts warned that each medicinal plant lost in the rain-forests could lose drug firms sales of more than $200 million[22].

The net effect of species and genetic erosion in the North is to leave industrialized countries almost 100% dependent upon the biodiversity of developing countries. Sadly, loss and erosion in developing countries is also dramatic. RAFI estimated in 1990 that more than 70% of the genetic diversity of the world's 20 major food crops had been lost from farmers' fields. Virtually all of those farmers are members of indigenous communities in Africa, Asia, and South and Meso-America.

B. Current Developments and Trends in Biodiversity Management and Use:

B.1. Germplasm Storage: Indigenous communities no longer control the genetic material they require for their survival. For most of this century, scientists and bio-explorers have argued that biodiversity represents the common heritage of humankind and is the property of no individual or country. Yet, biological materials can have enormous economic and social importance. Forty percent of the world's market economy is based directly on biological products and processes. In the United States, 4.5% of that country's gross domestic product (some $87,000 million) is actually based upon "wild" species[23]. For most indigenous peoples - who live on the edges of (or outside of) the market economy - biological materials account for 85 to 95% of their survival requirements. Species extinction and genetic erosion is not merely regrettable, it can be a matter of community survival. For the same reason, it is only proper that indigenous peoples who are nurturing and developing diversity should be the first to benefit from its commercial application. This has not been the experience.

Reference: UNDPINT92.209, 22 July, 1993

Box 9 - Control of Genetic Materials

*68% of all crop seed collected in developing countries is stored in gene banks in industrialized countries or at International Agricultural Research Centres (IARCs).

*An even higher share - 85% of fetal populations of livestock breeds - all originally domesticated in developing countries - are banked in industrialized countries.

*86% of global microbial culture collections (yeasts, fungi, bacteria etc.) are also held in industrialized countries.

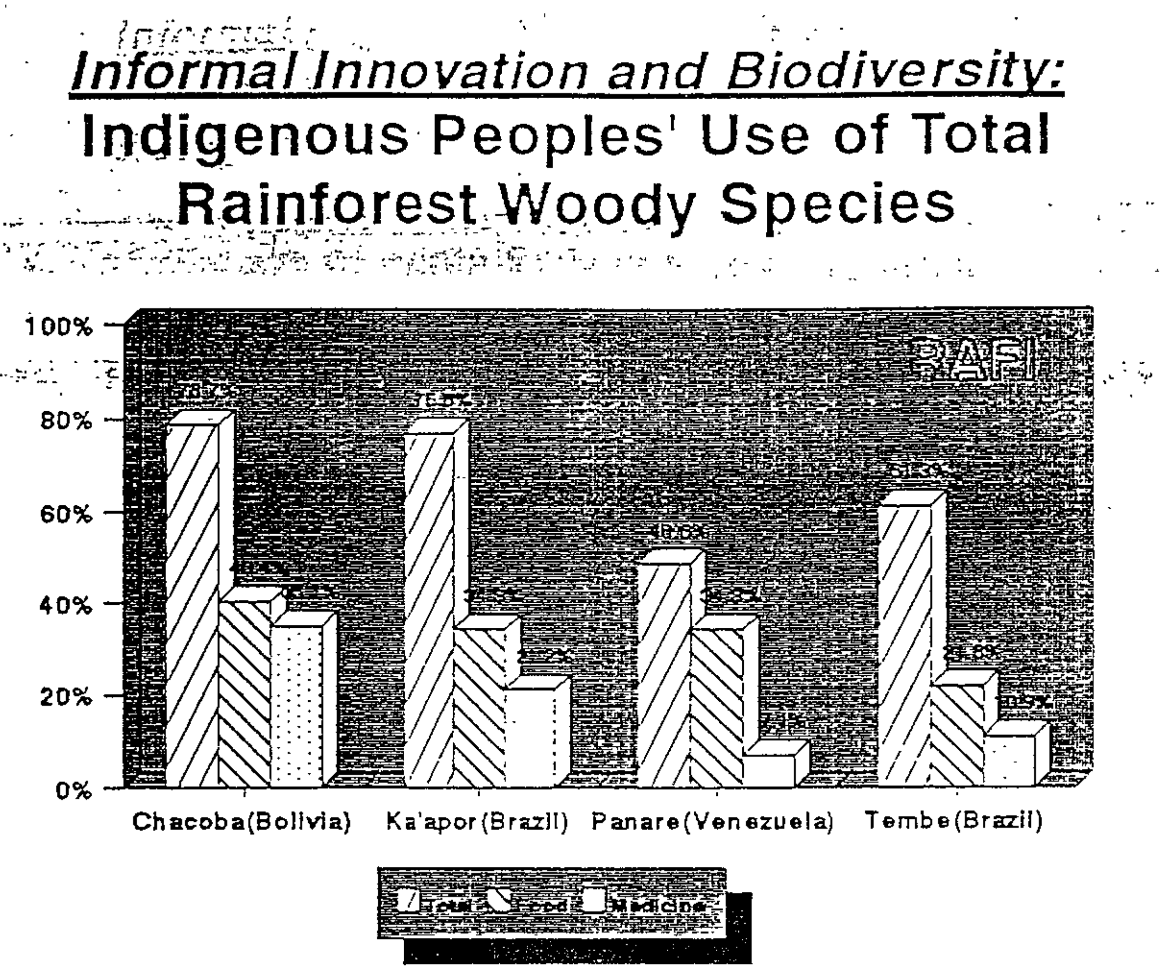
B.2. Equity Extinction: There is a crucial distinction to be made between "scientific" conservation and "survival" conservation. Effectively, *ex situ* germplasm collections are extinct (for all intents and purposes) to indigenous communities. Gene bank material is accessible to market economy breeders but practically inaccessible to survival conservation breeders. Almost all the seeds, fetal tissue, fungi, and bacteria already banked, safeguards the material's market accessibility but does nothing to ensure survival conservation and the welfare of inventor communities. In a sense, equity in conservation programmes, has become extinct.

It is often overlooked by the formal scientific community that almost every last flower and fungus has been discovered, developed, or at least nurtured and protected, by indigenous communities. As botanists search the fields and forests, they find people. That which was once comfortably assumed to be "wild" is now, somewhat uncomfortably, recognized to be someone else's toothbrush, shampoo, or vitamin supplement. If, once, formal sector researchers only acknowledged *domesticated* and *wild* species, they must also recognize an on-going dynamic relationship with *partner* species that are used and protected (by farmers and hunter/gatherers) but have been otherwise allowed to maintain their integrity.

The extent of species conservation/utilization by indigenous people is quite astonishing compared to industrialized country farmers. The most comprehensive collation of this information has come in a 1992 annotated bibliography of 942 documents and books compiled by Ian Scoones, Mary Melnyk, and Jules N. Pretty titled *The Hidden Harvest*. Prepared for Sweden's SIDA, WWF, and the International Institute for Environment and Development (IIED), the 256-page report offers a unique overview of the bio-knowledge of indigenous peoples.

B.3. Indigenous R&D: In the past decade, the contribution of indigenous peoples as innovators has become recognized at least in some quarters. There is a case to be made that virtually all of the biodiversity within traditional lands has been nurtured or developed by indigenous communities and that this diversity forms part of the intellectual integrity of these communities. According to the study, the Chacoba of Bolivia make use of almost four-fifths of the woody species in their surrounding forests. The Ka'apor of Brazil use three-quarters of their tree diversity while, in Venezuela, the Panere use about half the documented diversity, and the Tembo of Brazil work with over 60% of the woody species around them. These same four communities use between a fifth and a half of all woody species for food and up to a third for medicinal purposes[24].

Chart 6 - Indigenous Use of Woody Species



Source: G.T. Prance et. al. (1987 & 89)

The most avid gardeners in Europe and North America conjure with rarely more than 20 plant species, the Huastic of Mexico have been known to nurture as many as 338 different species. The Riberenos of Peru routinely protect 168 species. In Africa, the Suazi of Swaziland nurture/use about 200 species, and the Tembe of southern Africa commonly use 106 species[25].

The importance of "partner" species to the food supply of indigenous communities is brought home by the Mende of Sierra Leone, who draw less than a fifth of their nutrition from cultivated species and more than half from forests, streams, and fallow fields. The remainder comes from local markets and plantation crops[26]. In the Bungoma District of western Kenya, almost half of all families incorporate "partner" species in their home gardens and only a marginally lower percentage of families collect "partner" species for food in the forests[27].

Reference: UNDPINT92.209, 22 July, 1993

Chart 7 - Indigenous Use in Western Kenya

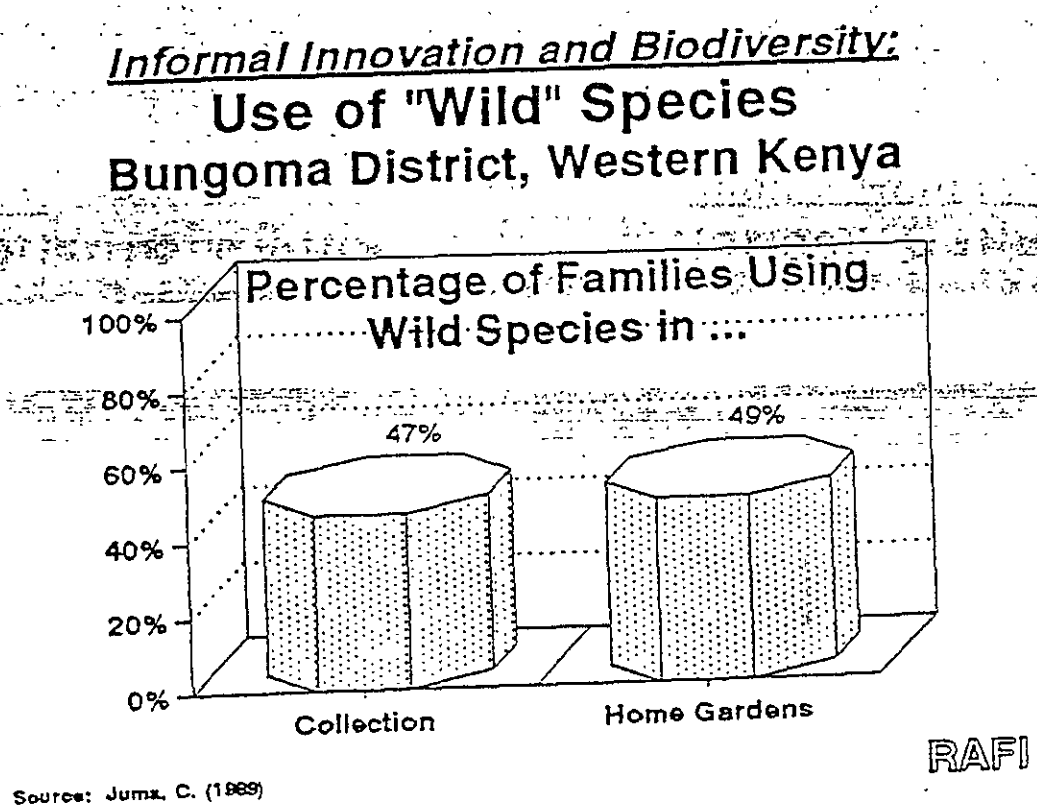
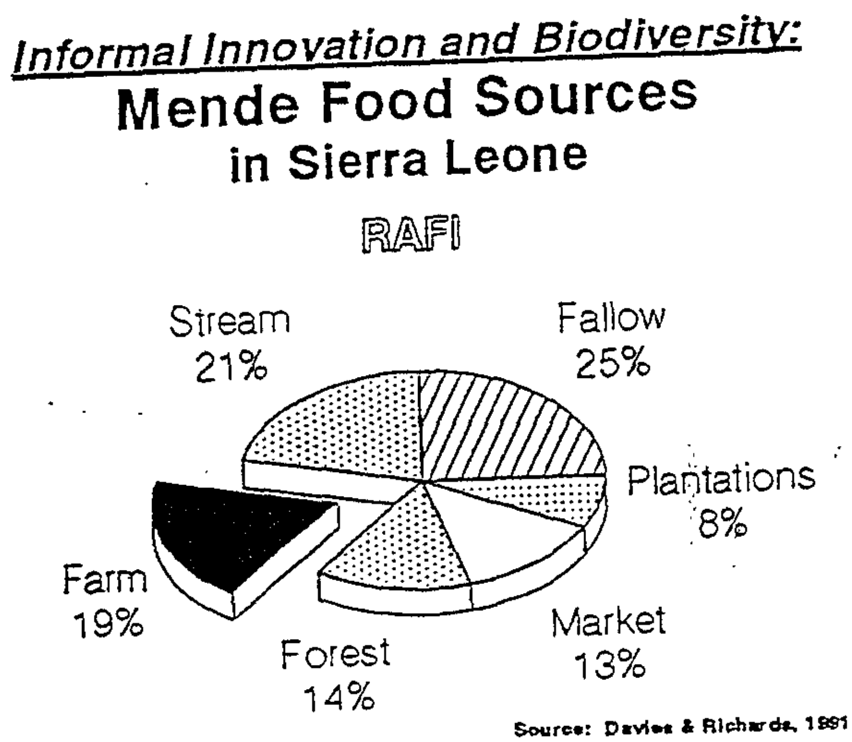


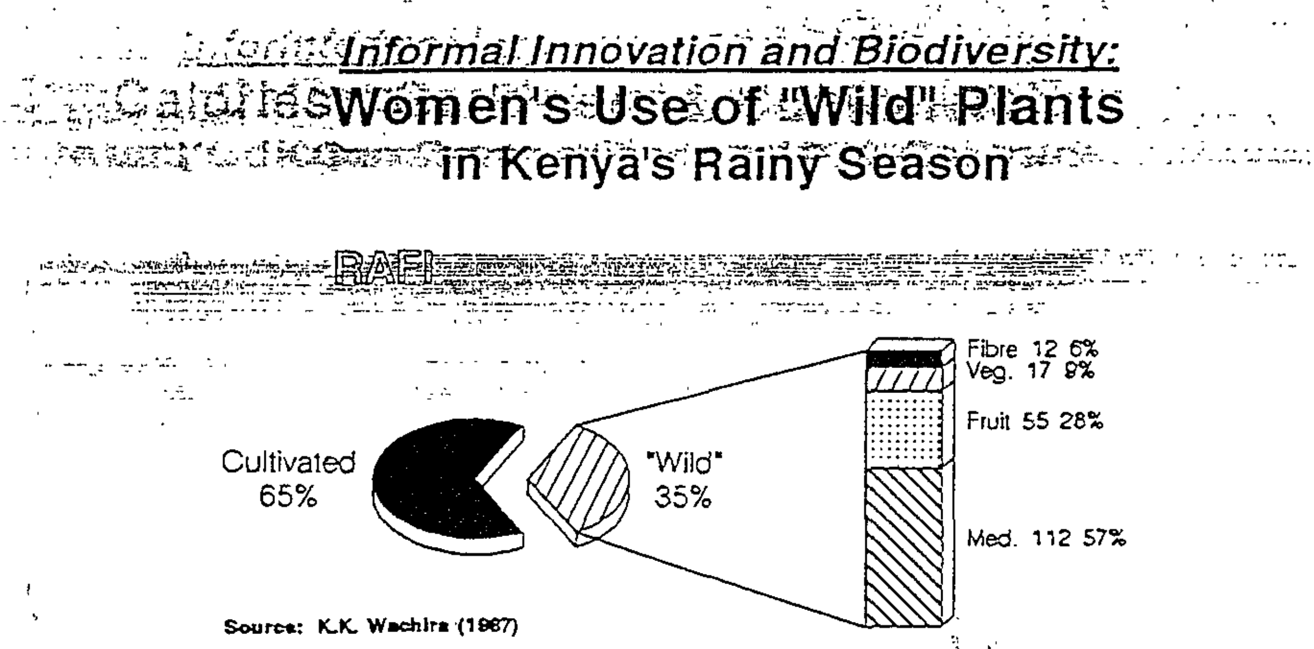
Chart 8 - Indigenous Use in Sierra Leone



Reference: UNDPINT92.209, 22 July, 1993

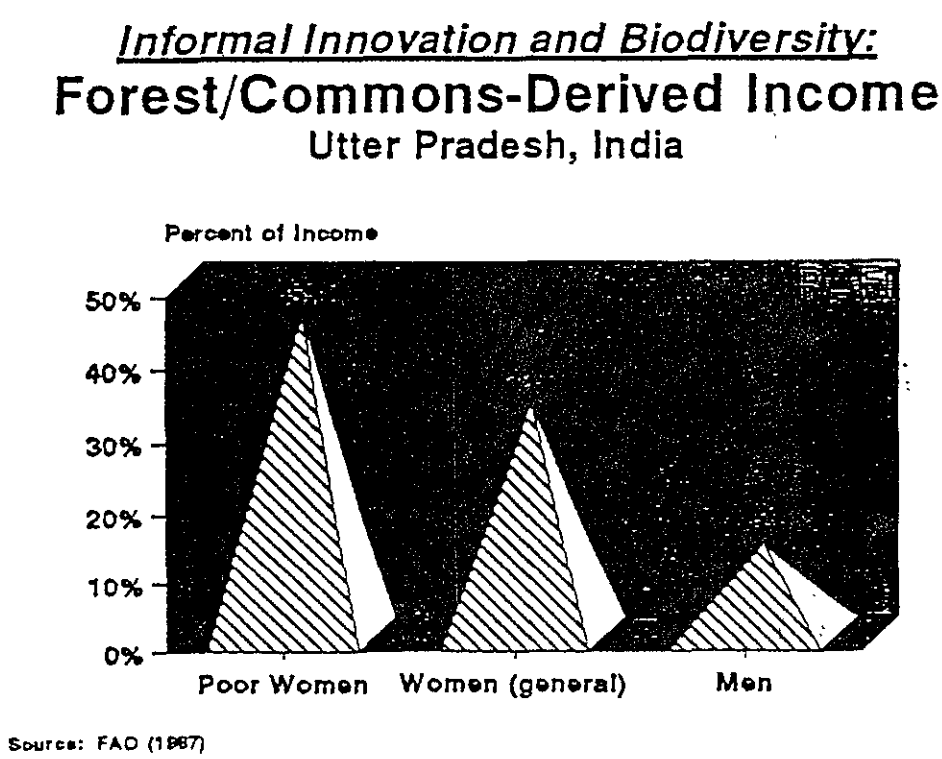
Not surprisingly, women tend to make better use of "partner" species than men. In Kenya, during the rainy season, women draw 35% of their plant material (for food, medicinal, and fibre purposes) from so-called "wild" plants[28]. Partner species are also important to the incomes of local communities, especially women.

Chart 9 - Women and Diversity in Kenya



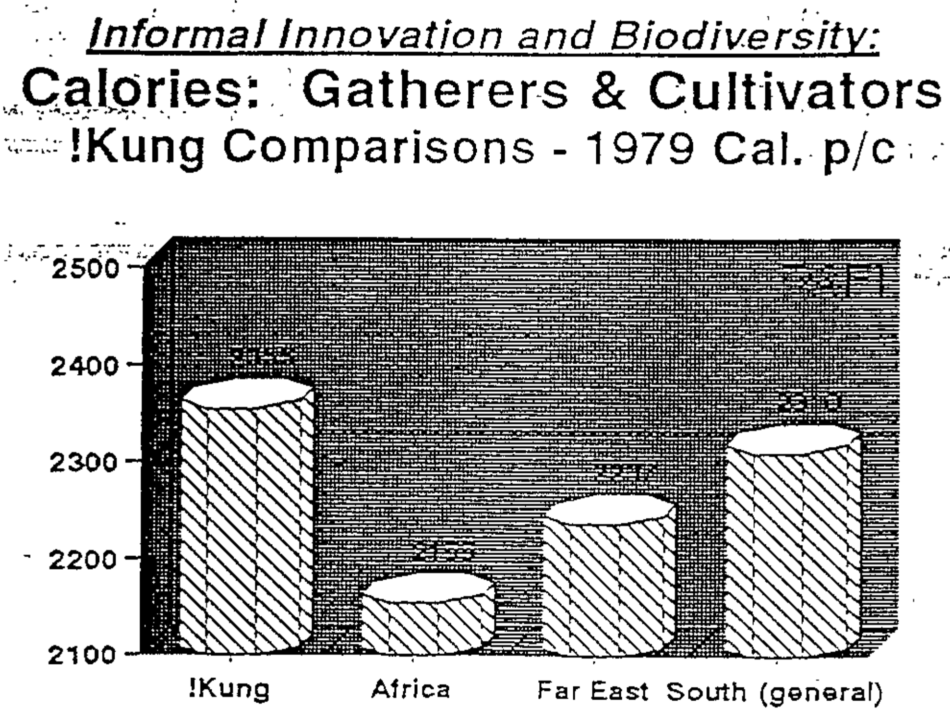
Poor women in Utter Pradesh, India derive almost half their income from forest species and plants found on the Commons. By comparison, middle-class women in the same region still obtain a third of their income from partners, while men in the region take barely 13% of their total earnings from this source[29].

Chart 10 - Women and Diversity in India



A study among transmigrant communities in Indonesia has underlined the importance of partners and minor cultivated crops. In regions known for their dependence upon rice, almost two-thirds of food production, four-fifths of consumption, and nearly half of all income is drawn not from rice fields, but from home gardens[30].

Chart 11 - Indigenous Peoples and Nutrition



Source: Lee, R.B. (1979)

The nutritional importance of partner species has also been under-estimated, despite R.B. Lee's ground-breaking 1979 study of the !Kung community in southern Africa that showed an average daily adult intake of 2355 calories. The !Kung have a higher per capita calorie intake than the average for either Africa or Asia, and manage to do this by hunting and gathering 84 plant, and 54 animal species over a work week, or 2.3 days at six hours per day[31].

B.4. New Ownership Pressures: The counterpoint to the intellectual integrity of the Cooperative Innovation System of indigenous communities has been the Institutional Innovation System's Intellectual Property Rights. For most of this century - but especially over the past three decades - industrialized countries have been extending their intellectual property system to include most fields of innovation including chemical and pharmaceutical products and processes, microbials, and plant and animal varieties. In the United States - and very likely soon in Europe and Japan - virtually all biological products, processes, and parts thereof, can be subject to exclusive patent protection.

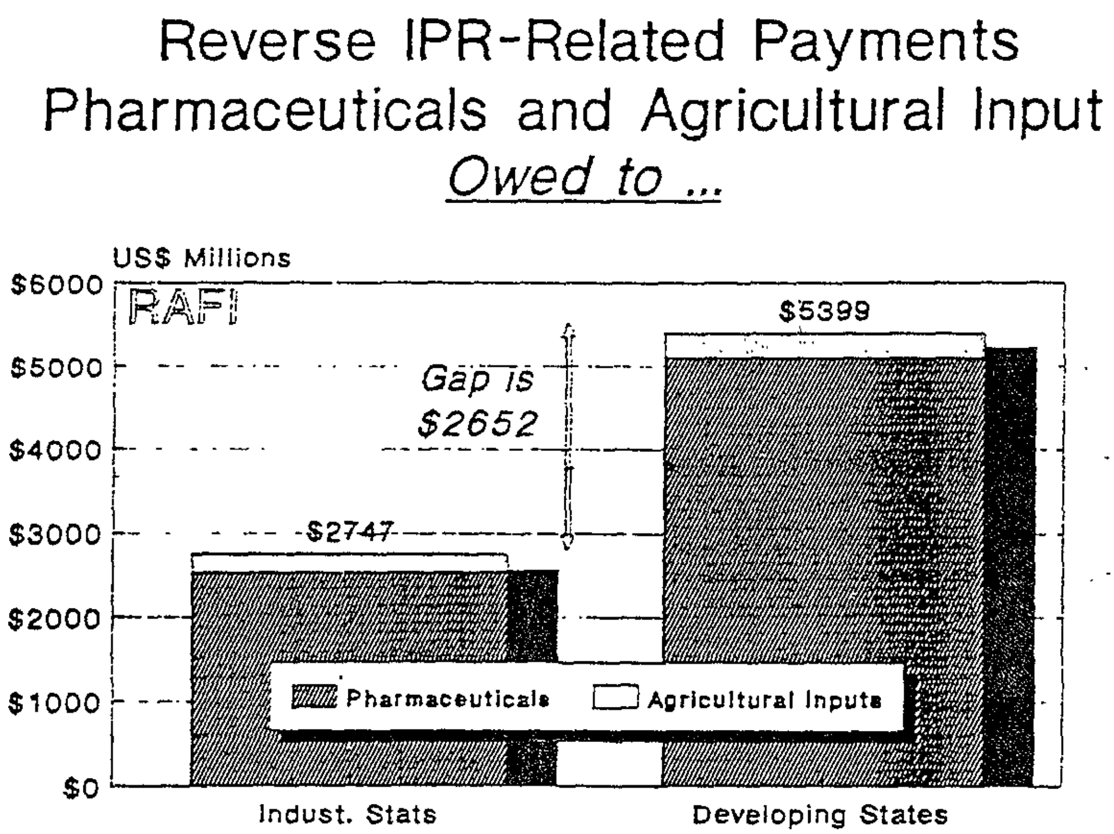
This trend is especially poignant for indigenous peoples in the context of the GATT TRIPS (Trade-Related Intellectual Property Systems) negotiations (See "I. Current Trends in Intellectual Property Systems" above.) In a 1990 study of the U.S. negotiating options, a detailed survey of seven large developing countries drew its researchers to the conclusion that corporations were losing more than $135 million a year in royalty payments on pirated agricultural chemicals[32], and $1,684 million in royalties on pirated pharmaceuticals[33]. By extrapolation, these estimates for seven major "offenders" to developing countries as a whole, RAFI estimates that U.S. agricultural chemical royalty losses (in the terms adopted by the U.S. researchers) are in the order of $202 million, and pharmaceutical losses are approximately $2,545 million.

B.5. Reverse Piracy: If the real contribution of the Cooperative Innovation System is calculated, however, the pirate roles could be reversed. RAFI has paralleled royalty payments for crop chemicals to (as yet theoretical) royalty payments for farmers' folkseed varieties, assuming the study's royalty rate of 2% for crop chemicals on global seed industry sales of $15,100 million. Although this would prove an unconscionably low royalty for farmers' varieties, the estimate would be $302 million - or $100 million more, than the pirated royalties for chemicals.

Similarly, RAFI has taken industry figures for global pharmaceutical sales in 1986 (the year in which study statistics are based - as well as the U.S. Trade Representative's data year) of $101,000 million and, estimating that one-quarter of industry sales are based on products derived from medicinal plants, has concluded that royalty charges due to developing countries would be in the order of $5,097 million. This assumes the study's royalty rate of 20% for pharmaceutical.

In other words, in these two biological industry sectors, industrialized countries would be a net loser to developing countries, in the range of $2,700 million per annum[34].

Chart 12 - Reverse IPR Payments



Reference: UNDPINT92.209, 22 July, 1993

The final dimensions of the Intellectual Property trend remain to be explored. The U.S. National Institute of Health (NIH), and the British Medical Council, as discussed in part one above, have claimed monopoly over several thousand genes and DNA fragments related to the human brain. The initiative has great implications for biological diversity. Everything in farmers' fields or in the rainforest could become patentable material. Patent aspirants need only a visa in order to lay claim to vast quantities of plants and animals bred and nurtured by indigenous or other rural communities. The Wall Street Journal reported that the NIH action was leading to a breakdown in the Human Genome Project, and that breeders had observed parallel problems in scientific exchange in rice and maize[35]. The Economist likened the claims to patenting by trawler[36].

In theory - very likely only in theory - the remarkable flexibility shown in the U.S. patent system opens up wide opportunities for indigenous peoples to stake their own substantial monopoly claims. Assuming access to legal support, indigenous communities could claim most (or all) of the biodiversity within their traditional lands.

C. Indigenous/Rural Communities and Agricultural Biodiversity:

In reckoning the flow of benefits to and from indigenous peoples, the role of the Consultative Group on International Agricultural Research (CGIAR) offers a helpful case study. CGIAR, since its inception in 1971, has performed a remarkable agricultural research and training function in developing countries. Their global effort to increase agricultural productivity has relied upon the enhancement of agricultural biodiversity (plant genetic resources) drawn, directly or indirectly, from the fields of indigenous farming communities in developing countries. This is a situation wherein the genetic materials have been contributed by developing countries for their own benefit. The initiative has also given some significant benefit to industrialized countries as well. It remains unclear if indigenous innovators have been adequately compensated and who is the major beneficiary of the exercise.

C.1. Plant Breeding: The sometimes random, sometimes systematic collection of indigenous people's agricultural genetic diversity has yielded considerable economic benefit to the world community, including industrialized countries. Genes from the fields of developing countries for only 15 major crops contribute to more than $50,000 million in annual sales in the United States alone[37]. RAFI estimates that the contribution of germplasm held by International Agricultural Research Centres (IARCs) to northern crop production is not less than $5,000 million per annum. Almost all of this germplasm has been collected in developing countries.

It is, of course, difficult to quantify the intellectual contribution of farmers and indigenous communities to industrialized countries. Most gene bank directors acknowledge that the contribution of farmers' varieties is considerable. A great deal of the most commercially usable material flowing northward passes through International Agricultural Research Centres either directly from their gene banks or as improved material for field trials. RAFI has attempted to establish reasonable calculations on the value of farmers' varieties exported in this way. Following is a summary of research related to only four IARC crops.

C.2. Wheat: RAFI estimates that germplasm obtained through CIMMYT (International Maize and Wheat Improvement Centre in Mexico) contributes to $2,700 million in crop production in industrialized countries. This calculation is based on figures from three national research institutes. For the United States, the estimate is drawn from a 1982 OECD report that somewhat cryptically estimated the value of eveloping countries' wheat germplasm to the United States at $500 million per annum. An informal

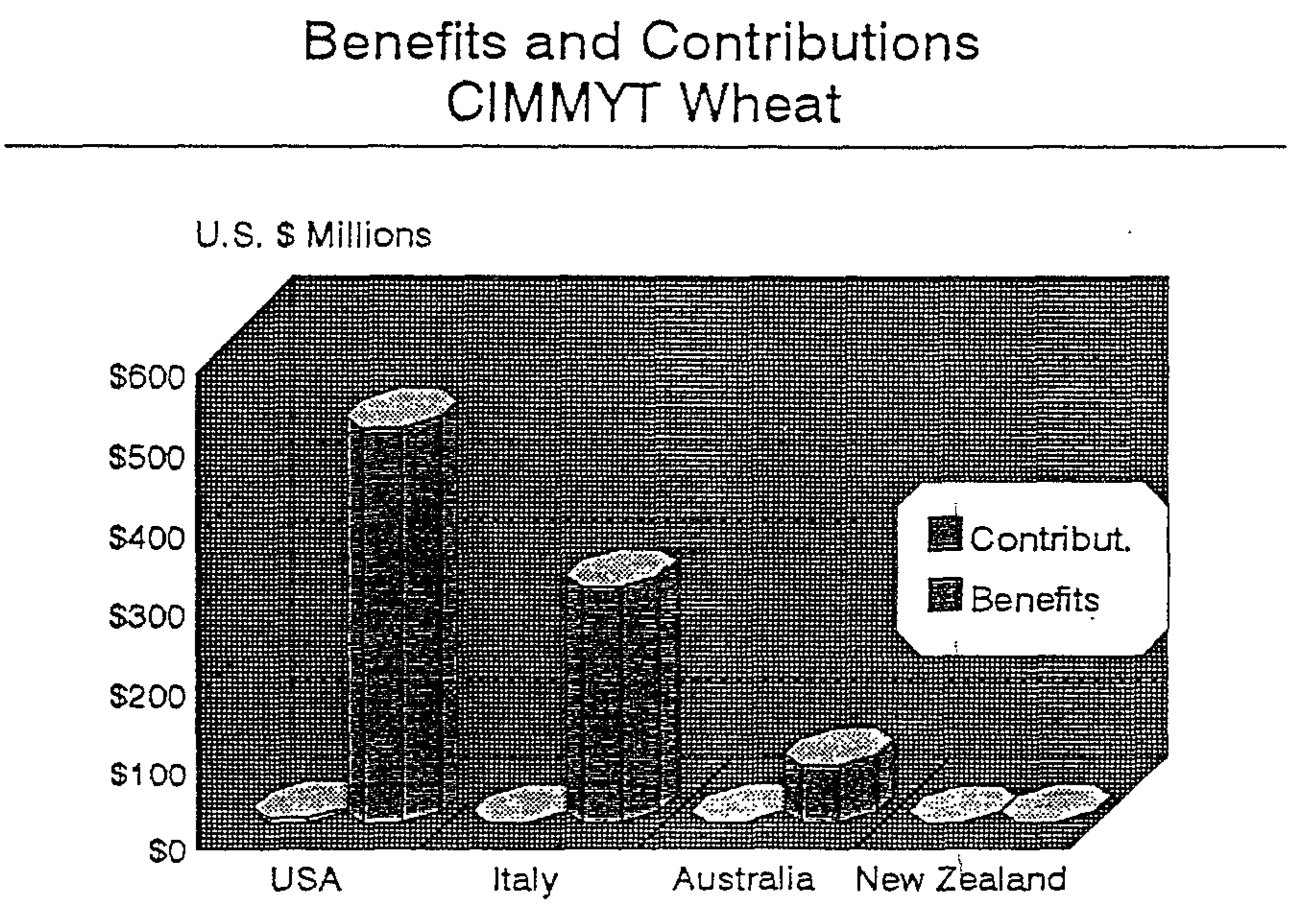
1983 study by Canadian and American government wheat breeders came up with a similar figure specifically related to CIMMYT germplasm. RAFI believes these figures are a minimal estimate. Two studies by Dana Dalrymple of USAID (1981 and 1986) show that 21% of the entire U.S. wheat crop was sown to semi-dwarf material derived from CIMMYT. RAFI estimated the value of the CIMMYT contribution at (roughly) $1,800 million in the mid-eighties.

In a report for The Crawford Fund for International Agricultural Research in Australia in 1991, Derek Tribe estimated that CIMMYT's wheat donation to Australia amounted to $75 million per annum. Tribe also cites a 1990 New Zealand estimate that CIMMYT's contribution to that country could be valued at NZ$338,000 per annum.

In 1992, a study from INTAGRES, a CGIAR-related documentation and information centre in Rome, concluded that CIMMYT's annual contribution to the Italian durum wheat crop was not less than $300 million.

The total value of CIMMYT wheat germplasm to the four industrialized countries is therefore, not less than $875 million a year according to governmental or semi-governmental estimates. Combined, these four countries account for 16% of average annual wheat production, while industrialized countries collectively, account for about 59%. Given that CIMMYT nursery material is used in every industrialized country, RAFI assumes that the ratio of benefit to other industrialized states must be crudely similar and, therefore, the value of CIMMYT wheat to industrialized countries can be reasonably set at $2,700 million. This approximates a 100-fold return on the CGIAR's annual investment in CIMMYT.

Chart 13 - CIMMYT Wheat Contribution



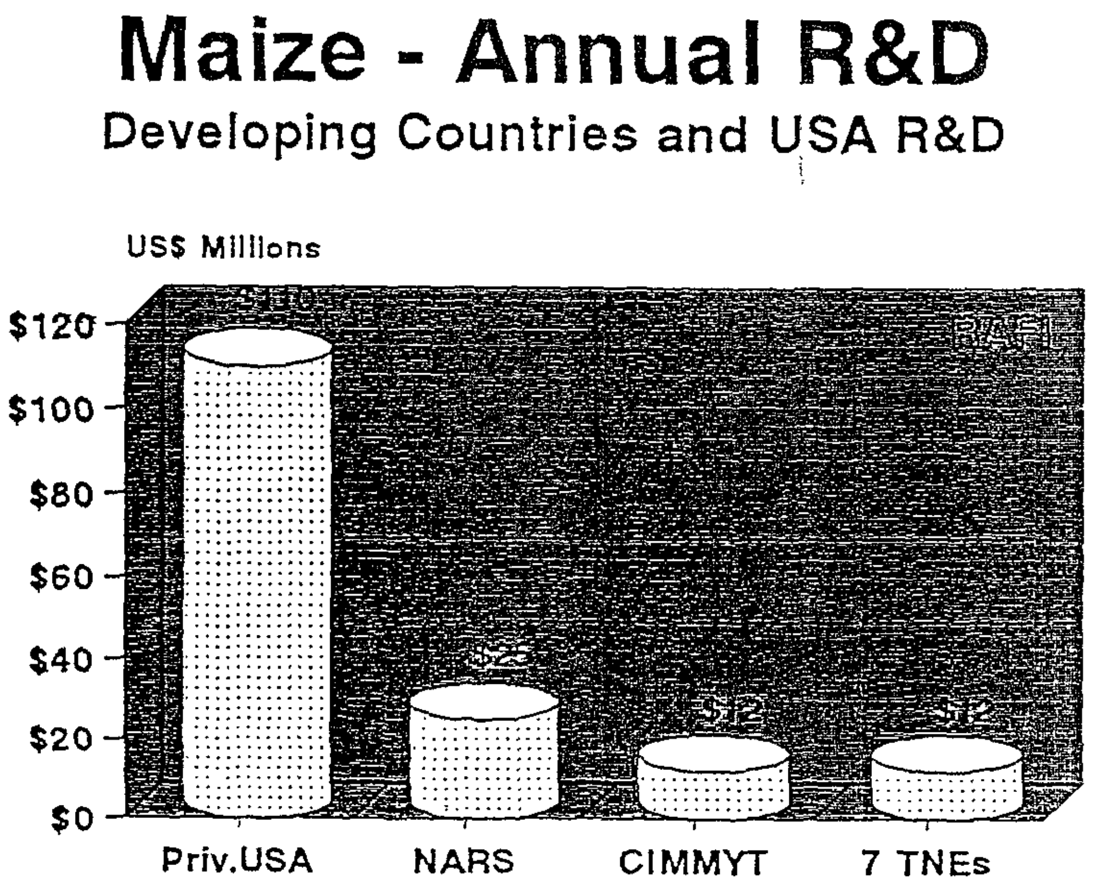
Source: RAFI Estimates

C.3. Rice: A 1986 USAID study (by Dana Dalrymple) showed that 73% of the semi-dwarf rice acreage in that country was based on IRRI material. Semi-dwarfs accounted for about 22% of the entire U.S. rice crop. Extrapolating from this, RAFI estimates that the annual farmgate contribution made by IRRI amounted to about $176 million in 1984. The semi-dwarf share of the American harvest has continued to grow, but RAFI has kept the figure at the 1984 level. Since the U.S. crop equals about 26% of the North's total rice production, the total value of IRRI material to the North is extrapolated to be about $655 million per year. In 1990, IRRI's budget was $30.6 million, offering the CGIAR a 22-fold return on investment.

C.4. Maize: Yet another U.S. study (by Dr. Major Goodman of North Carolina) of maize, shows that in 1985, perhaps one-tenth of one percent of the value of the American maize crop was based on "tropical" exotic germplasm. In the mid-eighties, this tiny percentage still equalled $20 million of the annual farmgate value of the crop. Since U.S. maize is equal to about 68% of all maize production in industrialized countries, the total value of the developing countries' germplasm is only about $29 million. Were all this material derived from CIMMYT, this would afford CGIAR's industrial donors an even return on their investment. Of course, CIMMYT's $27 million budget is also for wheat, barley, and triticale.

Recently, CIMMYT maize breeders reported that about 30% of the requests they receive for farmers' maize varieties (stored in CIMMYT's gene bank) now come from private companies, and that this percentage is growing. Major Goodman also reported that private American companies were anticipating a massive increase in their use of tropical maize material.

Chart 14 - Tropical Maize R&D



Source: Byerlee & Pereira

There has also been discussion within CIMMYT that its maize programme should, at least in part, return to the development of hybrid maize varieties and that this segment of CIMMYT's work might be privatized in order to more effectively work with small entrepreneurial seed merchants in developing countries and with high-tech biotech enterprises in industrialized countries. The impact of such a move on indigenous farming communities is uncertain but there would be cause for concern that the poorest farmers might not have the resources to access hybrid maize lines on a regular basis and that an important public sector source of innovation might close.

C.5. Beans: The United States accounts for an average (over the 1986-90 period) of 54% of the industrialized countries' dry bean production. According to CIAT authorities, CIAT material contributes $60 million to the U.S. agricultural economy every year. Extrapolating this figure, industrialized countries benefit by about $111 million from a CIAT (1990) budget of $28.1 million - a four-fold return.

It is worth remembering that these figures are crude estimates for just four crops. CIP's contribution in potatoes is probably enormous. ICRISAT and ICARDA established the Australian chickpea industry based on 16,000 farmers' varieties given to Australian breeders. There are no estimates for barley from CIMMYT, or vegetables from AVRDC, for example. Livestock breeds from ILCA and materials from ILRAD have also been important.

C.6. Sharing Benefits: Both IARCs and indigenous farmers could and should take pride in their contribution to global agriculture. There is no reason why industrialized countries should not benefit. The problem arises when the commercial value is both not acknowledged and not compensated for. The situation worsens massively when industrialized countries allow the patenting of material wholly or partially derived from farmers' varieties. As private companies move into developing countries' seed markets, indigenous farmers are finding themselves paying for the end product of their own genius.

The most contentious example of this situation arose in the late eighties when the British-based Agricultural Genetics Company applied for a patent on the Cowpea-Trypsin Inhibitor (cpTI) gene extracted from a cowpea variety obtained from the International Institute for Tropical Agriculture (IITA) in Nigeria. The initial institutional discovery and work had been done at IITA but the patent was applied for by the U.K. concern and the specific gene - estimated to have a sales value of hundreds of millions of dollars - was subsequently licensed to a number of private breeding and biotech companies.

West African governments felt that ownership of the discovery rested with African governments or farmers. In fact, the specific genetic material used seems to have come from an American gene bank to IITA. The American material, however, is assumed to have originated in Africa. Although indigenous farmers in Africa were not aware of the specific cpTI gene, they were apparently aware of the utility of the plant in inhibiting insect pests. Given some patent claims of late, it is conceivable that a U.S. patent could have been granted that would have included the plant's insect-resistance function. This is no more fanciful that the Agracetus "species" claim discussed above or the PGS "Bt" claim also described earlier.

Box 10 - West African Cow pea (cpTI) Gene

Patent Number	4987077
Issue Date	1991 01 22
Appl. Data	197970 1988 05 24
Assignee	Agricultural Genetics Company Limited
Inventor(s)	Charnley, Anthony K. Cooper, Richard M. St. Leger, Raymond J.
State/Country	GB2
Title	Preparations of protease enzymes derived from entomopathogenic fungi
Abstract	The invention provides an enzyme preparation comprising at least one protease derived from an entomo-pathogenic fungus of one of the following genera: Metarhizium, Beauvaria, Verticillium, and Aschersonia, and characterized by the following properties: (a) substantially not activity against hide protein azure, locust cuticel and elastin; (b) specificity for Bz-Phe-Val-ARg-NA; (c) not inhibited by soybean *trypsin inhibitor*.
Exmp. Claim	1. An enzyme preparation comprising at least one protease derived from an entomopathogenic strain of a fungus belonging to one of the following species: Metarhizium anisopliae, Beauveria bassiana, Verticillium lecanii and Aschersonia aleyrodis, and characterized by the following properties: (a) substantially no activity against hide protein azure, locust cuticle and elastin; (b) specificity for Bz-Phe-Val-Arg-NA; and (c) not inhibited by soybean trypsin inhibitor.
U.S. Class	435/223 435/212 435/254 435/911 IPC C12N 9/58 C12N 9/48 C12N 1/14 C12N 1/00
U.S. Refs	2927060 2936265
Other Refs	Leger et al., Archives of Biochemistry and Biophysics, vol. 253, pp. 221-232 (1987). Leger et al., Archives of Biochemistry and Biophysics, vol. 258, pp. 123-131 (1987) (First Page). J. Invertebrate Pathology, vol. 35, pp. 304-310 (1980). Search Report for European Patent Application 88 302907-6. J. Invertebrate Pathology, vol. 47, pp. 167-177 (1986). J. Invertebrate Pathology, vol. 48, pp. 85-95 (1986). Applied and Environmental Microbiology, vol. 53, pp. 1679-1684.
Priority	JPX 19880330 63-77966 EPX 19880331 88302907.6

C.7. Benefits for Indigenous Farmers: Thirty-seven million hectares of developing country lands are sown to CIMMYT's wheat varieties, for example. This represents 54% of all developing country wheat lands, and using CGIAR crop value estimates, gives farmers more than $17,000 million annually. Even CIMMYT maize - grown over only 8% of developing nation fields - contributes about $1,600 million per year to their farmers. IRRI and CIAT rice varieties are harvested in close to 70% of developing country fields. CGIAR's data would lead us to conclude that the value to developing countries, each year, is in the range of $50,000 million.

These figures offer us an important perspective. If this is all the data to be considered, and if it is correct, and we must remember that all of the data is "soft" - than probably 99% of the wealth created by the CGIAR system of germplasm conservation and enhancement accrues directly to developing country farmers and their communities.

This is, of course, an oversimplification. If 70% of Asia's paddy land were not in IRRI varieties, they would be in farmers' or national varieties. Farmers' varieties, while not always as high-yielding, tend to have a much higher market value than the less tasteful IRRI strains. Further, IRRI varieties have stimulated a U.S.$2,400 million agro-chemical market solely for rice fields. This has also benefitted enterprises in industrialized countries. IRRI has agreed that it has consistently over-estimated the need for chemicals on rice. IRRI has also agreed that the use of many of these chemicals on rice has caused severe human health hazards and contributed to significant environmental pollution in Asia. In some Asian countries, certainly the Philippines, IRRI's presence led to the stifling of national research planning and activity. It is hard to conjecture what all of this has actually cost indigenous farmers. It is safe to assume that the fact that IRRI varieties have a value of $50,000 million per annum does not tell the whole tale.

Reality is more complicated. Industrialized countries do not need to gain for indigenous communities to lose benefits. The only certain "winners" are the international enterprises seeking control and ownership over biological products and processes. The figures under discussion are in some ways, misleading. All the monetary benefit flowing North appears directly in the cash economy of industrialized countries. The financial gains for developing countries are only estimates since a small percentage of the crops involved (for rice only 5%) ever appear in the marketplace. This means that for corporations, the gain is relatively clear and direct. For indigenous farmers, there is an uncalculated opportunity cost since, in the case of rice again, Asian nations would be growing the crop anyway and they have already contributed farmer-bred germplasm to the cause. Clearly, financial calculations are not accurate or sufficient. CGIAR makes the case that 500 million people are being fed in the 90's who would not have been fed without the Green Revolution.

C.8. Missed Opportunity: It is evident that the traditional system of institutionalized scientific investigation pursued in CGIAR and most agricultural research institutes actually adopted the "end products" of indigenous innovation - farmers' already-enhanced germplasm - without adopting a research alliance with the original innovators and their "process" of innovation. Whatever the distribution of benefits, the world lost an opportunity for a collaborative research framework that could have spread greater benefit to all parties.

Box 11 - Private Sector Patents & Research Expenditures in Biotechnologies

(U.S. Patent Grants in all biotech. (1980-1993); R&D in Ag. Biotech. only (U.S.$Million, 1990)

Enterprise:	Pat.#*	Crop	Vet	Total
Monsanto	152	18	43	61
Du Pont	193	20	0	20
ICI	106	18	0	18
Sandoz	70	17	1	18
Ciba-Geigy	207	15	3	18
Rhone-Poulenc	91	13	5	18
Upjohn	101	4	14	18
Sanofi	69	11	6	17
Solvay	12	5	10	15
Smithkline Beecham	115	0	13	13
DNA Plant	22	13	0	13
Calgene	22	11	0	11
Mycogen	50	10	0	10
Bayer	212	8	2	10
Hoechst	309	4	6	10
Pitman-Moore	18	0	10	10
Eli Lilly	494	0	10	10
BioTechnica	14	8	0	8
Novo Biokontrol	73	8	0	8
PGS	1	8	0	8
American Cyanamid	207	4	4	8

Reference: UNDPINT92.209, 22 July, 1993

AGC	8	7	0	7
W.R.Grace	62	6	1	7
Abbott	313	6	1	7
Ecogen	6	6	0	6
Crop Genetics	1	6	0	6
BASF	74	5	1	6
Merck	821	0	6	6
Calliope	?	5	0	5
Dow Elanco	123	4	0	4
Shell	61	3	0	3
Kemira OY	3	3	0	3
Virbac	?	0	3	3
Syntro	3	0	2	2
Cambridge Vet. Sci.	?	0	2	2
Mogen	11	2	0	2
TOTAL		$248	$143	$391

Source: Patent data is drawn from MicroPatent, Biotech PatentSearch (1980, 1993); R&D data is from John Hodgson, "Biotechnology: Feeding the World?, Bio/Technology, Vol. 10 January 1992, p.49

* To the extent possible, patent figures take into account recent mergers and industry alliances. There is, however, the possibility of error.

Reference: UNDPINT92.209, 22 July, 1993

D. Pharmaceutical BioDiversity

D.1. Medicinal Plant Diversity: Eighty percent of the world's population is dependent upon traditional medicine and medicinal plants for their health security[38]. Thus, as with the conservation of agricultural biodiversity, the conservation of pharmaceutical biodiversity is a critical survival technology for developing countries in general and indigenous peoples in particular.

D.2. Economic Role: The situation in the pharmaceutical industry is similar to the agricultural industry. More than two-thirds of the world's plant species - at least 35,000 of which are estimated to have medicinal value - hail from developing countries. At least 7,000 medical compounds in the Western pharmacopeia are derived from plants. According to an intergovernmental meeting of developing country experts in Tanzania in 1990, the estimated value of the South's germplasm for the pharmaceutical industry by the year 2000 could be as high as $47,000 million[39,40].

This is a modest estimate. Roughly one-quarter of pharmaceutical sales in the United States are of drugs derived directly or indirectly from plants. Worldwide sales of all pharmaceuticals, at the beginning of the nineties, was over $130,000 million. Conservatively, $32,000 million of current sales are based upon traditional medicines[41]. Yet, the developing country export of medicinal materials to the North was only $551 million when surveyed a decade ago.

D.3. New Markets: New biotechnologies are also blurring the line between food and medicine. Already, the "*neutraceutical*" (food-as-drugs) sector in the U.S.A. is worth over $27,000 million and is growing quickly. In Europe, herb-based drug products account for 11% of the over-the-counter drug market and for 10% of the same market in Japan. If all pharmaceutical products with natural ingredients were included, they would account for a third of the total European market - valued at not less than $3,000 million by the year 2000. In Germany alone, over 280 of the 450 known medicinal plants have been evaluated and are being adapted for commercial use[42]. This mushrooming new market should be dominated by indigenous communities.

An indication of the importance placed on medicinal plants is provided by the U.S. National Cancer Institute (NCI) which suspended a twenty year programme to collect medicinal plants in 1980 only to renew and enlarge the programme in 1986 when the opportunities created by new biotechnologies became evident. Between then and the end of 1992, the NCI paid for the collection of 23,000 plant samples of 7,000 species. Almost all accessions were from developing countries.

Advances in biotechnology have been facilitated by other advances in micro-electronics making it possible to vastly increase the rate of sample screenings. Through random sampling, only one molecule in about 10,000 samples has any hope of commercialization. In the past, it could take many months or years to find a single useful substance. Today, it is possible for a modern pharmaceutical lab to survey 150.000 samples a year[43]. Specialist bio-prospecters such as Shaman Pharmaceuticals, increase their success ratio from one in ten thousand to one in two by consulting indigenous peoples directly. Where three different communities are found to use the same plant kind for medicinal purposes, Shaman collects the plant for careful study. There have been occasions where the company has shown local healers a photograph of a human disease and the healers have been able to identify specific plant remedies[44].

D.4. Soil Erosion: The contribution of indigenous peoples to world health is not only through medicines derived from plants and animals. The contribution is as likely to come through the soil or even though themselves. At least 12% of the fungus accessions in the American Type Culture Collection (Rockville, Maryland) are derived from developing countries - mostly from soil samples. Almost 4% of the bacteria accessions are also identified as originating in developing countries, also mostly from soils. Two such accessions, patented by an American pharmaceutical house, are described below. RAFI is attempting to ascertain that the Kenyan soil sample was obtained from a community that was aware of the properties offered by the sample. (The full text from the ATCC database is rendered below.)

Box 12 - Soil Samples & Patent Claims

Streptomyces sp.
ATCC 55043
Merck & Co., Inc. MA6751. *Soil*, Heather Forest, Mt. Kilimanjaro, Kenya. Production of an antihypertensive N2-tetrazole-beta-glucuronide analog (U.S. Pat. 5,057,552). Note: This material is cited in a U.S. and/or other Patent and may not be used to infringe the patent claims. Growth Conditions: Medium 196 28C Shipped: Freeze-dried.
Price Code: G

Gliocladium sp.
ATCC 20826
Merck & Co., Inc. MF 5010. *Soil*, Mexico. Production of testosterone 5 alpha-reductase inhibitors (U.S. Pat. 4,814,324). Note: This material is cited in a U.S. and/or other Patent and may not be used to infringe the patent claims. Growth Conditions: Medium 336 24C Shipped: Freeze-dried.
Price Code: G

It is likely that the extent of the contribution of indigenous peoples to soil sampling (including fungus and bacteria from soils and other sources) is seriously underestimated since the American Type Culture Collection does not consistently record collection sites or patent data. A particularly significant omission, in fact, was noted in 1990 when the University of Florida patented a Brazilian fungus known to be lethal to fire ants that can cause a billion dollars in damage to U.S. crops. Neither the patent application for the ATCC registration reported that the fungus was given to Florida researchers by Brazilians. Only anecdotal accounts in biotechnology industry journals made the connection[45]. It is RAFI's understanding that Brazilian farmers were aware that "something" in the soil killed fire ants.

Reference: UNDPINT92.209, 22 July, 1993

Chart 15 - ATCC Fungus Collection:

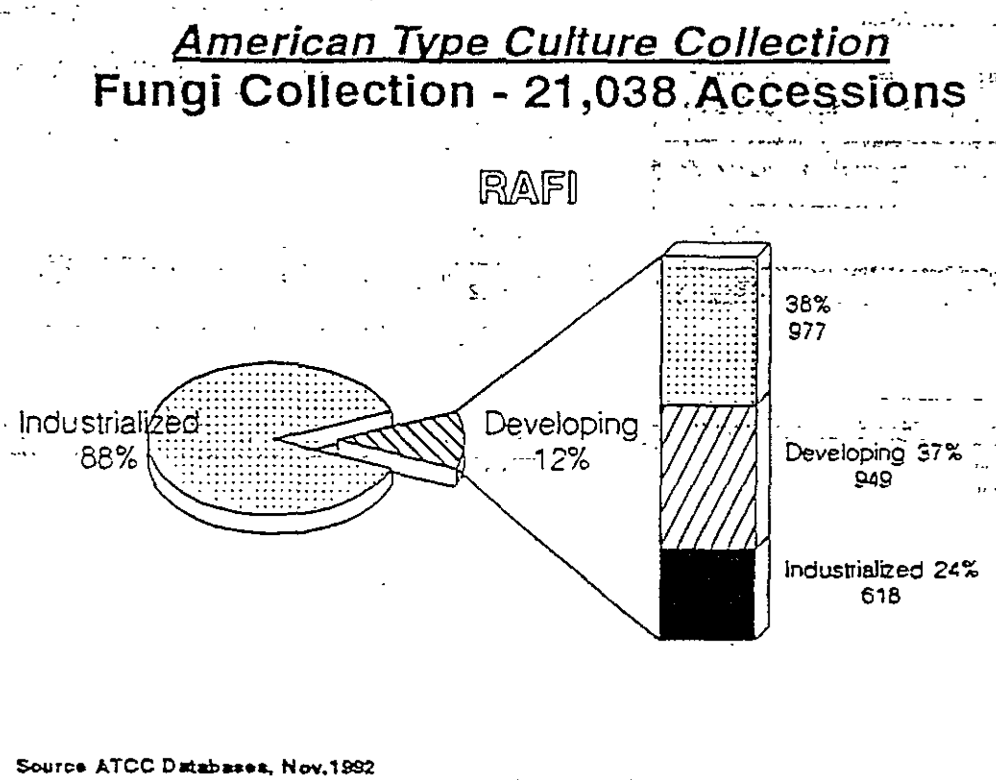
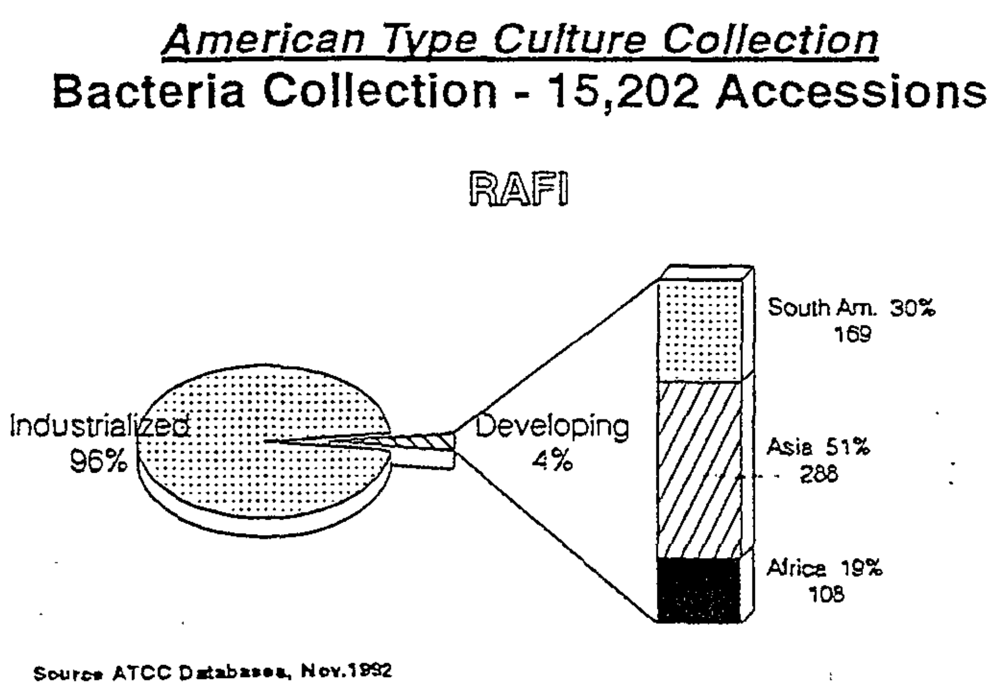


Chart 16 - ATCC Bacteria Collection:



Reference: UNDPINT92.209, 22 July, 1993

U.S. Patent Office Approval

Patent Number 4925663
Issue Date 1990-05-15
Appl. Data 140018 1987 12 31

Assignee University of Florida
Inventor(s) Stimac, Jerry L.
State/Country FL

Title Biological control of *imported fire ants* with a fungal pathogen

Abstract The subject invention concerns a novel biopesticide and its use to control imported fire ants which have caused significant economic harm to much of the southeastern United States. Specifically, a highly virulent isolate of Beauveria bassiana in an agricultural composition, can be used to effectively control ants of the genus Solenopsis. Exemplified herein is Beauveria bassiana No. 447, ATCC 20872. By using this novel fungus, or mutants thereof, fire ants can be controlled without the environmental and public safety hazards presented by chemical control agents.

Exmp. Claim 1. A Beauveria bassiana which, when in its essentially biologically pure form, has the virulence against fire ants characteristic of Beauveria bassiana No. 447 culture deposit ATCC 2087, and mutants thereof.

U.S. Class 424/93Q 424/92 435/254 435/911
IPC C12N 1/14
U.S. Refs 4751082

Other Refs Chem-Abstracts, vol. 72, 1970, 89237q, Sukhov.
Chem-Abstracts, vol. 73, 1970, 13464m, Velitskaya.
Chem-Abstracts, vol. 100, 1984, 116441g, Anderson et al.
Chem-Abstracts, vol. 70, 1969, 46398j, Brikman et al.
Chem-Abstracts, vol. 86, 1977, 84761k, Schaerffenberg et al.

Examiner Schain, Howard E.
Agent Saliwanchik & Saliwanchik

ATCC Registration Data

FUNGUS STRAINS
Beauveria bassiana
ATCC 20872
Univ. Florida 447. Biological control of *imported fire ants* (U.S. Pat. 4,925,663). Note: This material is cited in a U.S. and/or other Patent and may not be used to infringe the patent claims.
Growth Conditions: Medium 336 24C
Shipped: Freeze-dried.
Price Code: G

Reference: UNDPINT92.209, 22 July, 1993

Box 14 - ATCC Bacteria & Fungus

Incomplete Survey of Developing Country Contributions
to Fungal and Bacterial Accessions

ATCC COLLECTION		NOV., 1992	
FUNGUS	**No.**	**BACTERIA**	**No.**
AFRICA			
S. Africa	127	Egypt	17
Niger	118	S. Africa	13
Nigeria	60	Nigeria	12
Kenya	56	Zaire	9
Egypt	43	Ethiopia	8
Tanzania	36	Mauritius	7
Ghana	21	Kenya	7
Somalia	16	Mali	5
Congo	14	Burkina Faso	4
Mali	13	Ghana	4
Ivory Coast	12	Sudan	3
Cameroon	11	Congo	3
Mozambique	11	Senegal	3
Sudan	10	Morocco	3
Zaire	9	Zambia	2
Uganda	9	Chad	1
Zambia	9	Zimbabwe	1
Algeria	6	Angola	1
Tunisia	5	Ivory Coast	1
Namibia	4	Libya	1
Zimbabwe	4	Reunion	1

Reference: UNDPINT92.209, 22 July, 1993

Malawi	3	Togo	1
Morocco	2	Somalia	1
Madagascar	2		
Gabon	2		
Liberia	2		
Mauritius	2		
Botswana	2		
Angola	2		
Ethiopia	1		
Swaziland	1		
Guinea-Bissau	1		
Senegal	1		
Mauritania	1		
CAR	1		
Sierra Leone	1		
REGION:	618		108
ASIA			
India	381	India	90
Taiwan	157	China	43
China	63	Jordan	35
Thailand	43	Turkey	24
Pakistan	39	Philippines	16
Nepal	39	Indonesia	12
Philippines	34	Malaysia	10
Turkey	28	Taiwan	7
Indonesia	27	Guam	5

<u>*Reference:*</u> UNDPINT92.209, 22 July, 1993

Malaysia	24	Bangladesh	5
Vietnam	20	Thailand	5
Hong Kong	14	Pakistan	4
Bangladesh	13	Fiji	4
Iran	10	Kuwait	4
Saudi Arabia	9	Syria	2
Syria	8	Easter	2
Iraq	7	Samoa	2
Sri Lanka	6	Burma	2
Korea	5	Sri Lanka	2
Singapore	5	PNG	2
Jordan	4	Lebanon	2
Kuwait	4	Sumatra	2
Afghanistan	2	Singapore	2
Lebanon	2	Tonga	1
Cambodia	2	Java	1
Laos	1	Afghanistan	1
Seychelles	1	Iran	1
U.A.E.	1	Iraq	1
		Vietnam	1
REGION:	949		288
LATIN AM.			
Brazil	147	Brazil	48
Mexico	125	Mexico	34
Costa Rica	84	Argentina	12
Argentina	79	Costa Rica	12

Reference: UNDPINT92.209, 22 July, 1993

Fr.Guinea	76	Venezuela	11
Venezuela	67	Panama	9
Puerto Rico	52	Peru	6
Panama	51	Puerto Rico	6
Honduras	40	Trinidad	5
Chile	39	Bermuda	5
Belise	37	Cuba	4
Colombia	32	Ecuador	4
Nicaragua	29	Guatemala	4
Jamaica	23	Bahamas	2
Cuba	15	Colombia	2
Guatemala	14	El Salvador	1
Trinidad	12	Uruguay	1
Ecuador	12	Haiti	1
Bermuda	7	Surinam	1
Uruguay	7	Chile	1
El Salvador	6		
Surinam	5		
Guyana	5		
Dom.Rep.	4		
Bahamas	4		
Paraguay	2		
Haiti	2		
Antigua	1		
REGION:	977		169
SOUTH:	2544		565

Reference: UNDPINT92.209, 22 July, 1993

E. Indigenous Human Germplasm:

E.1. Human Diversity Collection: As part of the Human Genome Project supported by the U.S. National Institute of Health (NIH) and other agencies and governments, a Human Genome Diversity Project has been established to collect and "immortalize" the DNA of between 10,000 and 15,000 indigenous peoples from approximately 722 indigenous communities. Identified by the Project as Isolates of Historic Interest (IHIs), the samples will be collected and stored in the American Type Culture Collection in Rockville, Maryland (USA) where they will be studied for not only their historic significance but also their commercial pharmaceutical properties.

E.2. Patentable Cell Lines: The commercial value of such human material was underscored early in 1993 when renewed interest in unique genetic material found in an isolated Italian village was shown to bear a gene that codes against many cardio-vascular ailments. Swedish, Swiss and American firms are reported to be seeking patents on the human material. Also in 1993, the NIH has offered contract funds to private biotechnology enterprises to obtain DNA samples form weakened AIDS victims for testing against potential vaccines and in order to derive materials that might form components of future vaccines. Finally, it has recently been disclosed that the famous John Moore cell line derived from Mr. Moore's tumorous spleen and patented and licensed to Sandoz, has a potential market of $1,000 million to its owners. On this basis, RAFI assumes that the immortalized cell lines of indigenous peoples could be worth a very substantial sum to the pharmaceutical community.

In a survey of the American Type Culture Collection cell line database. RAFI has learned that at least a third of the human cell lines stored there are under patent claims. RAFI has evidence that a patent claim on the DNA of an indigenous person from Panama has been filed in the United States. Again, since the ATCC database was not designed to disclose collection sites or patent data, there may be other examples. An example of the use of human genetic material is offered below as recorded in the ATCC database. (Some technical information attached to this accession has been deleted for the sake of brevity.)

Box 15 - Indigenous Person's Cell Line

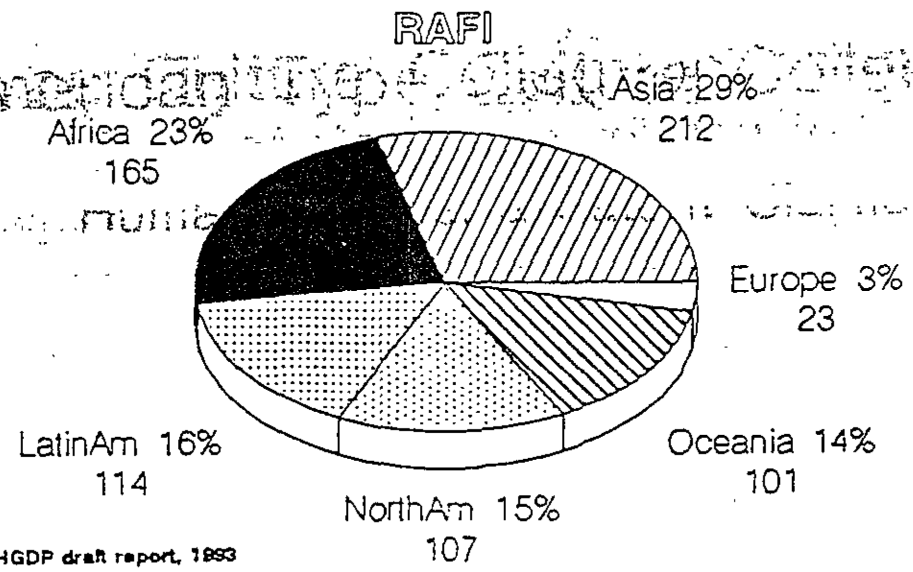
ATCC CRL-10598 G12.1 (T lymphoblast, human)

Passage Frozen: Unknown. Current medium for propagation: RPMI 1640 with 2 mM L-glutamine, 80%; recombinant interleukin-2 (IL-2), 5%; FBS, 15%. Additional Information: The G12.1 cell line was established by co-cultivating a Human T cell Leukemia Virus II (HTLV-II) positive T cell culture with normal peripheral blood mononuclear cells. The original T cells had been isolated from a 26-year-old female Guaymi Indian patient in Panama. The cells are CD4 positive, and produce HTLV-II antigens and mature virus particles. Handle as potentially biohazardous material under at least Biosafety Level 2 containment. Reference: Proc. Natl. Acad. Sci. USA 87: 8840-8844, 1990. Depositor: M.D. Lairmore, Columbus, OH. Note: This material is cited in a U.S. and/or other Patent Application and may not be used to infringe the patent claims.
Price Code: H

Reference: UNDPINT92.209, 22 July, 1993

Chart 17 - Human Genetic Diversity:

The Human Genome Diversity Project
"Isolates of Historic Interest"
722 Priority Communities



Source: HGDP draft report, 1993

The leading depositors of human-related cell line material under patent claim are cited below. Although 79 institutes have been active in intellectual property claims in this field, 10 institutes account for more than half of the claims for which depositor information is recorded.

Box 16 - ATCC Human Patent Depositors - Leading Ten Institutes

Depositors of Cell Lines with Human Content/applications under U.S. Patent Claim

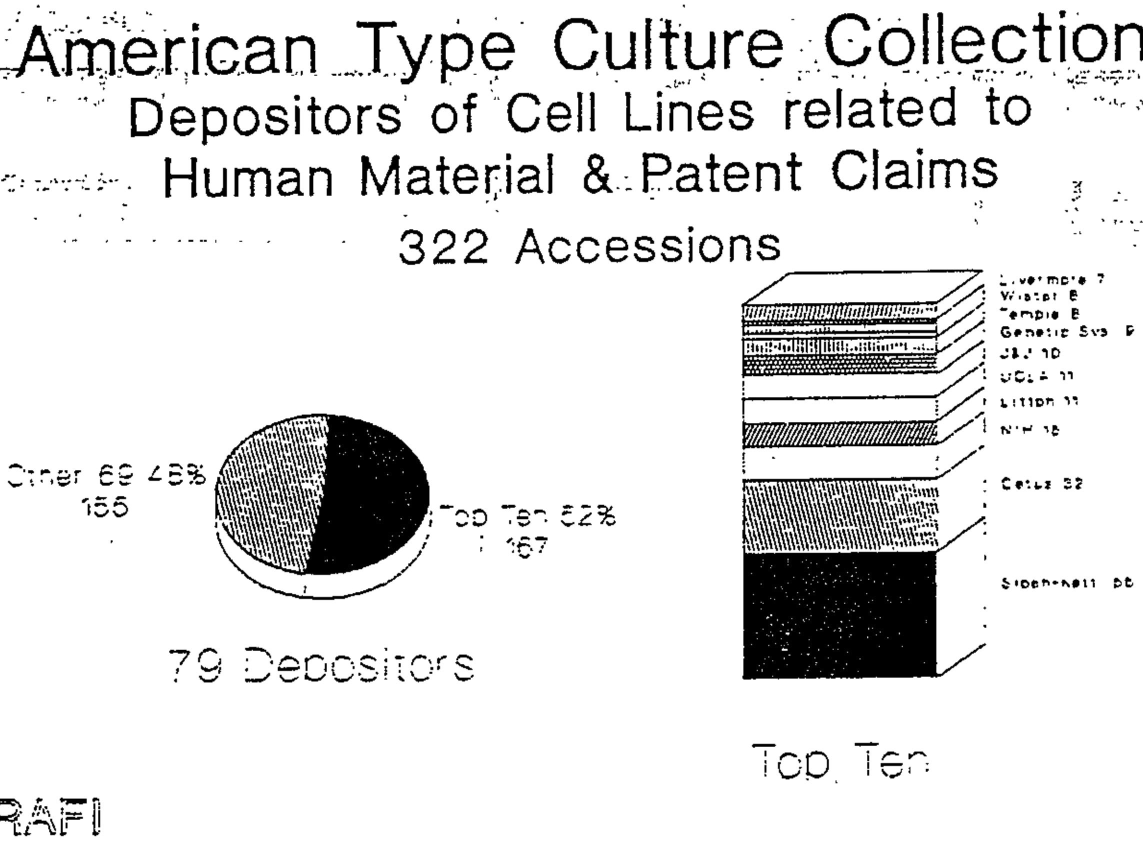
Memorial Sloan-Kettering Cancer Cen.	56
Cetus	32
NIH/NCI	15
Litton Bionetics	11
Johnson & Johnson	10
Univ. of California, (L.A.)	11
Genetic Systems	9
Temple Univ.	8
Wistar Inst.	8
Lawrence Livermore Nat.	7
TOTAL:	167

Source: American Type Culture Collection, Cell Line Infobase, November, 1992

The Human Genome Diversity Project is establishing an Ethics Committee to review intellectual property and Prior Informed Consent issues raised by the Project. Interestingly, they have been advised informally by U.S. Government and other officials that the collection and removal of human cell lines from other countries might have to be dealt with under the Biological Diversity Convention.

Reference: UNDPINT92.209, 22 July, 1993

Chart 18 - ATCC Major Depositers



Source: ATCC Cell Line Infobase, 11/92

Reference: UNDPINT92.209, 22 July, 1993

Box 17 - ATCC Depositors List
Cell Line Infobase - Human and Patent Search

List of Depositors

Private Sector (37):	Sub-total: 138
Abbott	2
Agen Biomedical	1
Ajinomoto	3
Amgen	3
Bionetics Res.	1
California Biotechnology	3
Cetus	32
Corning Glass	2
Coulter Immunology	2
Daiichi Seiyaku Co.	1
DNAX Res. Inst.	1
Eastman Kodak	3
Epitope Inc.	5
Genelabs Inc.	1
Genentech	2
Genetic Systems	9
Genetics Inst.	1
Hazelton Biotechnologies	1
Hoffmann-La Roche	2
Immunex	4
Immunomedics	2
Johnson & Johnson	10
Litton Bionetics	11
Merck Sharp & Dohme	1
Molecular Diagnostics	2
Monsanto	3
Oncogen	4
Ortho Pharmaceutical (Canada)	2
Otsuka Pharmaceutical	3
Scripps Clinic & Res. Found.	6
Syntex	5
T Cell Sciences	2
Takeda Chemical	2
Teijin Ltd.	1
Teva Pharmaceutical Industries	1
Wadley Technologies Inc.	1
XOMA Corp.	3

Reference: UNDPINT92.209, 22 July, 1993

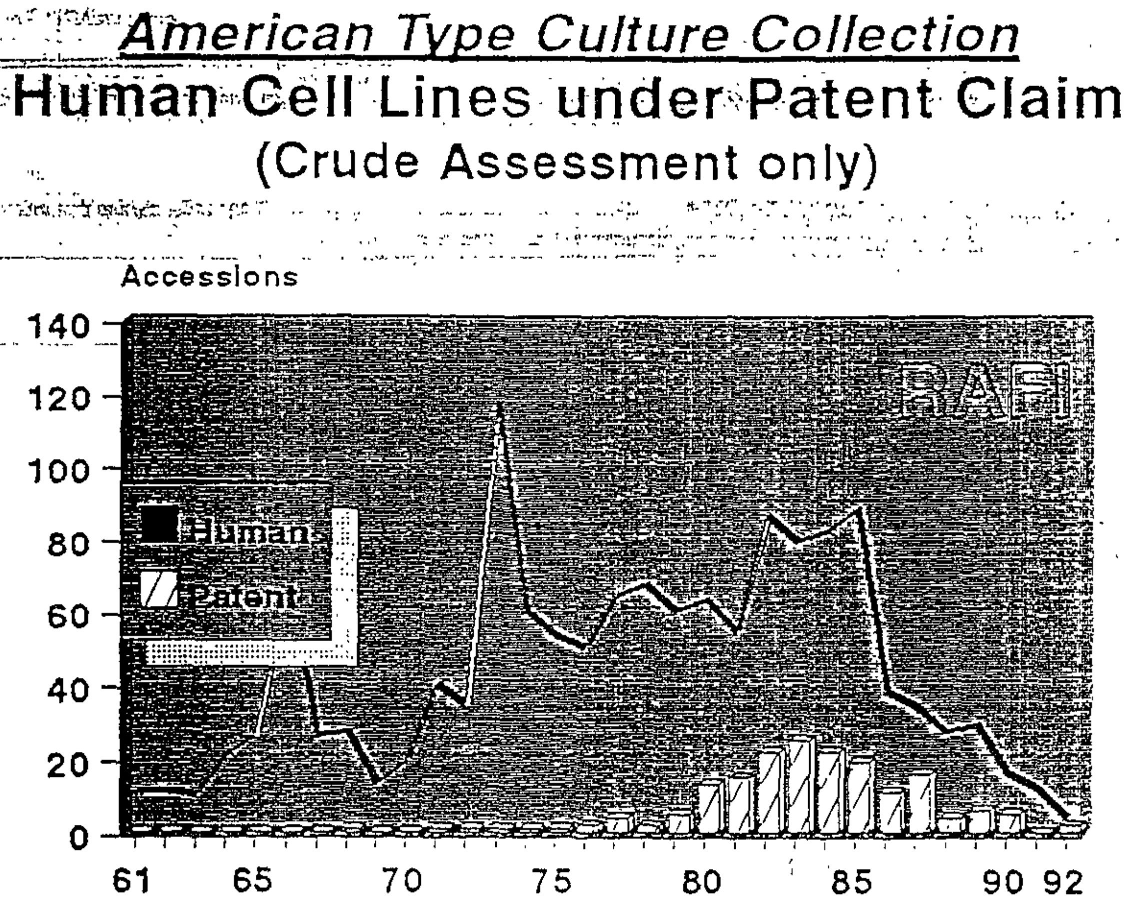
Public Sector & Foundation (42):	Sub-total: 184
Albert Einstein College	1
Beckman Res. Cen...City of Hope	1
Biomembrane Inst.	2
Dana-Farber Cancer Inst.	4
Sidney Farber Cancer	1
Dartmouth Medical School	2
Fred Hutchinson Cancer Res. Center	4
Harvard Univ.	2
Johns Hopkins Univ.	1
Lawrence Livermore Nat.	7
Lovelace Medical Found.	2
Mayo Found.	2
Medical College of Wisconsin	1
Medical Univ. of South Carolina	3
Memorial Sloan-Kettering Cancer Cen.	56
Michigan Cancer Found.	2
MIT	2
NIH/NCI	15
National Inst. of Mental Health	1
New England Medical Center	3
New York Hosp.-Cornel	4
Northwestern Univ.	3
Oklahoma Medical Res. Found.	1
Oregon State Univ.	2
Roswell Park Memorial Inst.	1
Salk Inst.	4
Stanford Univ.	2
Temple Univ.	8
Univ. Laval	2
Univ. of Alabama	2
Univ. of California, (Davis)	3
Univ. of California, (L.A.)	11
Univ. of California (Riverside)	1
Univ. of California (San Diego)	7
Univ. of Chicago	1
Univ. of Michigan	1
Univ. of Pennsylvania	1
Univ. of Rochester	1
Univ. of Texas	1
Univ. of Wisconsin	4
Washington Univ.	2
Wistar Inst.	8
TOTAL:	322

Source: American Type Culture Collection, Cell Line Infobase, November, 1992

The explicit patenting of human cell lines continues to be rather rare. The chart below offers a very crude description of the trend as it is now emerging through data from the American Type Culture Collection. Note that the drop off in applications is likely only due to delays in patent approval. Under the U.S. patent system, patent applications are not disclosed, only approvals.

Reference: UNDPINT92.209, 22 July, 1993

Chart 19 - ATCC Human Cell History



Source: ATCC Database cells.nfo (11/92)

Reference: UNDPINT92.209, 22 July, 1993

The box below shows a short list of patent claim approvals under the U.S. law that expressly identify human cell lines.

Box 18 - Sampling of U.S. Patents and Human Cell Lines - 1980-1993

Year/ U.S. Patent:	Assignees(s):	Title:
1985: 4495282	Kabushiki Kaisha Hayashibara Seibutsu Kagaku Kenkyujo Mochida Seiyaku Kabushiki Kaisha	Process for producing target [human] cell lysis factor & uses therewith
1986: 4608339	Yoakum, George H. et. al.	Protoplastfusion method for high-frequency DNA transfection in human cells
1989: 4798796	BIO-Response, Inc.	[Human] Cell lines & their use for the production plasminogen activators
1989: 4808532	United States Department of Energy	Continuous human cell lines & method of making same
1989: 4870163	New York Blood Center, Inc.& Sloan-Kettering Institute for Cancer Research	Preparation of pure human tumor necrosis factor & hybridomas producing monoclonal antibodies to human tumor necrosis factor
1991: 5026635	Du Pont Merck Pharmaceutical	Stable human cell lines expressing an indicator gene product under virus-specific genetic controls
1992: 5114847	Boehringer Mannheim GmbH	Process for the production of permanently culturable animal & human cell lines & the use thereof
1992: 5147790	t-PA Technology Trust	Serum-independent human cell lines, process for producing same, & processes for producing proteins therefrom
1992: 5173414	Applied Immune Sciences, Inc.	Production of recombinant adeno-associated virus vectors

Source: MicroPatent Biotech PatentSearch, May, 1993.

A recent RAFI *Communique* concerning the Human Genome Diversity Project is appended to this report.

F. Industrial Biodiversity

F.1. Renewed Natural Markets: After several decades of market share loss, plant material is rebounding and replacing industrial chemicals in some industrial sectors. Biotechnology and pollution concerns have combined to stimulate new commercial interest and the cost of living natural raw materials for industry has also declined. In 12 of 14 commodity groups studied in 1992, plant-derived materials had dropped in cost by as much as 30% since the mid-eighties. In the two other fields (detergents and plastics) plant materials were expected to drop by about 50% by the mid-nineties[46]. Plant materials are not only abundant and more environmentally-friendly than most industrial chemicals, they are also becoming price competitive.

Reference: UNDPINT92.209, 22 July, 1993

With the application of new bioprocessing technologies to plant matter, some analysts are projecting that plants could recapture the share of the total industrial materials market they enjoyed in the 1920's and that a full third of all industrial materials could be derived from plants. In 1990, the U.S. market for the industrial use of plants was about 6.5 million metric tons, or barely two percent of the total industrial materials market (excluding paper)[47]. If the catchword on Wall Street in the sixties was "plastics" and "synthetics", the rallying cry today is "plants" and "natural". Individual plants collected from Peru to Ethiopia give Northern manufacturers and food processors enormous value at almost no cost.

F.2. Implications for Indigenous Communities: The implication for indigenous people is that there exists a new interest within industry to explore natural oils, adhesives, latexes, etc., as well as to seek new sources of pulp and paper. This represents an opportunity.

There is also some risk. The Worldwide Fund for Nature (WWF) records that one bio-prospector in the 1970s shovelled up 150 kg. bulk samples of each of 17 different plant species in 17 days of work in Tanzania. The same prospector churned up 5 tonnes of plant material from Mexico and, on another expedition, 10-15 more tonnes of plants from around East Africa[48].

G. Summation:

There is no doubt that indigenous communities possess the substantial majority of agricultural and medical biodiversity that continues to exist in situ. There is also no doubt that indigenous people have nurtured and/or developed much of the material within their traditional lands and waters. Knowledge of the use of plants, animals, and microbial has been acquired and is continuing to accumulate wherever indigenous peoples are free to determine their own destinies.

It is also evident that indigenous communities pursue a Cooperative Innovation System that observes the same fundamental processes of discovery and experimentation common to Institutional Innovation Systems. While the innovation process is often incremental or evolutionary, it is no more so than is common in the Institutional System in the context of plant or livestock breeding.

From the preceding section, it is also clear that the Institutional Innovation System's form of Intellectual Property Protection is expanding and evolving with a flexibility with regard to biological products and processes that may make it reasonable to incorporate the innovations of indigenous peoples. What is technically thinkable, however, may not be politically realistic or even desirable.

III. Indigenous People and Intellectual Integrity

Section three reviews the major strategic policy alternatives available to indigenous communities and offers recommendations related to further action.

A. Overview:

A.1. Global Interdependence: Commercial Biodiversity has its mega-centres: China, India, and the Andes, for example, host a vast cornucopia of farmer-nurtured germplasm of incalculable wealth. Brazil, Colombia, Sarawak, Ethiopia, and Tanzania may also hold the answers to many of the world's major diseases within their forests and savannahs. The Convention on Biological Diversity adopted in Rio last June, encourages countries to "go it alone" by withholding their *ex situ* (gene bank) collections and/or by bartering access to *in situ* materials still in their fields, forests, and estuaries.

This could be short-sighted. Two-thirds of gene bank collections are held in industrialized countries, and well over four-fifths of livestock and microbial material is also controlled by these same countries. This is the material of most immediate commercial use. By and large, companies will only look to the fields and forests after they have rummaged through the gene banks and cell libraries.

Further, being the Centre of Diversity for a major crop or animal breed does not guarantee that a developing country (or indigenous community) has the most valuable material. Wheat, for example, originated in the Near East, but the specific genes that inspired semi-dwarf wheats and propelled the Green Revolution came from Japan via Mexico, and disease resistant genes found recently in Brazil may support crop yields as far away as India. Tomatoes originated in Latin America, but some of their most useful processing qualities have come from the Philippines, and when corn blight struck the southern United States, resistant genes were not found in Meso-America, the crop's genetic "home," but in West Africa.

Global genetic interdependence is better understood when we consider export commodities. Although the world's primary source of natural rubber originated in Brazil, the centre of production and many new innovations lies in Southeast Asia. Biotech companies are presently evaluating other latex-bearing plants with origins as scattered as India and Mexico. Southeast Asia is also the centre of production for oil palm although the crop's gene centre lies in Africa. Conversely, the centre for banana production is in South and Central America although "home" for bananas and plantains is in Southeast Asia. The centre of origin for the Latin American coffee industry is Ethiopia - and East Africa's sisal production is based upon germplasm from Central America.

Colonial history is a botanical chess game - a history of transferred production. The old centres of diversity are seldom the new centres of production - or of technology for that production. Tea may have originated in China, but some of the most commercially-viable material might well be found in Sri Lanka or East Africa. Cocoa is a South American plant, but its four centuries of traditional production in West Africa could mean that invaluable traits are a continent away from "home" now. Then, again, some biotech research on cocoa indicates that the crop could be supplanted by genetically-manipulated oil palm. Biotechnology could also further subvert sugarcane production in the Caribbean and elsewhere with thaumatin production in West Africa. Many of the spices that originated in Southeast Asia are now grown in the Indian Ocean and Africa, and may soon be brewed "naturally" in San Francisco processing plants.

Reference: UNDPINT92.209, 22 July, 1993

A.2. Economic Implications/Options: Conservatively, $80,000 million in annual South commodity exports are based upon germplasm that originated in another distant part of the South. Also conservatively, RAFI estimates that at least $20,000 million of this production (25% of the South's leading exports) could be de-stabilized by new adventures in biotechnology. Even the most genetically-abundant regions of the world look beyond their own borders for at least half of the germplasm they need for their staple foods.

The solution may not be environmental entrepreneurism but collective self-reliance and bargaining between developing countries and indigenous peoples on the one hand and industrialized countries on the other hand - the one region that indisputably needs - and now benefits from - the bio-wealth and knowledge of indigenous peoples and farming communities.

Indigenous communities are faced with a number of optional policy strategies that include adoption of existing (and evolving) intellectual property systems; the development of a *sui generis* system of intellectual property protection; bilateral contractual arrangements; or a combination of initiatives which, for the moment, could be described as the creation of an Intellectual Integrity System.

B. The Patent System:

B.1. Constraints to IPR Protection: At a meeting of African research institutes hosted in Nairobi by the African Academy of Sciences in 1989, the President of Research Corporation (a U.S. non-profit agency whose mandate it is to work with public universities to patent and commercialize academic research) provided the science policy leaders present with an overview of the potential licensing royalties that could arise from patentable research. According to the description, it was agreed that the costs of the meeting probably exceeded total potential Africa-wide royalty revenues over a ten year period. In industrialized countries, every million dollars in research should yield one publishable paper. One in every hundred papers should lead to a patent application and one in every hundred patents produces notable revenue. One patent in a thousand brings the research institute bonanza profits.

As it is for the Institutional Innovation System so it is also for the Cooperative Innovation System. In addition, indigenous communities must bear in mind the high cost of patent protection. British industry experts have estimated that 8 to 9% of corporate R&D budgets is spent - up front - on legal fees and other costs incurred to ensure protection and undertake litigation. The average cost of litigation over patents in the United States has risen from a quarter of a million dollars twenty years ago to well over a million dollars today. Since, for the moment, patents continue to be dealt with as civil law, the burden of these expenses rests with the patent holder. The existing intellectual property system is, therefore, scale-biased toward the largest enterprises with the strongest legal department.

B.2. The Feasibility of Protection: Although there is a growing assumption that indigenous knowledge can and should be protected under intellectual property law, the notion of IPRs for medicinal plants or for farmers' folk varieties is still in dispute. The box below offers a popular summary of the debate as it is currently expressed in one international forum.

Reference: UNDPINT92.209, 22 July, 1993

Box 19 - Intellectual Property Rights for Indigenous Innovations

Conventional "North" Arguments:	Conventional "South" Arguments:
The *Natural Phenomena* Argument: Landraces are the result of a combination of environmental & human selection pressures over millennia. Most of the credit goes to the environment and a little goes to a hundred generations of farmers.	Folkseeds are well-adopted/bred for specific micro-ecological niches. In a sense, they are "sustainable agricultural development" functioning in balance with nature, providing relatively-secure food and requiring no (or few) external inputs.
Expiry date Argument: IPR for a landrace is like trying to patent the wheel a few thousand years after publication. This would amount to an inexcusable monopoly under normal patent systems. The "best before" date has expired.	The folkseed in the field is no less "modern" (or more "traditional") than the latest hybrid maize release. Each is the up-to-date manifestation of on-going plant breeding.
The *Invisible Inventor* Argument: Who would receive the protection? What farmer from what country as defined at what point in history?	The local farm/ethnic community could be recognized. Compensation, however, is best through a global funding mechanism on a programme and project basis not tied to individual communities or even countries.
The *Commercial Irrelevance* Argument: Why bother? Almost everything collected has almost zero commercial value. It will cost as much (or more) to monitor germplasm flows than farmers will benefit through compensation schemes.	Most patents have little or no economic value. One in a hundred has value and one in a thousand has enormous value. The same is probably true of folkseeds except that a low commercial "return" in Northern terms can be a huge return for Southern farmers.
The *Hidden Genius* Argument: Where a landrace is used, breeders almost always extract and adapt a gene or gene complex which becomes one of several hundreds of components in a new variety. The useful properties extracted from the material may not have been known, or valued, or even expressed in the farmers' field.	Recent biotech patent decisions (Agracetus and cotton; PGS and Bt) imply that the rights holder doesn't need to know everything about the patented material in order to benefit.
The *Invisible Hand* Argument: Farmers are best served by a free flow of germplasm ensuring access to breeders' innovations. Efforts to assign benefits and provide compensation for their "raw" material will just slow innovation and restrict the spread of future benefits.	This is the *Father Knows Best* or *Trickle-Down-Upon* Neo-colonialist approach. The Northern equivalent would be for governments to tell corporations that "Governments Know Best" about distributing marketplace benefits.

In RAFI's analysis, the Cooperative Innovation System could be successful in winning the right to establish patent claims over biological products and processes. Indeed, industry and IPR institutions in the industrialized countries might well support this possibility and encourage patent applications. However, RAFI believes that the economic benefits of such protection would be both sparse and negligible in most situations most of the time and that the adoption of the current model of IPRs could divert attention and energy from more useful initiatives.

Reference: UNDPINT92.209, 22 July, 1993

B.3. Viable IPR Initiatives: Indigenous communities, UNDP and concerned governments and nongovernmental organizations could work within the present IPR system in a number of viable and useful ways. These include ...

1. *New Deposit Rules:* National regulations and, where appropriate, international conventions, could be altered to ensure that all inventions deposited for the legal record in gene banks or cell libraries must include passport data identifying all available information about the origin of the material including, where appropriate, the names of individuals and of communities that have contributed material or information related to material on deposit. The same information should be attached to all patent applications. Failure to disclose such information or any bad faith effort in disclosing information should lead to forfeiture of any patents emanating from the material.

2. *Gene Bank Accessions:* Material presently held in gene banks and cell libraries whose passport data gives indication that it has been collected form indigenous communities should be regarded as forming part of the intellectual integrity of indigenous peoples and no part of that material should be subject to patent claims by others. Effectively, this material should be regarded as "published" information precluding patent applications.

3. *IPR Ombudspersons:* In recognition that the existing intellectual property system could contribute to the piracy of innovations emanating from indigenous communities, each national patent office and the secretariat for each IPR convention should create the post of ombudsperson whose task it would be to investigate complaints from indigenous communities and governments and organizations acting in consultation with indigenous communities. The ombudsperson post should be filled in consultation with indigenous organizations and should provide an annual report on her/his activities. The ombudsperson should have the authority to delay patent approvals and to require the review of specific patents or patent applications.

4. *Tribunals:* Where indigenous communities challenge a patent claim through the ombudsperson or by other available means, a tribunal or patent court should be held to determine the dispute. The annual report of the office or convention acting on the dispute should provide full information on the status of the dispute.

5. *IPR Expenses:* The costs of deposit and disclosure as well as the expenses related to the office of the ombudsperson, tribunals and legal representation for indigenous communities should be borne through the fee structure for intellectual property rights in each jurisdiction. Where the ombudsperson determines that there exists grounds to dispute a patent claim, indigenous communities should be afforded all necessary legal support as part of the normal operating budget of the patent office.

6. *Other Initiatives:* New areas of intellectual property discussion such as the debate over product liability, criminal law enforcement and reverse burden of proof (see section one of this report), should they come into effect in any jurisdiction, should be reviewed for their potential utility to safeguard the intellectual integrity of indigenous communities. There is a strong case to be made that the uncompensated appropriation of farmers' varieties and medicinal plants constitutes real theft and that the parties responsible should be pursued under criminal law at the expense of national law enforcement agencies in the countries where the theft is enacted)the patenting country).

In RAFI's view, the recommendations made above are not a significant departure from the current work of the intellectual property system and would not constitute an unacceptable burden on that system. It is current practice for patent offices to assign the full cost of their offices on the fee structure imposed on applicants. The modest cost of these proposals, therefore, would simply become a slight additional part of the "cost of doing business" in the IPR community.

C. Sui Generis IPR Systems:

C.1. Inventors' Certificates: In the draft proposals from the GATT Secretariat on TRIPS, provision is made for Contracting Parties to adopt *sui generis* forms of intellectual property protection, at least, with respect to the coverage of plant and animal varieties. Indigenous communities and many governments are not aware that IPR systems include a number of options that do not imply exclusive monopoly control over inventions. Among these are Inventors' Certificates which can discard financial compensation altogether in favour of non-monetary awards and non-exclusive licensing arrangements. There is a great opportunity for innovation in this field and indigenous communities and the governments of developing countries, in particular, may wish to explore some of these possibilities closely.

C.2. Model Law on Folklore: Chief among these alternatives is the 1985 WIPO/Unesco Model Law on Folklore which has the benefit of having been adopted by both intergovernmental agencies. The Model Law affords indigenous communities three unique elements that are especially appropriate to the protection of biological products and processes...

1."Communities" (rather than identified individuals) can be the legally-registered innovators and can either act on their own behalf or be represented by the State;

2. Community innovations are not necessarily fixed and finalized, but can be ongoing or evolutionary and still be protected by intellectual property law;

3. Beyond standard patent - or even copyright - provisions, communities retain exclusive monopoly control over their folklore innovations for as long as the community continues to innovate.

The significant limiting factor with respect to the Model Law is that it has been interpreted to exclude scientific inventions. However, standard IPR law in most countries expressly excludes protection for plants, animals, pharmaceuticals and chemicals. Despite legislation to the contrary, Patent Offices have chosen to interpret law to permit the patenting of such innovations on the assumption that if legislators had known "then" what they know "now", they never would have made these exclusions. Certainly, the same case can be made for indigenous knowledge.

The significant point regarding the Model Law is that it acknowledges the concept of ongoing indigenous community innovation. It does not, however, offer any viable means of safeguarding community innovations. This is a practical problem that will plague all efforts to utilize the existing IPR framework.

D. Bilateral Contracts:

As noted above, the Convention on Biological Diversity and other private initiatives have encouraged developing countries and indigenous communities to seek bilateral contractual agreements with private companies in return for access to germplasm.

D.1. Materials Transfer Agreements, etc.: This form of bilateral agreement may or may not include IPRs. Essentially, the material is treated as a commodity rather than as knowledge and a contract is reached between buyer and seller based on the potential value of the commodity. Routinely, such contracts involve both initial "up-front" payments and then a formula for additional benefit if and when the material is commercialized. In RAFI's analysis, such agreements are inevitable in situations where both parties realize that the material to be transferred has real commercial potential. For example, rust-resistant coffee germplasm from Ethiopia or high-quality cacao from Brazil might always be expected to demand a premium over and above any general international arrangement. Such agreements can have a role to play in the protection of the interests of indigenous communities.

D.2. Bio-Prospecting: The Merck/Costa Rica contract deserves particular comment -- Costa Rica is estimated to hold 5% of the world's biodiversity[49]. If the Merck deal were replicated for the rest of the South's biodiversity, it would all go for $20 million. Merck's sales in 1991 were at $8,600 million, while Costa Rica's entire Gross National Product that year was less than $5,200 million.[50] Merck's research budget in 1991 was roughly $1,000 million, and it is not likely that the Costa Rican deal represented more than a fraction of a percent of its advertising budget. At present, Merck has three drugs on the market with a sales volume in excess of $1,000 million each. Given that Merck invests an average of $125 million on research for each new drug, the discovery charge for one single new drug arising from the Costa Rican agreement is barely loose change for Merck. If ten or twenty years from now, Merck and Costa Rica dispute the origins of a plant-derived active ingredient (was it from Nicaragua or from Costa Rica?) the country's capacity to appeal to the international courts to resolve such a dispute are poor. Anyway, Merck has more lawyers on its staff than can be found in all of Costa Rica.

Some observers argue that within the next two decades, the annual retail market for Amazonian nuts, oils, herbs, and flowers could reach $15,000 million. This could pay indigenous communities $1,000 million a year in sales and royalties[51]. By extrapolation then, the retail market for Costa Rica's biodiversity would hardly be less than $1,000 million and its corresponding annual return to the country should not be less than $60 million.

In RAFI's analysis, such arrangements are not likely to provide adequate compensation to either indigenous peoples or developing countries unless they are made within the framework of broader intergovernmental arrangements.

E. Conservation Compensation:

E.1. Keystone Initiative: In the context of plant genetic resources, developing countries have taken the position at the UN Food and Agricultural Organization that the best method of compensating farmers for their plant breeding efforts is through "Farmers' Rights". Within FAO and in Agenda 21, Farmers' Rights is understood to encompass the arrangements made for all aspects of plant genetic resources including Germplasm, Information, Funds, Technologies, and Systems that are necessary to make any raw material a usable resource. In FAO fora, governments have agreed that these "GIFTS" are best ensured through a consistent international funding mechanism by which governments transfer funds in an automatic way to an intergovernmental body for distribution to programmes and projects that will conserve and develop "GIFTS". Funds would not seek out individual farmers or indigenous people to compensate them for a specific contribution. Funds would go to meritorious work that encouraged conservation and use primarily in developing countries.

This approach to Farmers' Rights was first proposed through the Keystone International Dialogue on Plant Genetic Resources (1988-91). The Keystone Dialogue brought together government officials, industry executives, NGOs and scientists from developing and industrialized countries for off-the-record negotiations on GIFTS. At their closing round in Oslo in 1991, the individual participants agreed that a new Global Initiative on Plant Genetic Resources was necessary and a budget of roughly $300 million per annum for the first seven years was agreed upon. Keystone participants also agreed that the fund should be mandatory and automatic and that it should be channeled through a U.N. agency. Very great importance was given to the role of indigenous farming communities in collecting, conserving, and developing plant genetic resources.

Although the Keystone initiative was limited to agricultural plants, the basic principles could be extrapolated to all biological products and processes nurtured by indigenous peoples. Perhaps its most attractive feature is that elimination of legal mechanisms for intellectual property-protection. Indigenous communities could be compensated on the basis of development need/opportunity without reference to law courts, patent offices, or legal departments. The anticipated flow of funds - even at the modest level of $300 million per annum, still far exceeds any bilateral negotiations such as the Merck/InBio agreement discussed above.

E.2. Community Contribution: Following the recognition at Keystone and at FAO that indigenous rural communities have an essential role in biodiversity conservation and enhancement, RAFI took the Keystone budget figures and worked with a number of scientists to determine the realistic support that farmers could offer the conservation effort.

RAFI estimates that the number of crop germplasm accessions in gene banks should more than double during Agenda 21 and that the normal cost of such collection work through the institutional system would be at least $29 million. With the active participation of indigenous communities, the cost could be cut by about $20 million and indigenous rural communities could directly collect more than 600 thousand accessions.

Chart 20 - Community Germplasm Collection

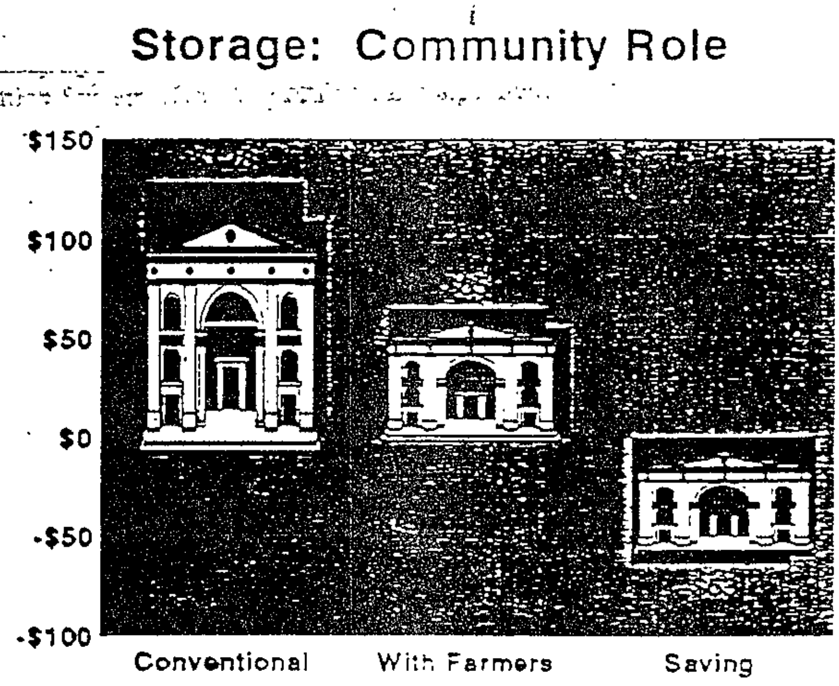
Source: RAFI estimates based om Keystone Report

Reference: UNDPINT92.209, 22 July, 1993

A fundamental tenet for the involvement of farming communities in germplasm conservation, of course, is that full samples are stored securely within the communities themselves. This is not merely a moral principle but also a scientific necessity if the integrity of samples is to be preserved. Further, many species resist gene bank storage and can only be protected in field gene banks.

RAFI estimates that the cost of germplasm storage in the coming seven years (1993-2000) proposed by Keystone would be not less than $128 million. With the active participation of indigenous rural communities, these costs would be almost halved.

Chart 21 - Community Germplasm Storage



The international community needs to understand the extent of the real scientific contribution indigenous communities can (and are) making. Compensation for indigenous knowledge and work must be undertaken with this contribution included.

F. Intellectual Integrity Framework:

The common objective shared by most indigenous communities is to nurture and protect indigenous knowledge. It is our understanding that most communities would prefer a framework mechanism that would allow them to ensure the intellectual integrity of their on-going innovations rather than to obtain intellectual property. Ultimately, a combination of initiatives may prove most appropriate...

Reference: UNDPINT92.209, 22 July, 1993

F.1. Intellectual Protection: UNDP and other parties could work with indigenous communities and with national governments to ensure that the series of recommendations cited above (rules of deposit, ombudsperson, tribunals, etc.) were established at least within the world's major patenting regimes (US, Japan, and USA). Indigenous communities need neither endorse nor support intellectual property systems in order to have their intellectual integrity protected. UNDP could work with indigenous communities to expand upon these proposals and encourage their discussion in regional and national fora.

F.2. Intellectual Recognition: Secondly, new initiatives are needed to assist indigenous communities and their organizations to counter the ongoing assumption in general and scientific society that indigenous knowledge is either "quaint", "quackery" or "quits". It is obviously none of the above but there will be no significant support for the conservation and development of Cooperative Innovation Systems until the real utility of this knowledge is understood in the context of today's social, scientific, and environmental problems. A public information campaign should be accompanied by a scientific information campaign directed to the Institutional Innovation System. The exact nature of this campaign needs to be developed under the direction of indigenous peoples' organizations.

F.3. Intellectual Development: Indigenous peoples' organizations and communities urgently need support to extend their existing systems of information-exchange and cooperation. It is now possible to establish efficient and relatively inexpensive closed-circuit information systems and "libraries" that make it possible for communities to document and control access to their knowledge. Linkages can also be made between indigenous peoples to allow for a closed exchange system. UNDP could play a very important role in assisting indigenous people in this work and bringing their organizations in contact with other bodies undertaking research in this field.

F.4. Intellectual Exchange: As a first step to developing any of these initiatives, it is essential for indigenous communities to meet and discuss their policy choices at least at the regional level. UNDP could play a critical role ion bringing indigenous groups together and providing them with some of the information it has obtained. Two and three-day workshops in each region of the world could do a great deal to establish a realistic understanding of the current situation and the real opportunities.

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RAFI is also in touch with Dr. Darrell Addison Posey, Oxford University, Institute of Social Anthropology, Oxford, U.K. Dr. Posey has been preparing a draft "Covenant" between local communities and genetic prospecting companies. We have not yet seen a copy of the Covenant, which will be presented in draft form to indigenous leaders at the U.N. Working Group on indigenous peoples.

Indigenous Knowledge and Development Monitor, a publication of and for the international community of people who are interested in indigenous knowledge. It is produced by the Centre for International Research and Advisory Networks (CIRAN), in close cooperation with the Centre for Indigenous Knowledge for Agriculture and Rural Development (CIKARD), the Leiden Ethnosystems and Development Programme (LEAD), and the national and regional Indigenous Knowledge Resource Centres.

Akke W. Tick
Editor,
CIRAN/Nuffic
P.O. Box 29777
2502 LT The Hague
The Netherlands
FAX: 31-70-4260329

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V. Footnotes

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VI. Appendices

I. Transfer of Technology: 100+ Examples of the Informal Innovation Systems Contribution to the North's Development, RAFI, 1993.

II. Macrobiological Innovations of Indigenous Communities: A Sampling of Potentially "Patentable" Products or Processes under the WIPO/Unesco Model Law on Folklore, RAFI, 1993.

III. Isolates of Historic Interest - Human Genome Diversity Project List of Targeted Indigenous Communities, RAFI, 1993.

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Transfer of Technology

100+ Examples of the Informal Innovation Systems Contribution to the North's Development

Country/Region to:	Species:	Discussion:
South to USA	General	The U.S. government estimates that every 1% gain in crop productivity brought about through the use of exotic germplasm means a $1 billion benefit to the American economy[1].
Mexico to USA	Maize	An almost extinct form of perennial teocinte (an ancestor of maize) protected by a Mexican farm-family may save farmers $4.4 billion per year[2]. The U.S. crop is valued at more than $10 billion per annum[3].
Ethiopia to USA	Barley	Farmer-derived Ethiopian barley is worth $150 million in the United States each year[4]. The annual value of the American crop is more than $670 million[5].
Near East to Germany	Barley	A barley variety collected in the Near East became the parent of a major German variety "patented" by the Max Plank Institute in 1965. The variety, Volgersamen Gold, dominated the $1 billion German barley market for several years.
North Africa, Ethiopia, South Asia, to Denmark	Barley	Danish breeders developed barley varieties resistant to powdery mildew in the late sixties thus preventing crop losses amounting to $200 million in the period 1967-1974. Resistant germplasm came from farmers in North Africa, Ethiopia, and Southern Asia[6].
Algeria, China, Egypt, to Canada & USA	Barley	North American barley has also depended heavily on the contributions of farmers in Algeria, China, and Egypt to provide disease-resistance[7].
South (CIMMYT) to USA	Wheat	In 1984, 21% of the U.S. wheat crop was dependent upon "green revolution" germplasm. The share of semi-dwarf wheats in the U.S. crop doubled over the previous decade and was still growing[8]. The value, estimated by the OECD in 1982, was not less than $500 million. The total value of the American crop is approximately $6 billion per year[9].
South (CIMMYT) to North	Wheat	26% of all CIMMYT wheat nursery trials are conducted in industrialized countries and are regarded, by these countries, as a major benefit to their own wheat breeding programmes[10].
Brazil (CIMMYT) to North	Wheat	An old Brazilian wheat variety has been found by CIMMYT to confer unusually durable resistance to leaf rust in new wheat varieties. Leaf rust costs millions of dollars per year and plagues crops in the South and North[11].
Turkey to USA	Wheat	A wheat sample from Turkey is valued at $50 million per annum in the U.S. Northwest[12].
South (CIMMYT) to Italy	Wheat	Italian scientists have valued the annual contribution of CIMMYT durum wheat material at nothing less than $300 million.

South (CIMMYT) to New Zealand	Wheat	New Zealand's modest wheat industry has gained well over $5 million in seed from developing countries since the creation of the international germplasm board in 1974.
South (CIMMYT) to Australia	Wheat	Australian authorities have valued the contribution of wheat seed from one such gene bank in Mexico (CIMMYT) at $75 million per year.
South (ICRISAT & ICARDA) to Australia	Chickpeas	Australia's multi-billion dollar livestock industry has benefitted from 16,000 chickpea seed samples collected through the green revolution centres in Third World countries.
Libya to Australia	Lucerne (Alfalfa)	Plant collector Clive Francis of Australia violated his contract and pocketed lucerne (alfalfa) seed he was sent to study in North Africa and, returning to Australia, now claims the seeds are "worth millions" to his country's livestock industry.
Afghanistan & Saudi Arabia to North	Lucerne (Alfalfa)	Lucerne variety AWPX3 traces its origins to genetic contributions from nine countries including Saudi Arabia and Afghanistan[13].
North Africa to Canada	Oats	North African farmers saved the Canadian oat crop from disaster in the Seventies[14].
South (CIMMYT) to private companies	Maize	About one-third of all maize germplasm requests made to CIMMYT come from private companies. Interest in tropical maize germplasm is increasing enormously among major seed companies[15].
South to USA	Maize	An early 1980's study indicates that only one-tenth of one percent of U.S. maize production was based on tropical maize germplasm. The study, however, also reported that private companies were increasing their use of exotic maize and that the share of the U.S. crop could rise to 15% or higher within a few decades.
West Africa to USA	Maize	The only genetic resistance to Southern Corn Leaf Blight - a disease that caused $1 billion in damages in the United States in 1970, was found in a farm field in West Africa.
South (IRRI) to USA	Rice	IRRI rice germplasm contributed to at least 16% of the total U.S. rice harvest in 1984 and the IRRI share was expected to increase[16]. The U.S. crop is estimated to be work at least $1.1 billion each year[17].
South (IRRI) to private company	Rice	CB-801, a rice variety receiving a U.S. Plant Variety Protection certificate (patent) in 1985 was described by U.S. AID as "an IR8 derivative". The "patent" is held by The Farms of Texas Co.[18].
South (IRRI) to Cornell - private companies	Rice	Rice research financed by the Rockefeller Foundation and involving the co-participation of IRRI and several Asian countries as well as Cornell University has led to Cornell patenting a number of rice probes and markers and selling non-exclusive licenses to biotech boutiques in the United States. The licenses sell for $1,000 each. Rockefeller designated Cornell as the repository and distributor of the collected wisdom of IRRI and Asian researchers[19]

Chile (CIAT) to France	Beans	CIAT (the International Centre for Tropical Agriculture in Colombia) is negotiating intellectual property rights over two new bean varieties with a French public sector institution. Royalties will be disposed of by CIAT. Officials concede that one of the varieties is based heavily on a Chilean accession in their gene bank and have wondered if they should turn over the profits to Chile[20].
South (CIAT) to USA	Beans	CIAT (working with beans) claims that its contribution to U.S. agriculture is at least $60 million per annum.
South (ICARDA) to Australia, Spain, & Portugal	Barley	Barley varieties based on breeding material from ICARDA were released in Australia, Spain, and Portugal in the Eighties. Portugal also obtained bread wheats and durum wheats from ICARDA during this period[21].
South (ICARDA) to France, Italy, Portugal, & Spain	Chickpeas	Kabuli chickpeas, based on ICARDA material, were released in France, Italy, Portugal, and Spain. ICARDA-based lentil varieties were also released in Canada and Australia and Portugal obtained ICARDA's Faba beans[22].
Korea to USA	Soybeans	Soybeans from Korea are worth $100-$500 million to U.S. farmers annually[23]. The crop is valued at more than $11 billion a year in the U.S.A.[24].
Near East to Europe	Beets	Wild beets collected in 1925 and in 1935 were discovered in 1983 to confer crop resistance to new root diseases in Europe's sugarbeets[25].
Nepal to UK	Brown Mustard	Nepal has donated the genes necessary to increase the pungency in born mustard grown in Britain[26].
China to UK	Cherry	Cherry germplasm provided by Chinese farmers saved the British industry some years ago[27].
Brazil to Europe	Potato	The Polo potato of Brazil has been used for breeding new varieties in Europe.
Andes to private companies	Potato	An orange potato from the Andes is being studied by the U.S. snack food industry as a potential novelty potato chip in a very lucrative market[28]. (The global seed tuber market is estimated at $8.5 billion[29].)
South (CIP) to private companies	Potato	In 1991, the International Potato Centre (CIP) in Peru signed a contract with Plant Genetic Systems of Belgium to trade gene bank material for access to a transgenic potato resistant to potato tuber moth that was derived from that material. PGS has exclusive rights to the germplasm in industrialized countries and CIP has the right to use the material in the South. For the first time, CIP is obliged to refuse requests for this germplasm from the North[30].
South (CIP) to private company	Potato	A Pepsico subsidiary, Frito-Lay, was allowed to come to CIP to screen gene bank accessions for potato chip processing qualities. Frito-Lay took useful germplasm samples back to the United States and is now developing proprietary (patentable) varieties which could be marketed in such countries as Korea and Taiwan where Frito-Lay has large operations. CIP traded access to the gene bank for access to (some or all of) Frito-Lay's screening documentation[31].

South (CIP) to private company	Potato	EscaGenetics, another U.S. ag biotech boutique, has also obtained germplasm from CIP which it is turning into patentable material. EscaGenetics is testing its new potatoes in a number of developing countries including Egypt[32].
Peru to USA	Tomato	Two wild tomatoes gathered in the Peruvian Andes contribute $5 million per annum to U.S. processors.[33,34] (The global market for tomatoes is $3.5 billion[35] of which more than $1 billion is in the United States[36].)
Philippines to USA	Tomato	A tomato collected in the Philippine uplands has been used to breed cold tolerance into U.S. tomatoes.
Galapagos Islands to private companies	Tomato	A wild tomato from the Galapagos Islands sporting a jointless fr it stalk is worth millions of dollars a year to the mechanized tomato harvest in the USA[37].
South to Cornell	Tomato	Cornell University has patented a new class of compounds, derived from wild tomatoes, that can be used for a very wide range of toiletry items including sunscreens, lipstick, and shampoos[38].
Ethiopia to USA	Sorghum	Sorghum from Ethiopia is worth $12 million a year to U.S. growers[39] Annual value of the crop in the United States is above $1 billion[40].
India, Korea, and Burma to USA	Cucumber	U.S. cucumbers depend upon germplasm from India, Korea, and Burma[41]
Mexico, Syria, Chile, & El Salvador to USA	Bean	Farm communities in Mexico, Syria, Chile, and El Salvador have all contributed disease-resistance germplasm to the American bean crop[42].
Iraq, Peru to North America	Pea	Iraqi and Peruvian farmers have joined forces to provide disease-resistant pea strains to North America[43].
India, Iran, and Manchuria to USA	Spinach	The California spinach crop owes its survival to farmers in Iran, Manchuria, and India[44]. The crop is valued at well over $300 million per annum in the United States[45].
Asia to private company	Neem tree	Agri-Dyne Technologies has patented two bio-insecticides derived from the neem tree - a plant famous for its medicinal and insecticidal properties in southeast Asia[46].
India to private companies	Neem tree	W.R. Grace and PJ Margo Co. of Karnataka, India are jointly-producing neem-based bio-pesticides in a new facility in India. Capable of processing 20 tonnes of neem seed per day, the two firms estimate the global market for their products could reach $50 million per annum by the end of the century[47].
Costa Rica to USA	Bacteria	The University of Massachusetts is patenting a bacteria collected from Costa Rican soil that has useful nematicidal and antifungal properties. (Crop losses caused by 100 strains of nematodes are estimated at $6 billion per year in the United States and $75 billion worldwide[48].)
China to Europe	Pig	China's Taihu pig, long famous for its hardiness, multiple-births and rapid growth rate, is being developed in both Europe and the United States to be bred into other porcine varieties[49].

East Africa to Australia	Bovines	Australian breeders recently introduced East African cattle breeds in order to improve the local stock[50].
West Africa to USA	Bovines	West-African-bred N'Dama cattle have ben crossed with Britain's Red Pol breed to create Senapol, a new and hardy breed now being used in, among other places, the southern USA[51].
Africa to Europe; North America	Bovines	Other African breeds have made a major contribution to U.S. and European herds through increased disease resistance and other qualities such as short-horns[52].
South (ILRAD) to private companies	Vaccine	ILRAD (the International Livestock Research and Development Centre in Nairobi) has taken out a patent on a live vaccine for East Coast Fever. Contrary to stated CGIAR principles, the patent was not taken out to prevent usurpation by others but to stimulate a market for the vaccine. The very first "live" CG patent thus breaks the "rules of the game" laid down by CGIAR. ILRAD has a board member from Merck (one of the world's two largest pharmaceutical companies)[53].
Brazil to USA	Fungus	Florida scientists recently patented a strain of fungus identified by Brazilian farmers as being death on fire ants. The ants cause hundreds of millions of dollars in crop damages in the United States.
India & Mexico to USA	Rubber	U.S. researchers are working with an ornamental plant from India, the guayule plant from Mexico and the U.S. southwest and traditional Brazilian rubber to bio-synthesize a new natural rubber that can grow commercially in the United States[54]. (If successful, the market value will be in the hundreds of millions per annum.)
West Africa to private companies	Cowpea	A pest-resistant cowpea variety originating in West Africa was taken from IITA in Nigeria to Durham University and the CpTi gene was ultimately patented by Agricultural Genetics Co. of the U.K. and licensed to seed and biotech companies.
West Africa to private company	Cowpea	Agricultural Genetics Co. has also developed a method for extracting animal vaccines from transgenic cowpea plants by infecting the Cowpea Mosaic Virus with antigenes. One leaf of a two week old cowpea can vaccinate 200 animals - reducing current inoculation costs substantially. The first vaccine Agricultural Genetics is developing is foot and mouth disease. Worldwide patent rights have been applied for[55].
Ethiopia to private companies	Endod	The University of Toledo is patenting Ethiopian research related to the endod (soapberry) plant used in Africa as a shampoo and detergent. Endod also appears to be safe and effective against zebra mussels that have infested the Great Lakes and are expected to cause damages of $5 billion by 2000[56].
West Africa to U.S. universities and private companies	Thaumatin	The University of California and Lucky Biotech have applied for patent rights over genetically-engineered thaumatin sweetener in industrialized countries and in West Africa. The plant has long been used as a sweetener in Africa.

Brazil to private companies	Fungus	Brazilian researchers have discovered a fungus in the Humicola genus that improves the quality of white paper and also accumulates dioxins in waste water from the paper-making process. This could substantially ease industry pollution[57].
Uruguay to USA	Nematodes	The University of Florida has patented Uruguayan nematodes and, in turn, has licensed BioControl, Inc. to market the nematodes for use on golf courses and sporting turf.
India to USA	Bajra	Bajra, a small grain grown in India, is yielding up to one-and-a-half tons per hectare on sand nurtured with seawater. The U.S. National Research Council and the biotech industry are interested in saline-tolerant plants such as Bajra in order to grow crops on coastal plains and other areas that are often not now usable. In addition, genetic material from saline-tolerant crops might be transposed into major crops to increase their viability on poorly-irrigated lands[58].
Africa to USA	Tilapia fish	Africa's Tilapia fish (sometimes known as the "aquatic chicken") have been transferred and bred for use in many parts of the world including the United States and Europe[59].
Southeast Asia to USA	Algae	Algae gathered from the China Sea region are spawning a whole new industry on the Carolina shores of the U.S.
Zambia & Zimbabwe to Australia	Bovines	Embryos of 269 Tuli and 264 Boran cattle from Zimbabwean and Zambia were brought to Australia in 1990 to improve local Friesan herds with higher fertility levels, docility, and environmental stress resistance. Using multiple ovulation and embryo transfer techniques, the imports have been hailed as the saviors of the northern Australian cattle industry[60].
South to North	Bovine Growth Hormone testing	Bovine Growth Hormone (also known as BST) is being test marketed in Latin America, Africa, and Asia although it is still illegal in Europe and North America. (The ultimate value to the global dairy industry is estimated by Monsanto, a major player, at $1 billion per annum. The low estimate is $400 million.) If the product is finally commercialized in industrialized countries, developing countries will have been the guinea pigs[61].
Colombia & Peru to private companies	Cotton	Farmer-bred cotton varieties from Peru and Colombia containing natural colours of browns and violets have been further developed, and patented, in the United States. U.S. breeders concede their invention is not "new" but argue that they have done considerable work to commercialize the varieties now being produced under contract to jean-maker Levi Strauss. It is illegal to grow these traditional varieties in Peru and many varieties have disappeared locally[62].
Latin America to private companies	Amaranth	Amaranth varieties based on material originating in Latin America, have been patented in the United States and are now being marketed in Mexico and Peru where farmers are being forced to pay royalties on their own inventions[63].

Country/Region to...	Medicinals:	Discussion:
2Near East to private company	Spiraea plant	Derived from traditional Arab medicinal plant, Bayer's synthetic aspirin is the most widely used drug in the world. More than forty million pounds are produced annually in the USA - almost a pill a person a day[64].
Andes to UK	Cinchona	Cinchona bark from the Andes is the basis for the anti-malarial drug, quinine, that lost much of its potency during the Vietnam War and is now being studied again by biotech companies.
China to North	Qing Hao	Qing Hao, a Chinese medicinal plant used to combat malaria for 2000 years, has been semi-synthesized by Phone-Poulenc Rorer and will be released, under patent, in Europe in 1993 as a new anti-malarial drug known as Paluther. Glaxo is exploring properties of the same plant and WHO is testing plant derivatives in Asia and Africa[65].
Latin America & Africa to private company	General	Glaxo's Natural Products Discovery Department is looking for medicinal plants in Latin America and Africa[66].
Indonesia to private companies	convolulaceae	Tonen Corp. (a Japanese oil refiner) and Eisai (a Japanese drug company) are studying a compound drawn from a traditional Indonesian medicine tree (of the family, convolulaceae) for its ability to arrest the proliferation of HIV in infected mice. The tree is used for a range of health problems in Indonesia[67].
Peru to private company	tree	Hauser Chemical Research Inc.supplies a naturally-derived drug, from a Peruvian medicinal tree, to Cambridge Bioscience Inc. for use in Stimulon, now being tested as a potential AIDS vaccine[68].
Samoa to North	plant	A medicinal plant used in Samoa has been discovered to have a positive impact against the AIDS virus according to U.S. National Cancer Institute researchers. Brigham Young University and the NCI are studying a plant that has been saved from extinction by Samoan herbalists[69].
Mexico to North	albahaca de monte (ocinum micranthum), pepelhun (cissampelos pareira) and la altaniza (parthenuim histerophorus)	Mexican scientists and companies are examining albahaca de monte (ocinum micranthum), pepelhun (cissampelos pareira), and la altaniza (parthenuim histerophorus) for their curative properties. Each plant has a long history in traditional medicine[70].
Nigeria to North	Monkeys	Researchers in the Okomu Forest Reserve in Nigeria have shown that rare monkeys endemic to the forest have similar blood constitution to humans, making them valuable for medical research and drug testing[71].
Madagascar to North	Rosy periwinkle	Two drugs derived from Madagascar's rosy periwinkle earn pharmaceutical companies more than $100 million per annum as anti-cancer and childhood leukemia drugs. Allelix (a Canadian biotech firm) is working with Mitsui Pharmaceutical to develop "natural" periwinkle compounds that will not need Madagascar any more[72]. (The leukemia drug has turned a cancer that used to kill 8 out of 10 victims into one where 8 of 10 children survive[73].)

Latin America to North	Pau D'Arco	Pau D'Arco, a medicinal plant from Latin America, has long been used to combat malaria and cancers. Its current market value is estimated at $200 million[74].
Latin America to North	Tecoma	Another Latin American plant used in traditional medicine, Tecoma, is now being studied for its potential use against diabetes[75].
Latin America to North	Stevia	Stevia, a plant used widely in Latin America as a sweetener and as an antacid and diuretic also seems to resist tooth decay and is being studied for its use in weight-loss regimes[76].
Argentina to private company	Bacteria	Mitsubishi has patented and marketed a streptomycin-based antibiotic isolated from Argentinian soil. The antibiotic is to be added to poultry and swine feeds[77].
Latin America to North	Quassia	Used for a multitude of purposes as a disinfectant in hair rinses, a stimulant to appetite and to kill intestinal worms, Quassia is widely used in indigenous Latin American medicine and is being studied for uses in industrialized countries as well[78]. The Suma plant of South America has long been used for diabetes and some cancers and is now being looked at in the North for its cancer-fighting properties[79].
Caribbean to private companies	Microbials	Muco-Search, a small U.S. bio-explorer, charges $2,000 a "hit" for unique algae and fungi gathered up on the beaches of Caribbean islands. The germplasm is sold to pharmaceutical and chemical houses in North America[80].
Latin America to North	Ipecac	Ipecac, an indigenous South American plant, has long been added to syrups to reduce lung congestion and as a cough medicine[81].
Brazil to North	Muira Pauma	Muira Pauma is a plant that has been used by indigenous communities in Brazil to cure impotency and to regulate the menstrual cycle. Scientists are now studying the plant for its ability to reduce cholesterol levels in the body[82].
Jamaica to North	Sponge	A Jamaican sponge has become the source of patented antiviral and anticancer drugs[83].
Brazil to North	Cephalis ipecacuana	Roots of Cephalis ipecacuana, a medicinal plant in Brazil, are being developed to treat dysentery.
China to private companies	plants	Xenova Co. (U.K.) has established an agreement with the Chinese Institute of Medicinal Plant Development and China's Institute of Botany to receive plant extracts and phytochemicals from traditional medicinal plants. Xenova will have exclusive rights outside of China and China will have rights internally and will receive royalties on Xenova's sales[84].
China to North	<u>Momordica charantia</u> & <u>Trichosanthes kirilowii</u>	The Chinese bitter melon, <u>Momordica charantia</u> and the root of the Chinese medicinal plant, <u>Trichosanthes kirilowii</u> have been shown to be effective against AIDS in lab tests. Also, the biotech industry is examining a Himalayan medicinal plant and the leaves of the Chinese carnation, <u>Dianthus caryophyllus</u> for their wide range of therapeutic uses[85].

India to private company	plants	Ciba-Geigy of Switzerland hired local people to collect useful plants in the Bombay region of India and, according to M.S. Swaminathan, devastated the availability of at least one local species in the area[86].
Brazil to private company	tiklúba	The tiklúba plant, long used by the Ure-eu-Wau-Wau community of the Brazilian Amazon is currently being developed by Merck as an anti-coagulant.
South to North	Derris trifoliate	A climbing vine, Derris trifoliate, found in mangrove forests from Africa to Asia and onto the Pacific islands has leaves containing rotenone. This chemical is extracted and used to eliminate competitors in fish ponds. The plant is now also being studied by the biotech industry for other uses[87].
South to UK	Shark	Shark bile is being tested by industry in the U.K. as a possible cure for severe acne[88].
Amazon to North	d-tubocurarine	An Amazonian plant, d-tubocurarine, used sometimes as a poison, is being developed as a muscle-relaxant
Colombia to North	Plasmodium falciparum	Colombian researchers have developed a malaria vaccine derived from the parasite Plasmodium falciparum which has been tested on 30,000 Latin Americans and seems effective four out of five times. (Malaria causes 2 million deaths - mostly children - each year and afflicts more than 200 million people[89].
Costa Rica to private companies	plants	Merck signed a $1 million (over 2 years) deal with Costa Rica for bio-prospecting rights to one-third of the country's land area[90][91][92].
South to private company	plants	Monsanto has signed a multi-million dollar agreement with the Missouri Botanical Gardens for bio-prospecting throughout the Third World[93].
China to private company	plants	Syntex and a Hong Kong University are engaged in a joint venture to screen traditional Chinese medicines for active compounds that could be incorporated into new biotech products[94].
Mexico to private company	barbasco	Syntex acquired its enthusiasm for medicinal plants in Mexico where it took advantage of local knowledge to use barbasco roots to make steroid hormones ultimately used in birth-control pills[95].
South to Israel	plants	Scientists at the Boyko Institute in Israel are studying 150 species of salt-tolerant plants gathered around the world. Included in these are a number of medicinal plants that may offer special therapeutic compounds[96].
South to private company	Tomato	Kanebo Ltd. of Japan is developing a new drug for high-blood pressure based on a virus-infected tomato. The tomatoes are the "manufacturing plant" for the medicine[97].
Malaysia & Pacific to private company	micro-organisms	Smithkline-Beecham is searching for plants, marine organisms and micro-organisms in Malaysia and the Pacific[98].

South to private company	General	In 1991, Monsanto began to advertise in its in-house magazine for vacationing staffers travelling to exotic places to bring back interesting biological samples".

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Macrobiological Innovations of Indigenous Communities

A Sampling of Potentially "Patentable" Products or Processes under the WIPO/Unesco Model Law on Folklore.

Country/Region:	Crop:	Innovation:
Burkina Faso	Millet	A method of sexual reproduction by planting in holes with maize seeds.
Congo	Louboto tree	Because of very easy coppicing, a method of tree harvesting to produce strong, rot-resistant tools.
Congo	Paw-paw trees	A process for pruning treetops of males to change sex and lead to fruiting.
Congo	Safou	A method of "pole" cutting is virtually only means of propagation.
East Africa	Banana	A method of suppressing male inflorescence to draw nutrients to female flowers and increase banana size.
Egypt	Sycamore Fig	A method of pricking the fig with an oiled needle to accelerate ripening.
Ethiopia	Ensete	A method for vegetative propagation through suckers and a complex of surgical and soil-related techniques.
Ethiopia	Leucaena	A method by which nitrogen-fixing Leucaena branches are woven into living fences that keep animals in and also act as fodder.
Ghana/Ivory Coast	Yam	A method of pyramid planting using leaves and earth strengthening root system and protecting plant from high temperatures.
Madagascar	Ylang-Ylang flowers	A method of harvesting facilitated by pruning.
Niger	Euphorbia	A method of "pole" cutting used to raise important trees used to stabilize sand dunes and as firewood.
North Africa	Date Palm	A process for inducing hydric stress by encircling trees in low trenches of salt to encourage early fruit formation.
North Africa	Olive trees	A process for propagation in sandy soil using cuttings with broad bean seeds, barley seeds, and pine cuttings.
Zaire	Banana	A method of selecting suckers to maximize plant fruit productivity.
Zaire	Guava	A method of mound layering has tree cut to base and coppices buried in soil for months until transplanted as new trees.

Zaire	Paw-paw	A method of fixing the sex of plants through seed selection.
Zaire	Sweet Potato	A method of selecting suckers to maximize plant fruit productivity.
Congo/ Indonesia	Manihot	A method of positioning cuttings to determine fruit size. Some Manihot have "memory" that farmers must take into consideration.
Congo/ Indonesia	Terminalia	A process of top-pruning to stimulate lateral growth creating much-needed shade trees.
Indonesia/ Malaysia/ Guinea	Kopak tree, Angsana, Manihot	A process by which giant "pole" cuttings are used to form living hedges and shade on plantations or to protect family gardens.
Indonesia/ Reunion	Difficult to propagate woods	A process to propagate difficult wood cuttings by placing them close to banana plants.
Burma	Sugar palm	A method of planting to produce male or female palms as required.
Burma/India/ Indonesia	Sugar palm	A complex method of pruning and training inflorescence causing trees to increase sap yield.
China	Litchi	A method for storage in clay vases with a mix of litchis and Graminaea leaves in order to slow ripening and preserve fruit.
China	Paulownia, Kaki	A process for propagation via isolated root truncheons (Paulownia is a shade tree used in Chinese farming systems).
Gilbert & Ellice Islands	Dasheen (genus Cyrtosperma)	A method of cultivation using sand dunes between ocean and lagoon, fencing and water lentils.
Indonesia	Aubergine	A process of grafting to wild species of solanum to withstand hot and humid conditions.
Indonesia	Cinnamon	A method of mound-layering of similar style used with cinnamon trees.
Indonesia	Coffee/ Durian	A process known as the "Pankas System" prunes and fixes branches to earth where branches crawl along the ground.
Indonesia	Cucumber	A process of grafting to Labu air-vine to double fruit size.
Indonesia	Damar	A method of layering ends irregular fruiting cycle and increases productivity.
Indonesia	Damar tree	A process used by Lampung (Sumatra) villagers involving unique tree nurseries and growth inhibitors and storage of young seedlings (Damar resin is exported for paints to Japan and Europe).

Indonesia	Durian	A method of gashing to stimulate fructification.
Indonesia	Jackfruit	A method of applying large bags over fruit to fend off rats and attract ants that deter other bugs.
Indonesia	Jengkok, Langsat	A process to propagate legume trees by root suckers.
Indonesia	Langsat	A method of air-layering to reduce fruiting from 10-15 years to 1-5 years.
Indonesia	Manihot	A method of grafting arborescent manihot onto manihot tubers to give ten-fold yield increase ("Mukibat" system).
Indonesia	Rice	A method of employing Azolla (floating fern) as green manure to fix nitrogen, suppress weeds, reduces mosquito reproduction (in water) and increases rice yields from 10-40%.
Indonesia	Tropical fruits, Tea	A process for top-grafting old trees to replace poor producers with improved stock.
Indonesia/ Thailand	Tropical Fruit	A process for grafting of young trees taking a bud from crown of older tree and grafting onto seedling to reduce time it takes Durian to reach sexual maturity from 30 years to 4.
India/Pakistan	Mango/ Lemon	A method of increasing water stress by cutting irrigation to encourage early flowering.
Malaysia	Starfruit	A method of tree-bending (daily) when young, to facilitate harvesting and to control fruit quality (plastic bags).
Malaysia/ Indonesia	Jackfruit, etc.	A process for pruning to increase flowering regularity and (sometimes) inflorescence on trunk, significantly increasing productivity.
Malaysia/ Indonesia	Rubber	A method of farmer-induced abrasions and gashes on Hevea to increase latex production.
Malaysia/ Thailand	Oilpalm	A process for pollinating oilpalm where normal pollinators are not readily available by using rotted palm leaves and imported larvae (used also on Phuket Island, Thailand).
New Caledonia	Yam	A method of cultivation using moulds and humus, yielding unique shapes and lengths of 3 meters (competitions have stimulated local breeding).
Philippines	Jackfruit	A process to prevent attack from insects and rats, seed is planted at bottom of bamboo tube and Jackfruit actually matures safely underground. Farmers locate fruit by its smell.
Philippines	Mango	A process for smoking-out mangoes, accelerating flowering.

Southeast Asia	Tropical fruits	A process for grafting for early flowering - technique for plants normally difficult to graft.
Southeast Asia	Tropical fruits	A method of ringing either to stimulate vegetative growth or encourage photosynthesis by-products.
Southeast Asia	Tropical fruits	Fusion of seedlings of same age to speed flowering, increase vigour.
Vietnam	Citrus	A method using offal on trees to attract red ants and using string to connect trees to allow ants to move about, warding off butterflies and bugs that would harm the fruit.
Vietnam	Lucuma	A method of tree pruning with branches arched and fixed to the ground to shade fruit and protect from predators.
Vietnam	Mango	A method for pruning flowers used to prevent premature fruit dropping.
Vietnam	Rice	A method of sowing several varieties simultaneously to reduce fragility and accelerate growth.
Brazil/ Congo	Manihot	A process in which cuttings are laid horizontally in trenches and buried in soil to ward off insects and disease.
Costa Rica	Erythrina, Pochote	Chorotega people use method of fast-growing shade to fend off weeds, provide livestock shade, and pasture fencing.
Ecuador	Paw-paw	A method of "pole" cutting for fencing and shade achieve 100% success using traditional strategies.
Guadaloupe	Coconut	A method of applying iron shanks or nails in base of tree to encourage fructification.
Haiti	Breadfruit	A process for propagation via root cuttings laid in original positions until sprouting (about 2 months).
Haiti	Pigeon Pea	A method of sexual reproduction by planting in holes with maize seeds.
Haiti	Sweet Potato	A method of propagation through cuttings involving heaping and storage until wounds heal.
Nicaragua	Grape	A method of slanted planting after one-day water submersion to strengthen root system when transplanted.

Source: Aumeeruddy Y., and Pinglo, F. Phytopractices in Tropical Regions, A Preliminary Survey of Traditional Crop Improvement Techniques, UNESCO/Man and the Biosphere Programe, Institut de Botanique/Laboratoire de Botanique Tropicale, Montpellier, 1989; and other sources.

Isolates of Human Interest

Human Genome Diversity Project List of Targeted Indigenous Communities

Name of Group	Country/ or Region	Size of Population
Mbundu	Angola	3K
Iko	Botswana	2.5K
Central (Naron/GWI/ANA)	Botswana	8K
Kgalagadi	Botswana	50K
Kwena Molepolole	Botswana	100K
Ngwato	Botswana	200K
Ikung	Botswana/Namibia	15K
Khwe-Speaking "Blacks"	Botswana/Nambia	100K
Gurma	Burkina Faso	400K
Mossi	Burkina Faso	4M
Senufo	Burkina Faso	34K
Baka	Cameroon	15K
Mundang	Cameroon	100K
Korop	Cameroon	12.5K
Bamilike	Cameroon	200K
Bulu	Cameroon	174K
Chamba	Cameroon	70K
Mum	Cameroon	200K
Somrai	Cameroon	50K
Masa (Masana)	Cameroon/Chad	125-150K
Mandara (Wandala)	Cameroon/Nigeria	43K
Banda	CAR	1M
Mbati	CAR	15K
Ngando	CAR	2K
Aka	CAR/Congo	30K
Ngbaka	CAR/Congo	3K
Sara	Chad	50K
Daza	Chad	N/A
Moncha	Chad	

Merarit	Chad	42K
Mimi	Chad	15K
Kaka	Congo	70K
Nubian (Nobiin)	Egypt/Sudan	338K
Ari	Ethiopia	42K
Dime	Ethiopia	2K
Kunama	Ethiopia	70K
Tigre	Ethiopia	600K
Tsmai	Ethiopia	7K
Kafa (Bonga)	Ethiopia	200K
Ongota (Virelle)	Ethiopia	N/A
Suri	Ethiopia	15K
Berta	Ethiopia/E.Sudan	50K
Koma	Ethiopia/Sudan	1.5K
Fang	Gabon	170K
Duma	Gabon	10K
Bongo	Gabon	4K
Akan	Ghana	4.3K
Kissi	Guinea	.3M
Baga	Guinea	45K
Kru	Ivory Coast	27K
Turkana	Kenya	250K
Digo	Kenya	176K
Pokomo	Kenya	40K
El Molo	Kenya	200
Kipsigis	Kenya	500K
Luyia (Wanga)	Kenya	1.3K
Maasai (Laikipiak)	Kenya	30K
Maasai (Purko)	Kenya	60K
Mau Okek (Dorobo)	Kenya	20K
Mugogodo (Yaaku)	Kenya	6K
Orma (Boran)	Kenya	32K
Rendille	Kenya	21K

Sanye (Dahalo)	Kenya	2K
Antesaka	Madagascar	325K
Betsileo	Madagascar	736K
Sakalavia	Madagascar	360K
Nyanja (Chewa)	Malawi	1.6M
Yao	Malawi	600K
Dogon	Mali	500K
Tuaeg (Kel Kummer)	Mali	450
Tsonga	Mozambique	1.5M
Chwabo	Mozambique	.5M
Khoi Nama	Namibia	60K
Kwangaere	Namibia	31K
Ambo/Herero	Namibia/Botswana	70K
Bambara	Niger/Mali	1.5M
Songhai	Niger/Mali	500K
Bole (Bolewa)	Nigeria	32K
Hausa	Nigeria	28M
Birom	Nigeria	200K
Jarawa	Nigeria	1.5K
Tiv	Nigeria	1.5M
Igbo	Nigeria	12M
Ijo	Nigeria	70K
Kurama	Nigeria	11K
Yoruba	Nigeria	16M
Fulani	Nigeria & others	6M
Kanuri	Nigeria/Cameroon/ Chad	3.5M
Tutsi	Rwanda	.5M
Hutu	Rwanda/Burundi	5.5M
Xhosa	South Africa	5M
Wolof	Senegal	2M
Mandenka	Senegal/Gambia	762K
Somali	Somalia	8M
Azande (Zande)	Sudan	1.1M

Kaila	Sudan	22K
Beja	Sudan/Ethiopia	1M
Nuer	Sudan/Ethiopia	840K
Iramba/Sukuma	Tanzania	2.7M
Aramanik	Tanzania	500
Asa	Tanzania	N/A
Dorobo (Akie)	Tanzania	4.5K
Gog	Tanzania	1M
Hadza	Tanzania	200
Iraqw	Tanzania	338K
Maasai (Kisongo)	Tanzania	200K
Sandawe	Tanzania	70K
So (Napak, Moroto, Kadam)	Uganda	
Baganda	Uganda	2.4M
Ik	Uganda	5K
Sabaot (Mt. Elgon)	Uganda/Kenya	100K
Fur	W. Sudan	500K
Sakata	Zaire	75K
Bira	Zaire	100K
Kela	Zaire	180K
Lese	Zaire	35K
Mbuti	Zaire	45K
Mongo	Zaire	216K
Lele	Zaire	26K
Efe	Zaire	3K
Kongo	Zaire	1M
Luba	Zaire	7M
Bisa	Zambia	82K
Tonga	Zambia	1M
Luangwa (Twa)	Zambia	136K
Shona	Zimbabwe	2.8M
Mordva	Russia	340,000
Udmurts	Russia	

Komi	Russia	387,000
Mari	Russia	305,600
Tatars	Russia	6,000,000
Bashkirs	Russia	963,000
Chuvash	Russia	887,000
Yukaghir	Siberia	<100
Itelmen	Siberia	
Asian	Siberia	<500
Eskimos		
Udege	Siberia	
Nganasans	Siberia	<500
Oroch	Siberia	<600
Tofalars	Siberia	<100
Kets	Siberia	<500
Ulchi	Siberia	1,200
Selkup	Siberia	1,500
Enets	Siberia	<500
Mansi	Siberia	6,000
Chukchi	Siberia	10,000
Koryak	Siberia	6,000
Evenki	Siberia/China	25,000
Evens	Siberia	10,000
Buryant	Siberia/Mongolia	250,000
Tatar	Siberia	62,000
Altyans	Siberia/Mongolia	150,000
Yakut	Siberia	400,000
Shor	Siberia	15,000
Nenets	Siberia	15,000
Han	China	1B
Mongol	China	4.8M
Nanchu	China	9.8M
Qingzu	China	.2M
Yizu	China	6.6M

Tibetan	China	4.6M
Uygur	China	7.2M
Gelo	China	.4M
Miaozu	China	7.4M
Taozu	China	2.1M
Lizu[illegible]	China	1.1M
Zhuangzu	China	15.5M
Vaca	China	
Saisiat	Taiwan	3K
Tsou	Taiwan	4.5K
Puyuma	Taiwan	6K
Rukai	Taiwan	6K
Yami	Taiwan	3K
Atakal	Taiwan	60K
Ami	Taiwan	120K
Bunen	Taiwan	40K
Paivan	Taiwan	40K
Khalkha	Mongol	
Dorbet	Mongol	
Bayat	Mongol	
Dariganga	Mongol	
Oolet	Mongol	
Torguut	Mongol	
Darkhat	Mongol	
Mingat	Mongol	
North Korea	Korea	
South Korea	Korea	
Cheju Island	Korea	
Ainu	Japan	15K
Ryukyan	Japan	
Wajin	Japan	
Kashmiri Pandits	Kashmir	100,000
Dogras	Jammu	> 100,000

Kulu Rajputs	Himalchal Pradesh	> 50,000
Kinner Kanets		
Ramgarhias	Punjab	100,000
Sansis	Haryana/Rajasthan	large pop.
Jats	Haryana	Millions
Bhatias	Alwar District of Rajasthan	20,000
Rajputs (Jaiselmer)	Rajasthan	200,000
Rabaris	Rajasthan	200,000
Lohanas	Gujrat	80,000
Audich	Gujrat	200,000
Chitpavan Brahmans	Maharashtra	12,000
Mahars	Maharashtra	50,000
Lahan-Chake Kumhars	Maharashtra	30,000
Coorgis	Karnataka	300,000
Gawda	Goa	95,000
Namboodri	Kerala	100,000
Nairs	Kerala	200,000
Lyengar	Tamil Nadu	100,000
Vellalas	Tamil Nadu	300,000
Kalans	Tamil Nadu	100,000
Kammas	Andhra Pradesh	500,000
Reddis		
Chamars	Uttar Pradesh	300,000
Rastogis	Uttar Pradesh	100,000
Brahman		
Kayasthas	West Bengal	10,000
Thakurs	Bihar	500,000
Sarguja Brahmans	Madhya Pradesh	50,000
Aggarwals	Madhya Pradesh	100,000
Kalitas	Assam	200,000
Rajbansis	Assam	50,000
Syrian Christians	Kerala	100,000
Anglo-Indians	West Bengal	100,000

Cochin Jews	Kerala (Cochin)	800
Parsees (Zorostrians)	Gujrat	100,000
Moplas (Muslims)	Laccadives	100,000
Dawoodi Bohras	Rajasthan	10,000
Ahmediyas	Kashmir	100,000
Meos ...	Haryana/Rajasthan	1M
Ladakhis	Kashmir	12,000
Tibetan Refugees	Himalchal Pradesh	10,000
Oswal (Jains)	Rajasthan	70,000
Siddis	Gujrat Karnataka	15,000
Greater Andamanese	Andaman Islands	28
Onge	Andaman Islands	98
Shompen	Nicobar Islands	135
Khasi	Meghalia	45,000
Ho	Bihar	50,000
Savras	Orissa	6,000
Korku	Maharashtra	70,000
Lahauli	Himalchal Pradesh	3,000
Bhotia	Uttar Pradesh	35,000
Lepcha	West Bengal	15,000
Sherdukben	Arunachal Pradesh	1,500
Toto	West Bengal	700
Kachari	Assam	80,000
Naga	Nagaland	
Riang	Tripura	70,000
Kadar	Kerala	1,500
Kota	Tamil Nadu	600
Toda	Tamil Nadu	900
Chenchu	Andhra Pradesh	30,000
Koya Dora	Andhra Pradesh	300,000
Man Kidiya	Orissa	200
Baiga	Madhya Pradesh	15,000
Katkari	Maharashtra	200,000

Cholanaikayan	Kerala	300
Gaddi	Himalchal Pradesh	50,000
Bhil	Gujrat	1,500
Dards (Baluchistan	Pakistan	Unknown
Lodha Rajputs (Sindh)	Pakistan	Unknown
Hunza	Pakistan	Unknown
Gilgitese	Pakistan	Unknown
Pakhtoons	Pakistan	Millions
Kjojas (Punjab)	Pakistan	Unknown
Chittagong Buddhists	Bangladesh	
Chakmas	Bangladesh	
Bhutanese	Bhutan	
Maldivese	Maldives	
Newar	Nepal	500,000
Raute	Nepal	200
Sherpa	Nepal	15,000
Gurung	Nepal	100,000
Magar (Tarali)	Nepal	1,000
Chhetri (Thakuri)	Nepal	thousands or millions
Tamang	Nepal	700,000
Brahman	Nepal	thousands or millions
	Nepal	10,000
Tharus	Nepal	600,000
Chepang	Nepal	5,000
Veddah	Sri Lanka	10,000
Sinhalese	Sri Lanka	Millions
Easter Island	Nuclear Polynesia	1,500
Tuamoto Arch.	Nuclear Polynesian	6,000
Ni'Hau	Native Hawaiian	
Rapa	Austral Islands	400
Kapingamarangi	Outlier Polynesian	900
Pukapuka	Northern Cooks	750

Tikopia	Solomon Islands	1,800
Ontong Java	Solomon Islands	1,100
Mangaia	Nuclear Polynesian	3,000
Tonga	Polynesia	90,000
Yap	Micronesia	5,000
Ponapean	Nuclear Micronesian	17,500
Ulithian	Nuclear Micronesian	1,100
Truk	Nuclear Micronesian	22,000
Kiribati/Marshalls	Nuclear Micronesian	
Lau	East. Fiji	Unknown
Fiji	Vanua Levu	
Rotuma	Fiji	7,000
Mare Island	New Caledonia	3,700
New Caledonia	New Caledonia	700
Ureparapara	Banks Islands/Vanuatu	160
Toga	Torres Isl./ Vanuatu	150
Tanna	South Vanuatu	10,000
Espiritu Santo		
Nendo	Santa Cruz/ Solomon Islands	3,000
Kwaio	Malaita	7,000
Nissan Isl.	Papua New Guinea	3,000
Bilua	Vella Lavella Isl. Solomons	4,300
Rotokas	North Bougainville	5,500
Siwai	South Bougainville	6,600
Tolai	New Britain	100,000
Baining	New Britain	5,000
Sulka	New Britain	1,100
Taulil	New Britain	400
Wasi Inland	New Britain	500
Anem	New Britain	500
Bola	Willaumez Penin.	5,000
Arawe		4,200

Kuot	New Ireland	900
Emira-Musau		3,600
Tenis	Tench Island	80
Lihir		5,000
Wuvulu-Aua		850
Ninigo		450
Manus Tru	Admiralty Isl.	2,200
Amphlett/Gumasi	New Guinea	250
Trobriand Islanders	New Guinea	14,000
Rossel Island/Yele	New Guinea	2,000
Misima Island	New Guinea	7,000
Maisin	New Guinea	1,700
Binindere	New Guinea	3,300
Guhu-Samane	New Guinea	6,000
Moto	New Guinea	14,000
Wanigela/Kori	New Guinea	3,000
Mailu	New Guinea	7,000
Porome	New Guinea	600
Ivori/Lohiki	New Guinea	1,200
Uaripi	New Guinea	2,500
Mpale	New Guinea	3,000
Wana Anga	New Guinea	32,000
Wantoat	New Guinea	7,000
Adzera	New Guinea	24,000
Wopkaimin	New Guinea	500
Gogodala	New Guinea	7,000
Fasu	New Guinea	750
Kaulili	New Guinea	1,000
Pawaia	New Guinea	3,000
Yuri	New Guinea	740
Kwomtari	New Guinea	800
Oksapmin	New Guinea	6,700
Mianmin	New Guinea	2,200

Abau	New Guinea	4,000
Amto	New Guinea	200
Krisa	New Guinea	350
Lake Chambri	New Guinea	3,000
Urim	New Guinea	2,300
Abelam	New Guinea	33,000
Kairaru	New Guinea	2,800
Waigeo Island	New Guinea	4,000
Vogelkop Peninsula	New Guinea	
Asmat	New Guinea	22,000
Grand Valley Dani	New Guinea	75,000
North Boazi	New Guinea	3,000
Marind	New Guinea	8,000
Sentani	New Guinea	11,000
Kalumburu	Australia	
Mowanjum	Australia	
Arnhem Land	Australia	
Hooker Creek	Australia	
Yuendumu	Australia	
Warrabri	Australia	
Doomadgee	Australia	
Mornington Island	Australia	
Groote Eylandt	Australia	
Cape York	Australia	
Torres Strait Islands	Australia	
Tasmania	Australia	
Chaudor	Turkemenia	
Goeklen	Turkemenia	
Kurdish Jews	Kurdistan	
Yazidi	Syria/Iraq	8,000
Ybykh	Turkey	1-3
Salubbi	Saudi Arabia	
Zabidis	Yemen	

Nuba	North Sudan	444,258
Mountain Berbers	North Africa	
Tuareg	North Africa	25,000
Teda/Daza	Chad	382,000
Siva Oasis	Egypt	30,000
Beja	E. Sudan	1,000,000
Nubians	S. Egypt/Sudan	
Saidi Egyptians	Upper Egypt	8,000,000
Coptic	North Egypt	4,000,000
Bedouin/Najdi	Arabian Penn.	
Yemeni	Yemen	10,000,000
Armenians	Turkey	40,000
Druze-Golan Heights	Lebanon/Syria	3,900,000
Ottoman Turks	Central Turkey	46,278,000
Shi'ite Arabs	S. Iraq/Basra	
Sunni Arabs	Central Iraq	
Persians-Qum	Iran	
Jewish Peoples - Israel	Israel	
Georgians	Sthwst Asia	4,000,000
Circassia	Russia/Turkey	180,000
Dargva	Pakistan	287,000
Turkmen	Turkmenistan	2,028,000
Uzbek	Uzbekistan	15,000,000
Kazakh	Kazakhstan	6,556,000
Tajik	Tajikstan	4,000,000
Afgans-Pushto	Afghan/Pakistan	7,390,000
Burusho	North Pakistan	60,000
Brahui	Pakistan	1,500,000
Nehali	India	75,000
Regeibat	Mauritania	
Moroccans	Coastal Morocco	
Algerians	Coastal Algeria	22,008,000
Sidi	Algeria	

Kabyles	Eastern Algeria	2,000,000
Shawiya	Eastern Algeria	150,000
Tukulor	Mauritania/N. Senegal	
Tunisian Berbers	Tunisia	
Chaamba	Algeria	
Wanama	Tunisia	
Wefusa	Coastal Libya	
Kufra	SE Libya	
Sanusi	NE Libya	
Dakhla	Egypt	
Kharga	S.Central Egypt	
Egyptians	Egypt Delta region	
Kabablish	Central Sudan	
Hadendava	E. Sudan	30,000
Soqotri	Yemen	
Alawis	Syria	
Madan	Middle East	
Chaldeans	Iraq	130,000
Mehri	Saudi Arabia	
Marsusi	Saudi Arabia	
Botahara	Eastern Arabia	
Shhauri	Eastern Arabia	
Jebbali	Eastern Arabia	
Bahreinis	Eastern Arabia	
Qataris	Eastern Arabia	
Ashkun	Afghanistan	7,000
Kalasha	Afghanistan	10,000
Kati	Aghanistan	5,000
Tregami	Afghanistan	
Wasi-Veri	Aghanistan	2,000
Bashkir	W. Turkic	
Kumyk	Turkey	189,000
Tatar	Turkey	thousands

Baraba	Turkey	
Karachay	Turkey	
Karaim	Turkey	
Khinalug	Western Turkic	
Khirghiz	Western Turkic	
Osseces		
Jebaliah		
Samaritans	Israel/Palistine	480
Assyrians	N. Israel	77,375
Island Jerba	Tunisia	
Mashad	Iran	
Catalan	Spain	
Nile populations	Egypt	
Kara-Kalpaks	Uzbekistan	
Yasidis	Iraq/Syria	
Tihama Arabs	Saudi Arabia/Yemen	
Israelis	Israel	
Timbuktu	Mali	
Cairo	Egypt	
Jerusalem	Isreal	
Fez	Morocco	
Marrakech	Morocco	
Tunis	Tunisia	
Sfax	Tunisia	
Algiers	Algeria	
Alexandria	Eygpt	
Khartoum	Sudan	
Bahrain	Bahrain	
Damascus	Syria	
Basra	Iraq	
Isfahan	Iran	
Yazd	Iran	
Konya	Turkey	

Istanbul	Turkey	
Samarkand	Uzbekistan	
Khiva	Uzbekistan	
Bokhara	Uzbekistan	
Fargana	Uzbekistan	
Dorasque	Panama	<50
Huetar	Costa Rica	500
Terraba	Costa Rica	35-300
Rama	Nicaragua	700
Paya	Honduras	600
Jicaque	Honduras	1,000
Lacandon	Mexico	
Seri	Mexico	600
Diegueno	USA/Mexico	400
Cocopa	USA	400
Madi	USA	200
Pomo	USA	1,000
Shasta	USA	200
Hupa	USA	1,100
Plains Apache	USA	1,000
Yuchis	USA	600
Chiwere	USA	
Wyandot	USA	1,500
Miami-Peoria-Illinois	USA	800
Sac & Fox	USA	
Pawnee	USA	2,000
Kansa (Kaw)	USA	300
Delaware	USA/Canada	600
Alabamas	USA	600
Koasatis	USA	400
Tunica-Biloxi-Ofo	USA	100
Kutenai	USA	1,500
Mandan	USA	400

Hidatsa	USA	1,200
Arikaras	USA	1,000
Naskapi	Canada	750
Athna	Canada	600
Bear Lake	Canada	350
Beaver	Canada	800
Han	Canada	250
Hare	Canada	600
Ingalik	Canada	600
Kaska	Canada	525
Kolchan	Canada	150
Mountain	Canada	175
Nabesna	Canada	300
Nashini	Canada	600
Sekani	Canada	450
Tahltan	Canada	700
Tanaina	Canada	900
Tanana	Canada	525
Tutchone	Canada	950
Sarcee	Canada	600
Winnebago	USA	3,500
Micmac	Canada/USA	11,000
Cayugas	USA	3,000
Onondagas	USA	1,500
Osage	USA	2,500
Wichitcha	USA	750
Caddo	USA	1,800
Comanche	USA	6,000
Shawnees	USA	2,000
Muskoke Creeks	USA	30,000
Cerokees	USA	70,000
Kiowas	USA	6,000
Choctaws/Chickasaws	USA	40,000

Mikasukis	USA	1,200
Houmas	USA	
Catawbas	USA	500
Cahuilla	USA	800
Luiseno	USA	1,500
Karok	USA	4,000
Yokuts	USA	500
Shoshone	USA	7,000
Ute	USA	5,000
Paiute	USA	4,000
Hopi	USA	4,857
Zuni	USA	5,020
W. Keresan (Acoma)	USA	2,861
E. Keresan (Santa Ana)	USA	472
Tanaon, Towa (Jemex)	USA	1,765
Tanoan, Tewa	USA	1,487
(San Juan)	USA	1,623
Tanoan, Tiwa	USA	200,000
Navajo	USA	
Ramah Navajo	USA	12,000
Western Apache	USA	2,000
Jicarilla	USA	2,000
Mescalero	USA	2,000
Chirichahua	USA	1,500
Havasupai	USA	
Tobono'Otam (Papago)	USA	
Pima	Mexico	
Pima Bajo	Mexico	
Tarahumara (Raramuri)	Mexico	
Tepehuan	Mexico	
Huichol	Mexico	
Yaqui	Mexico	
Mayo	Canada	

Siksika	USA/Canada	3,500
Assiniboin		3,200
Stoneys		
Yanktons		
Yanktonais	USA/Canada	20,000
Teton (Lakota)	USA/Canada	23,000
Dakotas	USA	5,000
Cheyennes	USA	5,000
Arapahos	Canada	
Aleuts	Canada	
Inuits	USA	3,000
Pacific Yupik		1,300
Caribou Eskimo		1,200
Netsilik Eskimo		1,000
Ungava Bay	Canada	2,000
Haida	Canada	1,000
Haisla	Canada	10,000
Tlingit	Canada	4,000
Nass-Gitsan	Guatemala	31,500
Chorti	Guatemala	
Quiche	Guatemala	
Mam	Mexico	
Tzotzil	Mexico	
Mixtec	Mexico	
Zapotec	Mexico	
Tlaxcala	Mexico	
Guerrero	Mexico	
Tarascos	Mexico	
Huastec	Mexico	
Totonac	Mexico	
Otomi	Columbia	8,000
Embera	Columbia/Panama	
Waunana	Nicaragua/Honduras	

Sumo	Caribbean	
Miskito	Honduras	5,000
Lenca	Honduras	
Black Caribs-Garifuna	Canada/USA	>200,000
Garifuna		
Metis		
Mexican-Americans		
Kuna	Panama	
Guaymi	Costa Rica	
Guaymi	Panama	
Teribe	Panama	
Teribe X Guaymi	Panama	
Bribri	Costa Rica	
Cabecar	Costa Rica	
Huetar	Costa Rica	
Rae Dogribs	Canada	2,400
Ottowa-Ojibwa	Canada/USA	
Nuu-Chah-Nulth	Canada	3,500
Bella Coola	Canada	700
Penobscots	Canada	1,800
Bar	Venezuela/Colombia	1,800
Yukpa	Colombia/Venezuela	4-5,000
Choc	Panama/Colombia	20,000
Warao	Orinoco delta	30,000
Guahibo	South Am	3,000
Yaruro	South Am	4,000
Piaroa	South Am	3,000
Ye'cuana	South Am	3-4,000
Wayana	South Am	<1,000
Waiwai	South Am	1,000
Akuriyo	South Am	<50
Yanomama	Venezuela/Brazil	20,000
Witoto	Colombia	5-6,000

Tukanoan	Brazil/Columbia	11,000
Iuana	South Am	1-2,000
Arawak speakers	Columbia	7,000
Maku	NW Amazonas	2,200
Ticuna	Amazon	15,000
Waorani	Ecuador	1,000
Jivaroans	South Am	66,600
Marubo	Peru/Brazil	5-600
Amahuaca, Yaminahua	Peru/Brazil	1,400
Amarakaeri	SE Peru	500
Ashaninka	Peru	20,000
Machiguenga	South Am	6-8,000
Piro	South Am	1,500-2,000
Yuqui	Bolivia	150
Ayooreo	Bolivia	2,200
Ache	South Am	350
Bororo	South Am	800
Pakaas Novos	South Am	1,000
Monde	South Am	1,500
Rikbaktsa	South Am	<500
Kuikuro	South Am	270
Mehinaku	South Am	120
Txico	South Am	146
Karajas	South Am	2,200
Kaiapo	South Am	2,500
Mentuktire	South Am	350
Xavante	South Am	4,000
Kraho	South Am	900
Maranhao-Tupians	South Am	750
Waiapi	Guiana/Brazil	300
Munduruku	South Am	1,500
Satere' Mawe'	South Am	3,000
Wapishana	Brazil/F. Guiana/ Venezuela	5,000

Macushi	Brazil/F. Guiana/ Venezuela	15,000
Colorado	Ecuador	1,800
Cayapa	Ecuador	5,000
Paez	South Am	40,000
Kaingang	South Am	10,000
Guarani	Paraguay/Brazil	3,000,000
Non-Quechua	Ecuador	6,000,000
Quechua	Ecuador	2,000,000
Aymara	Ecuador	2,000,000
Q'ero, Songo Cuy Paratia, Matapuquio, Chuito, Kallawaya, others	South Am	
Uru-Shipaya	Bolivia	400
Mapuche	Chile/Argentina	400,000
Alacaluf	Chile	50
Ona/Yahgan	South Am	6-8
Tehuelche	Argentina	24
Chaco	South Am	
Ayoreo	Paraguay	1,500
Chulupi	Paraguay/Argentina	12,000
Toba	South Am	2,000
Lengua	South Am	4,000
Mataco	Argentina	21,400
Chamacoco	South Am	1,500

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Endod: A Case Study of the Use of African Indigenous Knowledge to Address Global Health and Environmental Problems

This issue of *RAFI Communique* takes a look at the transfer of a Third World technology to address a First World problem: the potential use of a traditional African plant, Endod, to control the infestation of zebra mussels in North American waters. The story of Endod offers a fascinating case study in the application (and obstacles) to the use of a Third World technology to address global health and environmental problems.

The U.S.-based University of Toledo has applied for a patent on the use of Endod to control zebra mussels, but royalties will not go to the plant's original "proprietors"--the Ethiopian people who have selected and cultivated Endod for centuries. Nonetheless, if demand is created for Endod in the industrialized world, will Ethiopian people benefit from their botanical treasure?

Endod (*Phytolacca dodecandra*), commonly known as the African soapberry plant, is a perennial that has been selected and cultivated for centuries in many parts of Africa, where its berries are used as a laundry soap and shampoo. Endod is synonymous with "soap" in many African countries. People of the Ethiopian highlands, for instance, use Endod berries to launder their traditional *shamas*, the glistening white shawls characteristic of the region. The fish-killing property of Endod is also well known and, traditionally, people in rural communities use Endod as an intoxicant to collect edible fish.

Endod to Control Schistosomiasis

In 1964, while conducting field work in his native Ethiopia, biologist Aklilu Lemma observed that downstream from where people were washing clothes with the soapberry plant, dead snails were found floating in the water. After several years of intense research, Dr. Lemma discovered that the sun-dried and crushed Endod berries were lethal to all major species of snails--but not harmful to animals or humans, and completely biodegradable.

For Africa, where one of the most serious tropical diseases, schistosomiasis, is transmitted by freshwater snails, the discovery of a low-cost and biodegradable snail-killing agent (molluscicide) represents a major breakthrough. According to the World Health Organization (WHO), schistosomiasis, a debilitating and eventually fatal disease, is endemic in 76 countries in tropical Africa, Asia and Latin America. Only malaria causes more sickness and debility in the developing world. Over 600 million people are at risk of infection and another 200 million infected. Some 200,000 deaths per year are due to schistosomiasis.

Although chemical molluscicides are available to eliminate the parasite-carrying snails that transmit schistosomiasis, the cost is prohibitive. A chemical molluscicide called *Bayluscide*, manufactured by the Bayer Co. of Germany, sells for US $25,000-30,000 per ton. Despite the fact that this expensive

International Office: Suite 504, 71 Bank St., Ottawa, Ontario K1P 5N2 CANADA Tel: 1-613-567-6880 Fax: 1-613-567-6884 E-Mail (Web): Web:rafican
RAFI-USA: P.O. Box 655, Pittsboro, North Carolina 27312, USA Tel 1-919-542-1396 Fax 1-919-542-2460 E-Mail (Econet): Econet:rafiusa
RAFI-Australia: 4 Ocean Parade, Cooee Bay, Queensland 4703, AUSTRALIA Tel: 61-79-394792 E-Mail (Pegasus): Peg:rafiaus

chemical compound is out-of-reach for many developing nations, it is the only molluscicide currently recommended by the World Health Organization for global use.

Over the past 29 years Dr. Lemma's goal has been to develop Endod as a safe, low-cost alternative to expensive chemical molluscicides. Early field trials in one Ethiopian village showed remarkable success. Using locally-collected Endod to kill target snails, transmission of schistosomiasis was reduced from 63% to 33% in the overall population. Among children, the infection rate fell from 50% to 7%. In addition to effectively controlling disease-carrying snails, Dr. Lemma views Endod as a traditional African plant that can be developed as a capacity-building technology by and for African communities. In the words of Dr. Lemma:

"Through the development and use of simple, appropriate agronomic techniques and extraction and application procedures, people could easily grow, process locally and use Endod products to control schistosomiasis on a community self-help basis."

With suppport from international donors, Endod has been the subject of agrobotanical and extraction studies in Ethiopia, Zambia, Swaziland and Zimbabwe. These countries have undertaken research on large-scale cultivation of Endod, processing and distribution of the plant extract for the dual purposes of producing a locally-available molluscicide, and as a detergent for village-level use. In Ethiopia, with support from the Netherlands government, over 500 varieties of Ethiopian soapberry plants were collected under the direction of Dr. Legesse Wolde-Yohannes of the Addis Ababa University. Sixty-five varieties of Endod were cultivated, and 3 selected for their exceptionally high molluscicidal potency and high berry yields. One variety, E-44, was identified as the most promising candidate for molluscicidal properties, and has since been cultivated on an experimental basis. With support from the International Development Research Centre (IDRC) of Canada, extensive toxicity studies of Endod have also been undertaken.

Unfortunately, Dr. Lemma's 29-year quest to see Endod widely used in Africa has been repeatedly stalled by international regulatory obstacles. Despite rigorous toxicological studies performed by Lemma over the course of two decades, the World Health Organization disregarded Lemma's research (and the traditional wisdom of people who have used Endod for centuries), insisting that the scientific analysis conducted in Ethiopia be repeated under standardized "Good Laboratory Practices" by internationally-recognized institutions. Reflecting on lessons learned from his long struggle to overcome obstacles to widespread acceptance of Endod, Dr Lemma observes:

"We have learned the hard way that the root problems of scientific research in Africa are not only the lack of adequate facilities and funds, but also the biases and reservations of some individuals and organizations in industrialized countries who find it difficult to accept that any good science can come from our part of the world... Also, except for occasional lip service, little credit is given to the wisdom of traditional societies in their ability to select, over long periods of time, such natural products as Endod for their continued and demonstrably safe use."

Much needed and well-deserved support came to Dr. Lemma in 1989 when he and his colleague, Dr. Legesse Wolde-Yohannes, were recipients of the Right Livelihood Award. The "alternative Nobel prize" was awarded them for discovering a natural molluscicide and devising a community-based method of employing it against the snails that carry the schistosomiasis parasite. At long last, WHO plans large-scale field tests of Endod in Africa later in 1993. If successful, Endod may someday become widely available for the dual purposes of providing a molluscicide to control the spread of schistosomiasis, and as a detergent for village-level use.

Endod to Control Zebra Mussels--A New Use for a Traditional African Plant

In addition to the use of Endod to control the spread of a tropical disease afflicting millions of people in the Third World, the traditional African soapberry plant promises to become one of the most effective means of preventing zebra mussels from clogging water intake pipes in North American waters. In other words, a Third World technology comes to the rescue of industrialized nations. Ironically, the need to de-clog mussel-infested water pipes may seem petty in comparison to the value of controlling schistosomiasis, but the economic incentives for controlling zebra mussels are enormous.

The black and white striped zebra mussel (*Dreissena polymorpha*) is native to western Russia near the Caspian Sea. Zebra mussels were accidentally introduced into the Great Lakes in 1985, and have rapidly spread throughout the region. The zebra mussels are disrupting municipal water facilities because they restrict water flow by attaching themselves to pipes and other hard surfaces. In addition, they are a serious threat to fisheries because the mussels cover rocks in spawning areas, and remove algae (a source of nutrients) from the water. Municipal water plants and ship owners already spend millions to rid their pipes of zebra mussels. The U.S. Fish and Wildlife Service estimated in 1990 that the zebra mussel would create a $2 billion loss to fisheries by the end of the decade. Nobody knows for sure how much damage the zebra mussels will cause, but the potential damage is far greater now that the mussels have spread into inland waterways.

The discovery that Endod is lethal to the zebra mussel came about when Dr. Aklilu Lemma visited the United States in June, 1990 to receive an honorary degree from the University of Toledo. Lemma and his U.S. colleague, biologist Harold Lee, raised the question in casual conversation, and then tested it in the laboratory. The result: Endod is lethal to adult zebra mussels after 4-8 hours of exposure, and is biodegradable within 24 hours. Safety of Endod has been evaluated by a consortium of laboratories in Canada, the Netherlands, Denmark, Ethiopia and in the USA.

Patent Pending

In October, 1990, just a few months after Lee and Lemma first exposed zebra mussels to the Endod powder in the laboratory, the University of Toledo applied for a U.S. patent on the use of Endod to control zebra mussels. If a commercial product is developed in the future, the University of Toledo will share 50% of the royalties with the "inventors", Drs. Harold Lee and Peter Fraleigh of the University of Toledo, and Dr. Aklilu Lemma, who is presently working with the United Nations Children's Fund (UNICEF) in Uganda. According to Dr. Lee, several companies have expressed interest in developing a commercial Endod product to control zebra mussels, but he would not reveal their identities because negotiations are still in early stages.

The application for a U.S. patent on Endod raises many questions about the true "ownership" of Endod and the "discovery" of this traditional African plant as a control for zebra mussels. This legal claim ignores centuries of indigenous knowledge of Ethiopian people who have cultivated and selected Endod for centuries, using it not only as a detergent and shampoo, but as a fish intoxicant. If an Endod-based molluscicide is commercialized, the University of Toledo and three scientists stand to benefit from royalties, but there is no guarantee that the plant's true proprietors, the Ethiopian people, will be justly rewarded.

What Benefit for Ethiopia?

If Endod is commercially developed as a molluscicide to control zebra mussels, there would be immediate demand for large quantities of Endod berries. For example, scientists at the University of Toledo estimate that treating a 100 million-gallon water treatment system at 5 parts per million for 8 hours would require about 170,000 gallons of crude Endod extract. Rather than using Endod in open waters, specialized reactor systems containing the Endod extract would be placed at the entrance to water intake pipes.

According to Dr. Harold Lee of the University of Toledo, it is possible, but not economically feasible to produce small quantities of the mussel-killing Endod toxin in the laboratory using a technique known as "biosynthesis." However, laboratory biosynthesis of Endod is far too expensive, and tremendous quantities of the product will be needed for commercial use. Lee says that researchers in the U.S. have made an "informal agreement" to buy raw materials of Endod directly from Ethiopian sources.

Ideally, a new and substantial export market could be created in Ethiopia for Endod as a raw material or processed product. The most potent variety of Endod, the Ethiopian variety E-44, has already been cultivated on a large-scale by Ethiopian researchers, yielding approximately 1.5 metric tons per hectare of the berries. Under optimum conditions, there can be two harvests of berries annually. The outcome remains to be seen. Hopefully, Endod will become a positive example of a sustainable technology for both First World problems and Third World development.

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New and Controversial Developments in Intellectual Property

Agracetus Inc. (Middleton, Wisconsin, USA), a subsidiary of W.R. Grace and Co., has received a broad-based patent covering all genetically-engineered cotton products. The unusually broad scope of coverage is unprecedented in plant biotechnology and "may be an indication of how major corporations can use biotech patents to get proprietary control of huge segments of agriculture" (*AgBiotechnology News, December 1992*). Because it was first to develop transgenic cotton, Agracetus claims rights to any and all transgenic cotton, regardless of which engineering technique is used. All transgenic cotton products will have to be licensed through Agracetus before they can enter the marketplace.

Another broad-based patent was recently granted to Plant Genetic Systems (PGS) of Belgium. The U.S. Patent covers many plants and seeds genetically engineered with *Bacillus thuringiensis* (Bt) genes. According to PGS, it was the first to demonstrate that Bt genes could be engineered into plants and, accordingly, any company that genetically engineers Bt into most plant crops will need to negotiate a licensing agreement with PGS (*AgBiotechnology News, February 1993*).

RAFI COMMUNIQUE

RURAL ADVANCEMENT FUND INTERNATIONAL

FEBRUARY, 1987

Biotechnology and Natural Sweeteners

THAUMATIN

> <u>ISSUE</u>: The use of biotechnology to produce the intensely sweet thaumatin protein
> <u>PLANT</u>: Thaumatin is derived from the fruit of a West African rain forest shrub
> <u>COUNTRIES AFFECTED</u>: Product will be marketed as a low-calorie sweetener in Europe, Japan and U.S.
> <u>IMPACT</u>: In combination with other newly developed sweeteners, these products offer the potential to erode traditional sugar markets
> <u>WHEN</u>: A genetically-engineered thaumatin sweetener is now being produced in the laboratory; one company will apply for U.S. regulatory approval in 1988-89
> <u>COMPANIES INVOLVED</u>: Unilever (The Netherlands); INGENE for Beatrice Foods (USA); (unconfirmed: DNA Plant Technology, Inc. for Monsanto, USA)

Biotechnology is now being used to develop new, natural sweeteners from plants. One of the most promising natural sweeteners, the protein thaumatin, is extracted from the fruit of a West African plant, <u>Thaumatococcus daniellii</u>. Thaumatin is generally recognized as the sweetest substance known to man--about 100,000 times sweeter than sugar. The thaumatin plant originates throughout central and southwestern Africa where its fruits have been used for centuries as a sweetener.

The traditional method of extracting the intensely sweet protein from the thaumatin plant is labor intensive and extremely expensive. Tate & Lyle, a major producer of refined sugar based in Britain, markets a naturally-extracted thaumatin sweetener under the trade name "Talin." Since the thaumatin plant will not bear fruit outside of its natural habitat, Tate & Lyle's thaumatin comes from plants grown in

□ RR1 (Beresford), Brandon, Manitoba, R7A 5Y1, CANADA / 204-483-3955 / TELEX # 7601055RAFIUC
□ P.O. Box 1029, Pittsboro, North Carolina 27312, USA / 919-542-5292

the Ivory Coast and Ghana. The ripe fruit is frozen and then transported to the United Kingdom where the company extracts and purifies the thaumatin protein.[2] The end product, Talin, reportedly sells for upwards of $1000 per lb.[3]

Talin is currently sold as a low-calorie sweetener in Japan, the United Kingdom, Austria and Switzerland, and is under consideration for approval in various other countries. In the U.S., where regulatory approval for new sweeteners is especially lengthy, Talin has only been approved for use in chewing gum.

Biotechnology and Thaumatin

Several major corporations and small biotechnology firms in the United States and Europe are now attempting to use recombinant DNA technology (genetic engineering) to produce thaumatin protein in the laboratory. In 1985-86, the intensely-sweet thaumatin protein was successfully cloned by scientists at Unilever (the Netherlands) and Ingene (Santa Monica, California, USA).[5] According to Bioprocessing Technology, "if researchers can increase the yields to economical levels, production in microorganisms will give thaumatin a competitive edge over other natural sweeteners."[6]

Genetically-engineered thaumatin products will be marketed primarily as a low-calorie sweetener. Because of the extreme sweetness of the protein, it can be used in miniscule amounts with virtually no caloric content. Since the product has a licorice-like aftertaste, its application as a sweetener may be limited to certain products and uses.[7]

The following companies are actively pursuing research to develop a thaumatin sweetener via biotechnology:

INGENE (International Genetic Engineering, Inc.) of Santa Monica, California (USA), has been working on the development of a genetically-engineered thaumatin protein since 1982 under contract to Beatrice Foods (Chicago, Illinois, USA). INGENE holds a patent on the regulatory genetic sequences it developed to produce the thaumatin protein. The company plans to apply for U.S. regulatory approval of a thaumatin sweetener as early as 1988-89.[8]

UNILEVER, a multinational giant based in the Netherlands and Britain, was the first company to express genes for the protein thaumatin in microbial hosts.

DNA Plant Technology Corporation of Cinnaminson, New Jersey (USA) recently announced a new research agreement with Monsanto Corporation (St. Louis, Missouri, USA) "to develop plant varieties that will act as sources of naturally ocurring sweeteners" using cell culture technology.[9] The company refuses to discuss details of the research agreement, and will neither confirm nor deny specific interest in thaumatin.[10]

For more information on these companies, see box, "Corporate Profiles."

New Sweeteners Displace Sugar Market

Biotechnology offers the potential to displace sugar[11] as an industrial sweetener on a massive scale. The substitution of other sweeteners is already underway. In recent years, the introduction of high fructose corn syrup (HFCS--a sweetener manufactured from corn using immobilized enzymes) has seriously eroded traditional sugar markets.

U.S. consumption of HFCS grew from 1.35 million tons in 1978 to 4.3 million tons in 1984, while U.S. sugar imports dropped from 6.1 million tons in 1977 to 1.5 million tons in 1985-86.[12]

The use of sugar substitutes has had a devastating impact on sugar producing countries in the Third World. Carribean sugar exports to the U.S., for example, dropped from $686 million in 1981 to about $250 million in 1985. In the Philippines, sugar export revenues plunged by 39% from 1980 to 1984. According to Dutch researchers, the livelihood of an estimated 8 to 10 million people in the Third World is threatened by the loss of traditional sugar markets and the drop in world sugar prices.[13]

Conclusion

If the thaumatin protein can be economically produced using recombinant DNA technology, thaumatin could capture a substantial share of the sweetener market, particularly for low-calorie sweeteners in the U.S., Europe and Japan. (In the U.S. alone,the sweetener market is now worth $8 billion,[14] of which $900 million is low-calorie sweeteners.)

If commercially successful, the thaumatin sweetener will not single-handedly displace traditional markets for sugar. However, thaumatin is only one of several plants which produce naturally-occurring, sweet-tasting compounds. These plants and other sweetener sources will undoubtedly be the focus of further biotechnology research. The development of a thaumatin product via biotechnology is just the beginning of a transition to alternative sweeteners. New products of biotechnology will lead to the massive displacement of Third World sugar markets in the coming years.

* * * * * *

Biotechnology research is also underway on the following, lesser-known plants which are sources of natural sweeteners:

Stevia rebaudiana - A plant cultivated in Japan, Paraguay and other Asian countries which contains substances up to 300 times sweeter than sugar. Japanese and U.S.-based companies are seeking to produce a stevia sweetener.

Lippia dulcis - A natural sweetener (hernandulcin) derived from this plant is approximately 1000 times sweeter than sugar.

(For more information on these and other new sweeteners, refer to "Natural Sweeteners Find Specialized Niches in Low-Calorie Sweetener Market" in Bioprocessing Technology, August, 1986 and "Demand for Low-Cal Foods Invites New Sweetener Options" in Prepared Foods, August, 1986.)

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5 Bioprocessing Technology, July, 1986, p. 2.
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11 "Is Biotechnology a Blessing for the Less Developed Nations?", by Martin Kenney in Monthly Review, April, 1983, p.13.
12 "Product Substitution Through Biotechnology: Impact on the Third World" in Trends in Biotechnology, April, 1986, p.88.
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BEATRICE FOODS, Chicago, Illinois, USA, is a major food and consumer product corporation, with 1985 annual sales of (US) $12.6 billion. The company ranks # 26 on the *Fortune* 500.

DNA PLANT TECHNOLOGY CORPORATION, Cinnaminson, New Jersey, USA, is a small biotechnology firm founded in 1981. The publicly-held company specializes in cell culture technology and has numerous research contracts with major corporations working on products such as oil palm, tomatoes, coffee, cocoa, fragrances and flavors.

INGENE, Santa Monica, California, USA, is a small biotechnology firm formed in 1981 which focuses on genetic engineering to develop pharmaceutical, specialty chemical and food products. Research on thaumatin is the company's largest effort in the area of food additives. INGENE became publicly held in mid-1986.

MONSANTO, St. Louis, Missouri, USA, is a major agrichemical corporation with 1985 annual sales of (US) $6.7 billion, ranking # 53 on the *Fortune* 500. Approximately one-third of the company's 1985 research budget of $400 million was designated for biotechnology projects.

TATE & LYLE, Reading, England, is a major producer of refined sugar. With 1985 annual sales of $2 billion, the company ranks # 247 on *Fortune's* list of the International 500. The company is not working on a genetically-engineered thaumatin product, but is conducting research on enzymes to produce alternative sweeteners.

UNILEVER, headquartered in Rotterdam, the Netherlands and London, England, is one of the world's largest producers of consumer goods. The company ranks # 18 on *Fortune's* list of the world's largest industrial corporations, with 1985 annual sales of (US) $21 billion.

RAFI COMMUNIQUE

RURAL ADVANCEMENT FOUNDATION INTERNATIONAL

May, 1993

Patents, Indigenous Peoples, and Human Genetic Diversity

Issue: The Human Genome Diversity Project, an informal consortium of universities and scientists in North America and Europe, has launched a campaign to take blood, tissue and hair samples from hundreds of so-called "endangered" and unique human communities scattered over the globe. The Project is supported by the U.S. government's National Institute of Health, and linked to the multinational, multi-billion dollar initiative to map the human genetic structure known as HUGO--the Human Genome Organization.

Impact: The sampling of human genetic material for scientific research, as currently being discussed by the Human Genome Diversity Project, has serious implications for indigenous peoples. Products and processes extracted from the collected material could have enormous commercial value. The material itself may be patentable even without further research. Will profits be made from the genes of poor people whose physical survival is in question? Who will have access to stored genetic material, and where will these collections be located? What benefits, if any, will accrue to the indigenous peoples from whom DNA samples will be taken?

When: The Project's initial five-year effort to collect human DNA samples from a minimum of 400 indigenous communities will cost between (US) $23 million and $35 million. Some participating scientists have already begun collection work, but the full project will get underway in late 1993 or 1994.

Introduction

Earlier this year, RAFI received a copy of the draft proceedings of the second Human Genome Diversity Workshop held at Pennsylvania State University (State College, Pennsylvania, USA) October 29-31, 1992, along with a preliminary list of 722 human communities targeted for DNA sampling. Some participating scientists have already begun human DNA collection work along the biblical Nile, in northern Chile, and in parts of Southeast Asia. The Project's formal campaign, however, may not be launched until late 1993 or 1994.

This issue of RAFI Communique provides an analysis of the draft report and numerous concerns surrounding the Human Genome Diversity Project's plans to collect human DNA samples from indigenous communities around the world.

Human Genetic Erosion

It is a tragic fact that many indigenous groups are in danger of becoming extinct. Ninety of Brazil's 270 indigenous communities, for example, have met extinction since 1900. More than two-thirds of the remaining 180 communities have less than 1,000 surviving members.

The economic opportunity to collect--and the push to preserve--human genetic diversity has been fired by the development of new biotechnologies and the formation of HUGO. Medical science has long been aware that there is not just one human genetic map. Each ethnic community may have a slightly different genetic composition. Some of the differences and mutations could someday prove to be invaluable to medicine.

The Human Genome Diversity Project estimates that an initial five year sweep of relatively accessible populations will cost between $23 million and $35 million and will allow sampling from 10,000-15,000 human specimens. At an average total cost of (US) $2300 per sample, the project will spend more money gathering the blood of indigenous peoples than the per capita GNP of any of the world's poorest 110 countries.

White blood cells from each person will be preserved in vitro at the Ame ican Type Culture Collection in Rockville, Maryland (USA). The human tissue (scraped from the cheek) and hair root sampling will be used in shorter-term studies. The project's leaders, concerned that human blood can only survive 48 hours outside of storage, are planning their collections carefully. "*One person can bleed 50 people and get to the airport in one day*," they calculate.

Among those targeted for DNA sampling are the Yukaghir of Siberia (about 100 people remaining in the group), the Dorasque of Panama (50 remaining), the Amazon's Akuriyo (50 survivors), Asian communities such as the Salsiat of Taiwan, Somalis in the famine-laden Horn of Africa, and the Deleware and Sarcee of North America (each numbering around 600). Although the list is incomplete, the current roster stands at about 722 indigenous communities more or less equally divided between the continents:

Indigenous Communities
Targeted for DNA Collection

Africa	165
Asia	212
South America	114
Oceania	101
North America	107
Europe	23
TOTAL:	722

Project organizers stress that the list is incomplete and deficient in several areas including Southeast Asia and West Africa.

Control, Ownership and Access to Genetic Resources: Parallels between Plant Germplasm and Human Germplasm

Many of RAFI's concerns about collection of human genetic diversity stem from similar controversies related to the collection and storage of plant genetic diversity over the past two decades. Key issues relating to control, ownership and access to plant genetic resources include:

- the balance between in situ and ex situ plant germplasm collections;
- the location and ownership of ex situ (gene bank) collections;
- intellectual property rights over plant genetic resources.

The experience of Third World countries has been that scientists in industrialized countries have collected farmers' crop varieties for gene bank storage in the North. More than 90% of all the plant germplasm collected in the South in the last two decades has ended up in gene banks in Europe and North America. This material has been incorporated into Northern breeding programmes and has yielded billions of dollars of value to farmers and agribusiness in the industrialized world.

With the passage of new intellectual property laws in the North, virtually all of the collected material is either directly or indirectly patentable. This is cause for considerable consternation among Third World governments and has ultimately led to the creation of the Commission on Plant Genetic Resources, an International Undertaking on Plant Genetic Resources, and the International Code of Conduct for Plant Germplasm Collecting and Transfer at the United Nations' Food and Agriculture Organization (FAO). Many of the provisions in the Convention on Biological Diversity adopted at the UN's "Earth Summit" last June also address (albeit imperfectly) issues related to control and ownership of genetic resources, particularly with regard to indigenous people.

Preservation Versus Conservation

In the context of international efforts to collect and conserve plant genetic resources, the working assumption is that local communities have the right to maintain their own plant material and the world community has an obligation to help them conserve and develop these invaluable resources. There is no assumption that the material is destined for extinction. Conservation and use of genetic resources must be carried out as a process for "development" rather than a last ditch drive for "preservation."

In the draft report of the Human Genome Diversity Project, "preservation" is the dominant theme, and there is an assumption that many or most of the human populations are inevitably going to disappear. The project's emphasis on preservation and its insensitivity to indigenous peoples is best exhibited by the term they use to describe indigenous communities that have been targeted for human DNA sampling: "Isolates of Historic Interest" (IHIs).

Nevertheless, the project organizers are clearly sensitive to criticism and aware that their planned activities could cause some dismay among indigenous peoples. The draft report notes:

> *"...the establishment of permanent cell lines needs to be explained in terms that are understandable, but that do not mislead subjects in any population. English terms such as "immortalization" of cell lines can be badly misunderstood...Similarly, there is no fully acceptable way to refer to populations that are in danger of physical extinction or of disruption as integral genetic units (gene pools)...In this Report, we refer to such groups as "Isolates of Historic Interest" (IHI's), because they represent groups that should be sampled before they disappear as integral units so that their role in human history can be preserved."*

The Project is also aware that indigenous communities have rights, that the discovery of HIV-positive groups requires some action on the Project's part, and that there is such an issue as Prior Informed Consent. *"The population itself must demonstrably be provided a full level of informed consent,"* the draft states, *"Religious or other cultural concerns must be protected."*

Intellectual Property Rights

The report makes no reference to intellectual property issues, ignoring the fact that products or processes derived from the collected cell lines could be patented in the United States. The patenting of plants and animals is already a controversial topic worldwide. The patenting of human genetic material is far more controversial--especially if a corporation or government holding a patent stands to earn royalties from products derived from the genes of poor people whose physical survival is in question.

In the United States, the patenting of human genetic material is well underway. Blood samples collected by the Human Genome Diversity Project will be stored at the American Type Culture Collection, outside of Washington, D.C. (USA). A database search conducted by RAFI reveals that, as of November, 1992, the American Type Culture Collection held 1,094 human cell line entries. More than one-third of these are identified as being the subject of patent applications.

It is important to note that financial backing for the Human Genome Project comes from the U.S. government's National Institute of Health (NIH). In 1991, the NIH applied for patents on more than 2,800 genes and DNA fragments found in the human brain. The patent applications, denied by the U.S. Patent Office in 1992, were particularly controversial because the NIH scientists filing for the patents had no idea what function the gene sequences played in the human body. Despite the rejection of its patent claims, the NIH asserts that it will re-apply for patents on human gene sequences in the future.

The potential profit to be rendered from indigenous germplasm was brought home to pharmaceutical corporations earlier this year when Genetic Engineering News reported on the discovery that thirty citizens of Limone, an isolated Italian community, are carriers of a unique gene that codes against cardiovascular disease. Swedish and Swiss pharmaceutical companies, as well as the University of Milan, have since swarmed over the townspeople, taking blood and other samples, and applying for patents. Scientists have isolated the mutant gene and cloned the protein. If the gene can be turned into a marketable drug--and this remains a very big "if"-- the profits could be tremendous.

Will indigenous people have a share in such profits? Are the Human Genome Diversity Project managers aware of the need to bring some benefit to the people sampled?

Storage Location of Human DNA Samples

The draft summary report of the Human Genome Diversity Project discusses the need to provide laboratory facilities and training at national and regional levels in developing countries. They also stress the importance of basic health care for indigenous communities, conceding that it would be some time before indigenous peoples would find much value in genetic screening services. In closing, the Project commented:

"The study of the human genome, including elucidating its diversity, should not detract, in any way, from the need to address the health problems of the Third World, the bulk of which could be solved by the wide-scale application of knowledge already available; what is needed is the will to do so and the commitment of adequate resources."

However, the project members also expressed a need to impose some conditions to their aid: *"A condition for establishing such labs, however, would have to be that they cooperate on an open basis with investigators interested in their region."* In other words, the Project and its donors will require full access to all samples and duplicate storage in industrialized countries. There is little doubt that, as currently envisaged, the major human "gene bank" would be located in the United States.

Foreign Aid Diversion

Despite the clearly stated intention of the Human Genome Diversity Project's draft report, it is almost inevitable that foreign aid funds designated for Third World countries will be diverted to this project. The U.S. Agency for International Development, for example, could well decide that the construction of facilities and training to support the Human Genome Diversity Project--should come from foreign aid budgets. There is danger of this happening because the scientific and commercial pressure to establish the Project exceeds the pressure of developing countries to set their own aid agendas with donors. Monies that might have been used to provide poor communities with access to clean water, vaccinations, or more immediately-useful public health programs, will be diverted to this Project unless a transparent and conscious effort is made to prevent this from happening.

Biological Warfare Risk

Finances permitting, the Human Genome Diversity Project proposes to leave a duplicate sample of the DNA of each indigenous community with their national government. Failing that, samples would be left with regional institutions. Given the fragility of blood samples coming from remote areas (living samples are only viable for 48 hrs. outside of storage), the Project must depend on support from laboratory facilities at the national or regional level. According to the draft report, money will also be set aside for local training on how to handle cryogenic human material (freezing and storing of blood samples in liquid nitrogen for long-term preservation).

However, the draft report of the Human Genome Diversity Project makes no reference to the potential danger arising from the fact that knowledge of an indigenous communities' unique genetic make-up makes it theoretically possible for unscrupulous parties to devise cheap and targeted biological weapons effective against specific human communities. However distasteful or technologically remote this suggestion may appear, human rights violations against indigenous peoples, by their own governments and/or other governments within their region, is a major cause of their "physical extinction." Internationally, experimentation with biological warfare is by no means an isolated incident. In a world of rapidly changing technological possibilities, the potential of using human cell lines for biological warfare cannot be ignored.

Will the six indigenous communities in Iraq, destined for "immortality" in the capital of Baghdad, have any notion of how their cell lines (exposing their full DNA) could be used in biological warfare? What of the eight groups in Amazonian Brazil or the six populations in war-threatened Uzbekistan?

Most indigenous peoples--now seeking their own seat at the United Nations--would be no happier knowing that their DNA samples are in national or regional hands than in the hands of the U.S. government.

Next Steps?

RAFI has provided information and analysis of the Human Genome Diversity Project to the World Council of Indigenous Peoples, Survival International, and Third World Network, as well as to its regional partners: CLADES in Latin America, SEARICE in Asia, Seeds of Survival in Africa, GRAIN in Europe, and ACFOA in Australia. RAFI has also sent its report to many development and human rights agencies and to the Faith community. RAFI's Executive Director, Pat Mooney, addressed a mid-April meeting of the Pan-American Health Organization (PAHO) with indigenous peoples. The issue will also be presented at the UN Human Rights Conference in Vienna in June, 1993.

These steps were taken only after RAFI wrote to the Human Genome Diversity Project, expressing grave concerns about the implications of their plans for indigenous peoples. In its letter of 6 April 1993, RAFI suggests the following measures:

1. The Human Genome Diversity Project should immediately halt any collection efforts and advise any parties it is in contact with to do likewise;

2. The Project should then convene a meeting with the World Council of Indigenous Peoples, Survival International and other major international and regional organizations of indigenous peoples, to discuss the best mechanisms for addressing these issues.

3. The minimal conclusion to be reached would be that organizations of indigenous peoples would participate fully in every aspect of the Project and would have the equivalent of veto power over any aspect of the Project.

4. Together with indigenous peoples organizations, the Human Genome Diversity Project should take the project to the United Nations' Conference on Human Rights scheduled for Vienna this June in order to have the issues fully discussed by the international community.

5. Depending on the outcome of the above activities, RAFI and other parties engaged in plant genetic resources conservation and development activities would be pleased to work with indigenous peoples and the Project in a joint effort to conserve and develop genetic diversity.

As of mid-May, the Project's organizers have not responded to RAFI's letter of 6 April. With only a month to go before the UN Human Rights Conference, RAFI has determined that it must make its research public.

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