

Occasional Paper Series

Vol. 1, No. 1, March 1994

The Benefits of Biodiversity:

100+ Examples of the Contribution by Indigenous & Rural Communities in the South to Development in the North

Synopsis: There is slow, but growing recognition worldwide that agricultural and medicinal plant species - nurtured, selected and bred over millennia by farmers and healers from the South - have yielded, and continue to yield, benefits to industry in the North.

Similarly, there is growing recognition that the knowledge of indigenous peoples worldwide has contributed enormously to the seed and pharmaceutical industries of the North.

But little concrete evidence is available to illustrate the commercial value of Southern plants, and indigenous knowledge.

In this paper, RAFI has compiled data from dozens of scientific and trade journals, to give an insight into the enormous contribution made by the South to the wellbeing of Northern citizens and/or the economic benefit of Northern corporations.

The Rural Advancement Foundation International (RAFI) is an international non-governmental organization which conducts research on agricultural biodiversity, biotechnology, and intellectual property. RAFI Occasional Papers are published irregularly, to disseminate RAFI research and work-in-progress, and they are available from all RAFI offices. We encourage readers to copy and distribute our material, and request only that RAFI be credited when RAFI publications are used.

COST Per Issue: U.S.\$10, Canadian \$12, Australian \$12

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RAFI has compiled the following list of more than 100 instances where genetic resources and/or local knowledge from the South have made - or are making - a contribution to agriculture, food processing, or pharmaceutical development in the North. In some cases, research is at the exploratory stage and its commercial significance is not known. The South may also benefit from this research. The following table should not be regarded as a roster of all benefits from all parts of the world to all parts of the world; it is an incomplete list of proven or potential contributions made by the South to the North.

CG SYSTEM:		
Country/Region to ...	Species:	Discussion:
South (CIMMYT) to USA	Wheat	In 1984, 34% 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. 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.
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.
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 \$126 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.
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.
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. The U.S. crop is estimated to be worth at least \$1.1 billion each year.
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..

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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
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.
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.
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.
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.
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.
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.

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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).
LATIN AMERICA		
Country/Region to ...	Species:	Discussion:
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. The U.S. crop is valued at more than \$10 billion per annum.
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.
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. (The global seed tuber market is estimated at \$8.5 billion.)
Peru to USA	Tomato	Two wild tomatoes gathered in the Peruvian Andes contribute \$5 million per annum to U.S. processors. (The global market for tomatoes is \$3.5 billion of which more than \$1 billion is in the United States.)
Galapagos Islands to private companies	Tomato	A wild tomato from the Galapagos Islands sporting a jointless fruit stalk is worth millions of dollars a year to the mechanized tomato harvest in the USA.
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.
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

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		losses caused by 100 strains of nematodes are estimated at \$6 billion per year in the United States and \$75 billion worldwide.)
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.
Brazil to private companies	Fungus	Brazilian researchers have discovered a fungus in the Humicoia 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.
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.
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.
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.
Country/Region to...	Medicinals:	Discussion:
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.
Latin America & Africa to private company	General	Glaxo's Natural Products Discovery Department is looking for medicinal plants in Latin America and Africa.
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.
Mexico to North	albahaca de monte (ocinum micranthum), pepeltun (cissampelos pareira)	Mexican scientists and companies are examining albahaca de monte (ocinum micranthum), pepeltun (cissampelos pareira), and la altaniza (parthenium hysterophorus) for their curative properties. Each plant has a long history in traditional medicine.

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	and la altaniza (parthenium hysterophorus)	
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.
Latin America to North	Tecoma	Another Latin American plant used in traditional medicine, Tecoma, is now being studied for its potential use against diabetes.
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.
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.
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. 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.
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.
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.
Brazil to North	Muiria Pauma	Muiria 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.
Jamaica to North	Sponge	A Jamaican sponge has become the source of patented antiviral and anticancer drugs.
Brazil to North	Cephatis ipecacuana	Roots of Cephatis ipecacuana, a medicinal plant in Brazil, are being developed to treat dysentery.
Brazil to private company	tikluba	The tikluba plant, long used by the Ure-eu-Wau-Wau community of the Brazilian Amazon is currently being developed by Merck as an anti-coagulant.
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	Colombian researchers have developed a malaria

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	falciparum	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.
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.
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.
AFRICA		
Country/Region to ...	Species:	Discussion:
Ethiopia to USA	Barley	Farmer-derived Ethiopian barley is worth \$150 million in the United States each year. The annual value of the American crop is more than \$670 million.
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.
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.
North Africa to Canada	Oats	North African farmers saved the Canadian oat crop from disaster in the Seventies.
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.
Ethiopia to USA	Sorghum	Sorghum from Ethiopia is worth \$12 million a year to U.S. growers Annual value of the crop in the United States is above \$1 billion.
East Africa to Australia	Bovines	Australian breeders recently introduced East African cattle breeds in order to improve the local stock.
West Africa to USA	Bovines	West-African-bred N'Dama cattle have been 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.
Africa to Europe,	Bovines	Other African breeds have made a major contribution

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North America		to U.S. and European herds through increased disease resistance and other qualities such as short-horns.
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 antigens. 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.
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.
West Africa to U.S. universities and private companies	Thaumatococcus	The University of California and Lucky Biotech have applied for patent rights over genetically-engineered thaumatococcus sweetener in industrialized countries and in West Africa. The plant has long been used as a sweetener in Africa.
Country/Region to...	Medicinals:	Discussion:
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.
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 Friesian 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.
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.
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

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		Madagascar any more. (The leukemia drug has turned a cancer that used to kill 8 out of 10 victims into one where 8 of 10 children survive.)
ASIA		
Country/Region to ...	Species:	Discussion:
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.
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.
Turkey to USA	Wheat	A wheat sample from Turkey is valued at \$50 million per annum in the U.S. Northwest.
Afghanistan & Saudi Arabia to North	Lucerne (Alfalfa)	Lucerne variety AWPX3 traces its origins to genetic contributions from nine countries including Saudi Arabia and Afghanistan.
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.
Korea to USA	Soybeans	Soybeans from Korea are worth \$100-\$500 million to U.S. farmers annually. The crop is valued at more than \$11 billion a year in the U.S.A..
Nepal to UK	Brown Mustard	Nepal has donated the genes necessary to increase the pungency in born mustard grown in Britain.
China to UK	Cherry	Cherry germplasm provided by Chinese farmers saved the British industry some years ago.
Philippines to USA	Tomato	A tomato collected in the Philippine uplands has been used to breed cold tolerance into U.S. tomatoes.
India, Korea, and Burma to USA	Cucumber	U.S. cucumbers depend upon germplasm from India, Korea, and Burma
Iraq, Peru to North America	Pea	Iraqi and Peruvian farmers have joined forces to provide disease-resistant pea strains to North America.
India, Iran, and Manchuria to USA	Spinach	The California spinach crop owes its survival to farmers in Iran, Manchuria, and India. The crop is valued at well over \$300 million per annum in the United States.
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.

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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.
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.
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. (If successful, the market value will be in the hundreds of millions per annum.)
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.
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.
Country/Region to...	Medicinals:	Discussion:
Near 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.
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.
Indonesia to private companies	<u>convululaceae</u>	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, <u>convululaceae</u>) for its ability to arrest the proliferation of HIV in infected mice. The tree is used for a range of health problems in Indonesia.

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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.
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.
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.
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.
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.
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.
Malaysia & Pacific to private company	micro-organisms	Smithkline-Beecham is searching for plants, marine organisms and micro-organisms in Malaysia and the Pacific.
GENERAL		
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.
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.

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		crop could rise to 15% or higher within a few decades.
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.
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.
Country/Region to...	Medicinals:	Discussion:
South to North	<u>Derris trifoliata</u>	A climbing vine, <u>Derris trifoliata</u> , 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.
South to UK	Shark	Shark bile is being tested by industry in the U.K. as a possible cure for severe acne.
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.
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.
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.

ENDNOTES

Dana G. Dalrymple, Development and Spread of High-Yielding Wheat Varieties in Developing Countries, US-AID, 1986, p.96.

Christine and Robert Prescott-Allen, The First Resource, Yale University Press, 1986, p.198.

Personal communication in conversation with members of the CIMMYT wheat breeding programme at CIMMYT in September, 1992

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- Personal communication with members of CIMMYT's maize breeding programme held at CIMMYT in September, 1992.*
- Dana G. Dalrymple, Development and Spread of High-Yielding Rice Varieties in Developing Countries, US-AID, 1986, p.115.*
- Christine and Robert Prescott-Allen, The First Resource, Yale University Press, 1986, p.198.*
- Dana G. Dalrymple, Development and Spread of High-Yielding Rice Varieties in Developing Countries, US-AID, 1986, p.115-116.*
- Hope Shand, RAFI Communiqué, "Rice", November, 1992.*
- Personal Communication from the Deputy Director-General of CIAT, February, 1992.*
- Nasrat Fadda, "An Introduction to ICARDA", Aleppo, 1991, p.26.*
- Nasrat Fadda, "An Introduction to ICARDA", Aleppo, 1991, p.27.*
- Hope Shand, RAFI Communiqué, "Potatoes", October, 1993.*
- Hope Shand, RAFI Communiqué, "Potatoes", October, 1993.*
- Hope Shand, RAFI Communiqué, "Potatoes", October, 1993.*
- Personal Communication from CGIAR officials as well as from an ILRAD staff member, Rome, 23 March, 1993.*
- UNEP, Saving Our Planet: Challenges and Hopes, Nairobi, 1992, p. 56.*
- Christine and Robert Prescott-Allen, The First Resource, Yale University Press, 1986, p.198.*
- Robert Cooke, "Gene Found to Cure Ancient Wheat Blight", New York Newsday, 23 October, 1992.*
- Agbiotechnology News: Orange Spud Found", December, 1992, p.12.*
- Agbiotechnology News, January, 1993, p.11.*
- Congress of the United States, Office of Technology Assessment, Technologies to Maintain Biological Diversity, 1987, p.4.*
- Jack Ralph Kloppenburg Jr., First The Seed Cambridge University Press, 1988, p. 168.*
- AgBiotechnology News, "Another Patent Challenge Against Flavr-Savr?", November, 1992, p.1 & 7.*
- Christine and Robert Prescott-Allen, The First Resource, Yale University Press, 1986, p.198.*
- Congress of the United States, Office of Technology Assessment, Technologies to Maintain Biological Diversity, 1987, p.53.*
- USDA, "The National Program for the Conservation of Crop Germ Plasm", U.S. Department of Agriculture, June, 1971, p.46.*
- Industrial Biotechnology, January, 1993, p.2.*
- Biotechnology Business News, 13 November, 1992, pages 1 & 13.*
- Personal communication from Camila Montecinos of CET/CLADES, Chile, 3 March, 1993.*

RAFI (Rural Advancement Foundation International)

The Global Research Agenda - A South-North Perspective, International Development Research Centre, Ottawa, 1990, p.9.

A.B. Cunningham, "Botanists, Brokers and Biodiversity", draft manuscript, November, 1992, p.5.

Mike Henley, "Healthcare: Colorado is home to many entrepreneurial medical device companies", Denver Business V 13 p.8(5) June-July, 1991.

"Scientists Study Validity of Medicinal Plants", Latin American Business News Wire, January 24, 1993, p.1.

Kathi Keville, "The Herbalist - Exploring South America's Medicinal Plants", Vegetarian Times, April 1987, p.46-50.

Kathi Keville, "The Herbalist - Exploring South America's Medicinal Plants", Vegetarian Times, April 1987, p.46-50.

Kathi Keville, "The Herbalist - Exploring South America's Medicinal Plants", Vegetarian Times, April 1987, p.46-50.

Bio/Technology, Vol.6, January, 1988, p.19.

Kathi Keville, "The Herbalist - Exploring South America's Medicinal Plants", Vegetarian Times, April 1987, p.46-50.

Kathi Keville, "The Herbalist - Exploring South America's Medicinal Plants", Vegetarian Times, April 1987, p.46-50.

From a speech by Dr. Jack Kloppenburg Jr. given in Ottawa on 15 October, 1987.

Kathi Keville, "The Herbalist - Exploring South America's Medicinal Plants", Vegetarian Times, April 1987, p.46-50.

Kathi Keville, "The Herbalist - Exploring South America's Medicinal Plants", Vegetarian Times, April 1987, p.46-50.

Congress of the United States, Office of Technology Assessment, Technologies to Maintain Biological Diversity, 1987, p.44.

Biotechnology News, November 5, 1992, p.6.

New Scientist, 19 October, 1991.

"Merck needs more gold from the white coats", Business Week, March 18, 1991, p.102 reports that Proscar, Vasotec and Mevacor are top sellers for Merck, for example.

Michael C. Jensen, The Financiers, Weybright and Talley, 1976, p.30.

Jack Ralph Kloppenburg Jr., First The Seed, Cambridge University Press, 1988, p. 168.

Christine and Robert Prescott-Allen, The First Resource, Yale University Press, 1986, p.198.

"Seedling", ICDA Seeds Campaign (now GRAIN), October 1984, Amsterdam, p. 2.

J.W. Martens, from a speech given by Dr. Martens to the "Chemicals in Agriculture" Conference held in Saskatchewan, Canada in 1984.

Jack Ralph Kloppenburg Jr., First The Seed, Cambridge University Press, 1988, p.168.

Christine and Robert Prescott-Allen, The First Resource, Yale University Press, 1986, p.198.

Jean Christie of RAFI, work in progress.

RAFI (Rural Advancement Foundation International)

Hope Shand, RAFI, work in progress based on information from the American Minor Breeds Conservancy.

Congress of the United States, Office of Technology Assessment, Technologies to Maintain Biological Diversity, 1987, p.53.

European Biotechnology Newsletter, 26 June, 1992, p.1-2.

Industrial Bioprocessing, January, 1993, p.7 and DIALOG McGraw-Hill 647 database.

Hope Shand of RAFI, work in progress, March, 1993.

Jean Christie, RAFI, 18 March, 1993.

"Nigeria: Commerce Threatens State Forest Reserves", Inter Press Service, March 25, 1993.

Angela Stafford and Michael W. Fowler, "Plant Cell Culture and Product Opportunities", March/April, 1991, p.11.

John Naisbitt, "The Medicinal Miracles of Mother Nature", Inside Guide, November, 1992, p.13.

C.W. Schaller, "Utilizing Genetic Diversity on the Improvement of Barley Cultivars", California Agriculture, September, 1977, pp.i

Jack Ralph Kloppenburg Jr., First The Seed, Cambridge University Press, 1988, p.168-167.

USDA, "The National Program for the Conservation of Crop Germ Plasm", U.S. Department of Agriculture, June, 1971, p.42.

IBPGR, "Biodiversity and Plant Genetic Resources", CGIAR Fact Sheets, June, 1992.

Jack Ralph Kloppenburg Jr., First The Seed, Cambridge University Press, 1988, p. 168-9.

Christine and Robert Prescott-Allen, The First Resource, Yale University Press, 1986, p.198.

Pat Roy Mooney, The Law of the Seed, Development Dialogue, 1983:1-2, p.12.

Pat Roy Mooney, The Law of the Seed, Development Dialogue, 1983:1-2, p.12.

USDA, "The National Program for the Conservation of Crop Germ Plasm", U.S. Department of Agriculture, June, 1971, p.47.

USDA, "The National Program for the Conservation of Crop Germ Plasm", U.S. Department of Agriculture, June, 1971, p.52.

USDA, "The National Program for the Conservation of Crop Germ Plasm", U.S. Department of Agriculture, June, 1971, p.56.

Christine and Robert Prescott-Allen, The First Resource, Yale University Press, 1986, p.200.

Agbiotechnology News, January, 1993, p.12.

AgBiotechnology News, February, 1993, p.4.

Hope Shand, RAFI, work in progress based on information from the American Minor Breeds Conservancy.

Industrial Bioprocessing, January, 1993, p.6.

Agricultural Information Development Bulletin.

Royston M. Roberts, Serendipity: Accidental Discoveries in Science, New York: John Wiley & Sons, 1989, p.195-196.

RAFI (Rural Advancement Foundation International)

European Biotechnology Newsletter, 11 September, 1992, p.6.

Biotechnology Newswatch, July 6, 1992, p.14.

Reuters, "Samoan plant is tested as AIDS drug", Boston Globe, 25 August, 1992, p.12.

Genetic Technology News, December, 1992, p.13.

Chemistry & Industry, 2 September 1991.

Personal communication to Pat Mooney of RAFI in Ottawa in July, 1985.

Nature, Vol. 352, 25 July, 1991.

Development Forum, January/February, 1990.

A.B. Cunningham, "Botanists, Brokers and Biodiversity", draft manuscript, November, 1992, p.5.

IBPGR, "Biodiversity and Plant Genetic Resources", CGIAR Fact Sheets, June, 1992.

AgBiotechnology News, February, 1993, p.7.

"Is Monsanto 'burning money' in its biotech barn?", Business Week, September 2, 1991 p.74.

Agricultural Information Development Bulletin.

John Naisbitt, "The Medicinal Miracles of Mother Nature", Inside Guide, November, 1992, p.13.

New Scientist, 19 October, 1991.

AgBiotechnology News, February, 1993, p.14.

Kathy Heine, "Treasure in the Jungle", Monsanto Magazine, Issue #1, April 1991.