RAFI COMMUNIQUE

December, 1989

RURAL ADVANCEMENT FUND INTERNATIONAL

Introduction

Commercialization of agricultural biotechnology has lagged far behind developments in the field of human diagnostics and therapeutics. One reason has been insufficient knowledge about basic plant molecular biology and gene transfer techniques. This issue of *RAFI Communique* reports on three important developments in the field of plant biotechnology and the companies that control them. In the following pages we offer a brief look at the particle gun, RFLP technology, and a new breakthrough in the development of hybrid crops.

But first, RAFI provides a brief, year-end summary of selected RAFI activities.

During 1989, RAFI staffpersons have been active not only in research and writing related to biotechnology and genetic resources, but also as active participants in meetings and conferences around the world. What follows is brief summary of selected activities.

January -- RAFI assisted in the organization of--and spoke at--the SADCC Conference on Biotechnology and Plant Genetic Resources, co-sponsored with ENDA-Zimbabwe in Harrare. RAFI staffer Pat Mooney gave the keynote address at the Pesticides Action Network International Conference in Penang with IOCU. RAFI also spoke at the first statewide conference for biotechnology activists in California.

February -- RAFI spoke to the African Academy of Sciences/ICIPE Seminar in Nairobi where the concept of "Informal Innovation System" was introduced. RAFI also participated in the European Conference on Life Patenting, held in Brussels, organized by the ICDA Seeds Campaign (now GRAIN) and the Green Parties.

March -- RAFI provided a keynote speech at the Society for International Development conference on biotechnology held in Amsterdam. And in the United States, RAFI joined with other public interest NGOs to help form the Biotechnology Working Group.

April -- RAFI co-organized the Nordic Workshop on Biotechnology

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with its hosts, the Dag Hammarskjold Foundation. It brought together policy-makers and NGO's from Norway, Sweden, Finland and Denmark--including a variety of ministry heads from each country. RAFI also met with governments and NGOs in the UK, Belgium, Denmark, Norway, Austria, Italy and Switzerland and attended the Third Session of the FAO Commission on Plant Genetic Resources as observers.

June -- RAFI spoke at U.S. Department of Agriculture conference for state-level policymakers on social and economic impacts of biotechnology.

August -- RAFI participated on Working Group panel preparing for the second full round of the Keystone International Dialogue on Plant Genetic Resources (Leningrad) and visited NGO's in Sweden.

October -- RAFI met with the African National Congress in Lusaka and visited their farms. With the ANC, we discussed their participation in a seed-saving training programme in Ethiopia and in a Tanzanian conference in January, 1990.

November/December -- As part of its ongoing work on the USC African "Seeds of Survival" Programme, RAFI held meetings in Nairobi with the All Africa Conference of Churches to prepare for a workshop on biotechnology and plant genetic resources which will be held in Maputu, Mozambique in March, 1990.

We were also in Tanzania to discuss preparations for the first Tanzanian Conference on Biotechnology and Plant Genetic Resources which will be held in Arusha, January 16-20, 1990. We also discussed an upcoming conference on traditional medicine and medicinal plants which will be hosted by the Tanzanian Ministry of Health, February 19-23, in Arusha.

In Ethiopia, we joined with USC Canada in meetings with the Plant Genetic Resources Centre and in evaluating first-ever NGO training course on seed-saving. Plans were laid for further training sessions in June and October, 1990.

In Rome, we held meetings to plan a booklet with Genetic Resources Action International (GRAIN--formerly ICDA) and CROCEVIA; attended the biennial FAO Conference; met with other Seeds Action Network partners to plan for proposed conference in Bangkok next year.

In Geneva, we discussed Farmers' Rights with officials at Union for the Protection of New Plant Varieties (UPOV), World Intellectual Property Organization (WIPO), and General Agreement on Trade and Tariffs (GATT). We collaborated with the International Federation of Plantation and Agricultural Workers and laid plans for a 1990 workshop with the World Council of Churches. We also met with the United Nations Center for Trade and Development (UNCTAD) and Non-Governmental Liaison Service (NGLS) colleagues to discuss biotechnology and the Common Fund for Commodities.

In Vienna, RAFI discussed joint program work with IIZ, held staff meetings and began preparations for upcoming African workshops. RAFI was also in Norway to provide the resource people for a two-day workshop with the Development Fund and a special one-day seminar for NORAD and other agencies on plant genetic resources. We travelled on to Uppsala for discussions with the Dag Hammarskjold Foundation and other organizations.

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Particle Gun

ISSUE: The particle gun--a new tool for genetic engineering of plants.
IMPACT: Increased potential for successful transformation of major cereal crops.
PARTICIPANTS: Du Pont, Pioneer Hi- bred, Agracetus--among others.

In 1984, a team of Cornell University scientists invented the "particle gun"--a new instrument for implanting foreign genes into cells. Popularly known as "the bioblaster", the particle gun literally shoots tiny pellets coated with genes into the reproductive area of the cell. The seeds or tissue then grow into plants that exhibit the new trait and pass them on to succeeding generations.

Scientists predict that particle bombardment will become "one of the most useful techniques for genetic engineering of plants."[1] It is especially valuable because it overcomes limitations of other genetic engineering techniques.

Until recently, for example, many scientists used viruses to carry alien genes into plant cells cultured in the laboratory. This technique is used successfully in many broadleaf plants, but is not successful with most commercially important cereal grains (monocots) such as maize, wheat, rice, etc.

Another important advantage of the particle gun procedure is that it is capable of bombarding whole tissue instead of a single cell. This is significant because some plants are extremely difficult to regenerate from single cells. Typically, each "firing" sends three to four million gene-covered pellets into a plate of a million cells.[2]

In a very short time period, the particle gun has vastly expanded the potential for genetic engineering of major cereal crops. Using the particle gun, Agracetus Co. (a plant biotech company jointly owned by W.R. Grace chemical corporation and Cetus) became the first company to transfer genes into soybean plants in 1988.

Of all the major grains, maize is considered one of the most difficult to manipulate using genetic engineering. Several

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companies are using the particle gun in hopes of achieving fertile, genetically-transformed maize plants. The potential rewards are enormous. Agricultural Genetics Report explains:

> "...the genetic manipulation of corn has been the Holy Grail of plant biotechnology. Corn is the largest seed market in the U.S., with an annual U.S. market of $1.5 billion. Moreover, corn is a hybrid crop and thus must be purchased from the seed company every year; any proprietary traits introduced through genetic manipulation may thus be protected."[3]

Pioneer Hi-bred, the world's largest seed company, is one of the companies anxiously pursuing genetic engineering of maize. Pioneer has developed and patented their own particle gun. Pioneer spokesman Scott Erickson told Genetic Engineering News: "We could achieve transformation [of maize] next week or in a year."[4]

It is important to note that use of the particle gun is not limited to plants. **The apparatus has also been used for successful transformation of nematodes and other insects, yeast, algae, organelles and mammalian cells.**

Proprietary Rights

In May, 1989, the Du Pont agrichemical corporation acquired the patented particle gun invented by Cornell University scientists in exchange for $2.8 million in royalties and research support for the university. Du Pont now leases the only commercially available model of the particle gun for an initial fee of $19,000 (for university researchers) and $50,000 for industry. As of December, 1989, Du Pont has leased more than 50 particle guns. Du Pont intends to collect royalties on any genetically-engineered product resulting from the use of their particle gun.[5]

Not surprisingly, many companies are developing their own, slightly modified versions of Du Pont's particle gun. Both Agracetus and Pioneer have patents pending.

The particle gun has rapidly become an essential tool for plant molecular researchers. Virtually every agricultural biotechnology company has developed their own version of the particle gun, or is attempting to lease the apparatus from another company.[6] But the particle gun is still an expensive and complex instrument. Will high costs and proprietary rights limits its use by public sector researchers?

1 Wood, Marcia, "Blast Those Genes", Agricultural Research, June, 1989, p. 15.
2 Genetic Engineering News, November/December, 1989, p. 16.
3 Agricultural Genetics Report, August, 1989, p. 3.
4 Genetic Engineering News, November/December, 1989, p. 16.
5 Agricultural Biotechnology News, May/June, 1989, p. 27.
6 Conversation with Dr. Sean Gallagher, Hoefer Scientific Instruments, San Francisco, by telephone, December 11, 1989.

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New Hybrid Crops

ISSUE: Plant Genetic Systems (Belgium) announces discovery of pollen-inhibiting gene to create new hybrid crops via genetic engineering.
IMPACT: Hybridization may increase yields; will enhance seed industry profits and control.
CROPS AFFECTED: Rapeseed *(Brassica napus oleifera)* initially; future potential to use technique for hybridizing other major field crops (i.e. cotton, rice, wheat, soybean).
WHEN: Hybrid rapeseed now in development; other new hybrids not expected soon.

According to biotechnology and seed industry analysts, one of the most promising commercial opportunities in agricultural biotechnology today is the quest for new, hybrid crops. Hybridization of new crops is big business, capable of adding more value to seed sales than anything else.[1] The following comments by biotechnology industry representatives and seed industry analysts offer further insight:

> "One big factor which is exciting knowledgeable seedsmen is the potential to produce pure hybrids that will add 15-30% to yield in one stroke. The opportunity to hybridize a major field crop is one which seldom comes along in the seed business. It happened with corn, sorghum and sunflowers, but for most other field crops it either is still virtually impossible (soybeans) or is encountering difficulty in demonstrating sufficient yield benefit to overcome marginal seed production economics (wheat, cotton, rice). - James Castagno, Allelix, Inc.[2]

> "We'd like to turn rapeseed into a crop like corn. Hybrids would give us a chance to recoup our investment because farmers would have to buy seed every year." - Wallace Beversdorf, Allelix, Inc.[3]

> "Take a look at acreages. If you could change from a nonhybrid to a hybrid seed, you would have the basis for a commercial business. You could go from 50-percent-purchased seed to 100-percent-purchased seed with a hybrid." - George Kidd, Vice-President, L. William Teweles, seed and biotech industry consultant[4]

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In October, 1989, researchers at Plant Genetics Systems N.V. (Ghent, Belgium) announced a major breakthrough using genetic engineering for the creation of new, hybrid crops. As reported in the Wall St. Journal:

> "The researchers [Plant Genetic Systems] said they have isolated a plant gene that prevents the production of pollen. The gene thus can prevent a plant from fertilizing itself. Such so-called male-sterile plants can then be fertilized by pollen from another strain of the plant, thereby producing hybrid seed. The new generation of plants will possess the flourishing, high-production trait known as 'hybrid vigor', similar to that now seen in hybrid corn."[5]

Plant Genetic Systems successfully introduced the pollen-inhibiting gene into oil-producing rapeseed plants, a major crop in both Canada and Europe. The company claims that new, hybrid rapeseeds produced by this technique will increase yields by 15-30 percent over current commercial varieties.

The development announced by Plant Genetics Systems has far-reaching implications for creating other commercially-important hybrid crops. Jan Leemans, Research Director of Plant Genetic Systems, told the Wall St. Journal that the new technique "is applicable to a wide variety of crops" and that the company is experimenting with alfalfa, cotton and maize. (Although hybrid maize has been available since the 1930s, Plant Genetic Systems' hybridization technique offers labor-saving shortcuts which could save the U.S. maize seed industry approximately $70 million annually.)

Delta & Pine Land Co. (a subsidiary of Soutwide Inc.), one of the largest cotton seed producers in the United States, is now negotiating with Plant Genetic Systems to acquire the technique for developing hybrid cotton. Hybridization of other major field crops (e.g., rice, soybeans, wheat) is still a long way off, but discovery of pollen-inhibiting gene enhances future commercial potential.

[1] Castagno, James, "Canola: Cinderella Crop?", Seed World, October, 1987, p. 35.
[2] Castagno, James, "Canola: Cinderella Crop?" Seed World, October, 1987, p. 35.
[3] Anonymous, "Biotechnology: A Young Industry with Potential", Journal of the American Oil Chemists Society, Vol. 64, no. 9 (September, 1987), p. 1228.
[4] Ratner, Mark, "Crop Biotech '89: Research Efforts are Market Driven", Bio/Technology, Vol. 7, April, 1989, p. 341.
[5] Naj, A.K., "Belgian Company Says it Has Developed Genetic Technique to Make Hybrid Plants", Wall St. Journal, November 1, 1989, p.B4.

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RFLP Technology

ISSUE: RFLP technology is an important new tool for identifying genes and the traits they control.
IMPACT: Integration of RFLP technology into plant breeding will expedite identification and movement of desirable genes among crop varieties.
PARTICIPANTS: Native Plants, Inc. (USA); a consortium of major transnational seed corporations with Agricultural Genetics Co.--among others.
WHEN: Plant breeders are now using RFLP technology to select for a variety of traits.

The development of RFLPs (Restriction Fragment Length Polymorphisms) represents a major advance in the technology of plant breeding. RFLP technology provides a tool for identification and selection of valuable plant traits. As a breeding tool, it is unequaled in its ability to identify the genes, or combination of genes, responsible for specific plant characteristics and, thereby, makes product development more efficient and predictable.[1] In the words of George Kidd, vice-president of the consulting firm L. William Teweles & Co. (Milwaukee, WI):

> **"Anyone who's a breeder must be in it...I've never seen any breeding tool like it. It's predictive. Standability of corn, days until harvest, grain moisture content, and complex, multigenic characteristics all can be predicted by RFLPs."[2]**

First described in 1980, RFLPs now occupy a major role in human genetic research and the mapping of the human genome.[3] RFLPs are obtained from variation in DNA sequence. In plant science, these differences enable researchers to discriminate among two or more genotypes, ie. varieties of the same plant species, with a high degree of accuracy. According to Peter Innes, the Technology Transfer Manager at Agricultural Genetics Company (Cambridge, U.K.), RFLP probes have a range of uses in breeding research and varietal identification and protection. Because they provide positive identification of a hybrid or variety, they can play a role in patenting and registration. But, their greatest value, states Innes, "lies in their use as markers for genes of agronomic importance."[4] Once RFLPs have been marked and located on the plant's genome, it is possible for any gene

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to be localized on a chromosome by its linkage to a RFLP. RFLP technology "provides a means of producing extensive physical genetic maps of plants that provide information on the presence of specific genes and their location on specific chromosomes."[5]

Using traditional plant breeding methods, the time for development of an improved variety for many crops often exceeds 10 years.[6] RFLP technology can accelerate breeding programs by identifying useful genes in plants without having to wait for mature plants to express specific characteristics. Industry observers predict that RFLP will shorten development time for new hybrid crops by about 70%.[7] Furthermore, the ability of RFLP technology to reduce complex or polygenic traits to their individual genetic components and to map their linkages will allow plant breeders to select for a combination of traits which previously were too difficult and time-consuming to produce.[8,9]

> **RFLP techniques...will likely be integrated into existing plant breeding programs allowing researchers to access, transfer and combine genes at a rate and with a precision previously not possible.[10]**

In 1987, Native Plants, Inc. (USA), the self-described "world leader" in the application of RFLP technology to plant breeding, announced the development of detailed RFLP maps of maize and tomato.[11] CERES, a division of NPI, provides RFLP technology for industry plant breeding programs via licensing, service and variety protection programs.[12]

After four years of research, Agrigenetics, a subsidiary of Lubrizol, has generated a RFLP map of maize with over 300 markers.[13] At the US Department of Agriculture, plans are in the making to develop a $500 million plant genome program to map agriculturally important genes in major food and forest crops.[14]

At the Agricultural and Food Research Council (AFRC) Institute of Plant Science Research (IPSR) in Cambridge, U.K., work is underway to complete RFLP maps of wheat and barley, Europe's two major cereal crops.[15] The effort is being financed by a licensing agreement between Agricultural Genetics Company (AGC) of Cambridge, U.K. (which has first option to develop and market AFRC's plant biotechnology discoveries) and five major European seed companies. Spending a total of 1.5 million pounds (approximately US $2.5 million), the five companies will have sole access, over the next 3 years, to the new RFLP probes and maps developed. The companies involved are Cambridge Plant Breeders, a subsidiary of AGC; Plant Breeding International Cambridge, a subsidiary of Unilever; Nickerson International Seed, a subsidiary of Shell, Ltd.; ICI; and CIBA-Geigy. Says Peter Innes of AGC:

> **"With the RFLP licensees we are able to link the unique expertise of IPSR with the breeding teams of some of the world's leading seed companies. This will result in rapid research progress and the immediate application of the technology developed."[16]**

[1] M. Walton & C. Martinez, "Tools for a Revolution", in Seed World, December 1989, p.30

[2] M. Ratner, "Crop Biotech '89" in Bio/Technology Vol.7 April 1989, pp.339-340

[3] S.D. Tanksley, N.D. Young, A.H. Paterson, M.W. Bonierbale, "RFLP Mapping in Plant Breeding: New Tools for an Old Science" in Bio/Technology Vol.7 March 1989, p.257

[4] Peter Innes, "The Development and Use of RFLPs and Their Exploitation in Genetic Analysis and Breeding", Agricultural Genetics Company, May 1989, p.2

[5] Agricultural Genetics Report, March/April 1988, p.3

[6] "RFLP Mapping in Plant Breeding", op.cit. p.257

[7] Agricultural Genetics Report, March/April 1988 p.3

[8] "RFLP Mapping in Plant Breeding", op.cit. p.263

[9] "Tools for a Revolution", op.cit. p.33

[10] "RFLP Mapping in Plant Breeding", op.cit. p.263

[11] Agricultural Genetics Report, March/April 1988, p.3

[12] CERES Plant Technology Applications brochure

[13] "Crop Biotech '89", op.cit. p.340

[14] Nature, Vol.340, August 17 1989, p.491

[15] Bio/Technology, Vol.7, March 1989, p.211

[16] Agricultural Genetics Company News Release, January 12, 1989

LOOK FOR:

Shattering: Food, Politics and Genetic Diversity by Cary Fowler and Pat Mooney, to be published by the University of Arizona Press, Spring, 1990. Foreign editions and translations are under negotiation.

"The Socio-Economic Impact of Biotechnology on Agriculture in the Third World" by Hope Shand, in *Agricultural Bioethics*, ed. by S. Gendel, Iowa State Univ. Press, Spring, 1990.

"Seeds and Geopolitics" by Cary Fowler in the next issue of *Multinational Monitor*.