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## Bioserfdom: Technology, Intellectual Property and the Erosion of Farmers' Rights in the Industrialized World

***Issue:*** With the decline in public sector agricultural research, the commodification of information and the nearly complete privatization of genetic resources in the North, many large-scale, commercial farmers have lost the right to control plant and animal germplasm on their own farms. "Bioserfdom" is fast becoming an accepted reality rather than a futuristic concern. "Gene licensing agreements" and "precision farming" are among the tools that are driving the industrialization of agriculture and the erosion of farmers rights in the North.

***Impact:*** As the life industry tightens its grip on food and agriculture by using intellectual property and new proprietary technologies, farmers will grow crops according to a formula dictated by industrial processors. Farmers will sign contracts or negotiate agreements that stipulate precise levels of inputs, dictating what seed, fertilizer, chemicals, row spacing, irrigation and harvesting techniques are used, and other management requirements. Many farmers will become "renters" of proprietary germplasm and information, rather than relying on local knowledge and experience. In the 21st century, large-scale farming in the industrialized world will seldom be described as farm production of crops and livestock. It will more closely resemble the manufacture of proprietary food and fibre products that are controlled by off-farm industrial firms from seed to end-user.

***Economic Stakes:*** Under the guise of protecting the environment, industrial farming technologies seek to legitimate and reinforce chemically-based, Green Revolution agriculture, with significant gains for the global agricultural input suppliers. In the United States alone, farmers spend about $10.5 billion per annum on fertilizers; approximately $9.4 billion on farm equipment,[1] and over $3 billion per annum on seeds for major farm crops (maize, soybeans, cotton, etc.)[2] The US market for farm chemicals reached a record high of $10.4 billion in 1995.[3]

***Policy:*** At a time when civil society organizations and many governments, both South and North, are debating plant intellectual property laws, the urgency of legally securing farmers' rights must not be overlooked. This *Communiqué* illustrates what's at stake when farmers lose control over plant germplasm. "Bioserfdom" is not just a threat to farmers and peasants; it is a trend that jeopardizes global food security.

***Participants:*** The life industry (particularly major agrochemical firms) is positioned to play a major role in precision farming via electronic commerce and information brokering. Other participants include military/aerospace corporations and farm equipment manufacturers.

*"In essence, the relative control of raw material suppliers depends upon the substitutability of other inputs. The one input with the fewest substitutes is the genetic material in plant and animal production. Biotechnology and increased predictability and control of genetic manipulation provides additional power to those who control genetic material."*

– Michael Boehlje, *"Industrialization of Agriculture: What are the Implications?"*[4]

### Introduction--What does Farmers' Rights Mean?

The principle of Farmers' Rights, endorsed by the United Nations Food and Agriculture Organization in 1989, recognizes the fact that farmers and rural communities have contributed greatly to the creation, conservation, exchange and knowledge of genetic resources, and that they should be recognized and rewarded for their past and ongoing contributions. Farmers' Rights acknowledges that farmers who have consciously selected and improved crop genetic resources since the origins of agriculture should be rewarded no less than plant breeders who benefit from


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Breeders' Rights (patent-like monopolies on new plant varieties). Many governments and civil society organizations have embraced the principle of Farmers' Rights, not only as a counterpoint to Plant Breeders' Rights, but also as recognition of the critical and innovative role that farmers and rural communities play in the conservation and further development of genetic resources and their right to benefit from it.

It is important to stress that the principle of Farmers' Rights extends beyond the issue of compensation for farmers and farming communities; it includes rights to land and secure tenure, the farmer's fundamental right to save seed and exchange germplasm (in direct contradiction to evolving intellectual property regulations), and the right of farming communities to "say no"--to choose *not* to make their germplasm and knowledge available. Many people mistakenly assume that Farmers' Rights is an issue that relates only to poor farmers and peasants in the South. But this is not the case.

This *RAFI Communiqué* examines two trends in industrial agriculture that contribute to the erosion of farmers' rights and lead to "bioserfdom." We discuss Monsanto's 1996 "gene licensing agreement," and the related issue of "use-tailored, identity-preserved crops." We also examine "precision farming" and the potential role it will play in the commodification of information technology and the growing influence of the life industry in farm-level decision-making. We focus primarily on agronomic crops; a future issue of *RAFI Communiqué* will explore similar trends in industrial livestock production.

## Controversy over Monsanto's "Roundup Ready" Soybeans

At the end of 1996, controversy over Monsanto's genetically engineered soybeans made headline news in Europe and North America. Many consumer and environmental groups voiced concerns related to human health and the environmental safety of a new, gene-altered soybean that is engineered to withstand spraying of Monsanto's chemical weed killer--glyphosate--the world's top-selling broad spectrum herbicide, sold under the trade name Roundup. The herbicide kills weeds without harming the genetically engineered soybean plant. According to Monsanto, Roundup Ready beans deliver both economic and environmental benefits because the farmer is able to lower his/her costs by using less frequent applications of costly herbicides to control weeds.

While Monsanto claims that Roundup is environmentally benign, many consumer and environmental organizations disagree. Crushed soybean oil is ubiquitous and ends up in thousands of consumer food products ranging from salad dressing to infant formula and chocolate bars. Many European and North American NGOs believe that genetically-engineered soybeans have been inadequately tested and are unsafe for human consumption. They demand that the gene-altered beans be separated from other harvested soybeans and clearly labeled. As a result of the controversy, many European buyers are now looking for sources of non-Roundup soybeans. Canadian soy exports to Europe reportedly grew by 80,000 metric tonnes over the previous year because of the demand for non-Roundup beans.[5]

## Monsanto Plays Hardball With Farmers' Rights

The controversy surrounding Monsanto's gene-altered soybean is not just an environmental issue. Though less visible to the public, Monsanto's efforts to monopolize and control its proprietary genes also raise profound issues of morality and social justice for farmers and rural communities. With the 1996 release of its "gene licensing agreements," Monsanto is attempting to alter the way farmers buy and use proprietary seed and agricultural inputs, and the conditions under which they are allowed to farm. As far as Monsanto is concerned, the fundamental right of farmers to save seed from their harvest and exchange seed with their farm neighbors is a violation of patent law.

## The Gene Agreement

Monsanto's "1996 Roundup Ready Gene Agreement" is a licensing agreement between the farmer and the company. In order to buy Monsanto's genetically engineered seed, the farmer must first agree to sign and abide by the terms of the licensing agreement. The farmer's motivation to sign such an agreement is straightforward: some farmers are willing to buy premium-priced, gene-altered seed in hopes of higher profits. But the farmer pays dearly for the expectation of increasing the bottom line. In addition to the cost of the seed, the grower must pay Monsanto a $5.00 per 50 lb. bag "technology fee." And that's only the beginning:

- Any farmer who signed the 1996 licensing agreement with Monsanto gave the company the right to inspect and test his/her soybean fields for up to 3 years. This includes the right to "monitor" the farm for up to 3 years to ensure that the farmer complies with the terms of the licensing agreement. Specifically, the agreement states:

> *"Grower grants Monsanto, or its authorized agents, the right to inspect and test all of Grower's fields planted with soybeans and to monitor Grower's soybean fields for the following three years for compliance with the terms of the Agreement. All such inspections shall be performed at a reasonable time, and if possible, in the presence of Grower. Grower also agrees to supply upon request the locations of all fields planted with soybeans in the following three years."*[6]

- The farmer also promises to use only Monsanto's Roundup® brand herbicide on the patented soybean seeds. The use of an alternative glyphosate herbicide sold by a different company is a violation of the agreement.

- The farmer must relinquish his/her right to save or re-plant the patented seed, or sell seed derived from it to anyone. Using or selling the patented seed, even for breeding research, is strictly forbidden:

*Grower may not: resell or supply any seed purchased under this Agreement to any other person or entity; use or sell to anyone the purchased seed or any of the soybean material derived therefrom for breeding, research, seed production, reverse engineering or analysis of the genetic makeup thereof, save any of the seed produced from the purchased seed for the purpose of using it for planting seed; save any of the seed produced from the purchased seed for the purpose of selling it to anyone who would use it to plant a soybean crop.*[7]

Monsanto means business. If the farmer violates the agreement, the farmer agrees *"to pay Monsanto as liquidated damages a sum equal to 100 times the then applicable fee for the Roundup Ready gene, times the number of units of transferred seed, plus reasonable attorney's fees and expenses..."*[8] The agreement specifically states that nothing contained in the agreement shall limit the amount of damages that Monsanto might recover for any violation of the agreement. A farmer who violates the contract could lose his/her farm and all other assets--a steep penalty to pay for saving or re-planting patented seeds.

## Reaction from Farmers

According to Monsanto, about one million acres of Roundup Ready soybeans were planted by US farmers in 1996, approximately 2% of the total soybean crop. The company predicts that between 5-10 million acres will be planted in the US in 1997. (Roundup Ready soybeans have also been introduced in Argentina.) According to American Soybean Association representative Bob Callanan, soybean farmers complained about Monsanto's licensing agreement, "It goes against the grain, and they didn't like it--but they signed it anyway," he said. Callanan adds that there has been a great deal of enthusiasm for the Roundup Ready soybeans. "The Association understands how important and how expensive the new technology is. Private industry needs incentive to invest in new technology," explains Callanan.[9]

But not all farmers agree. Arkansas farmer John McClendon had hoped to buy enough Roundup Ready soybean seeds to plant 1,000 acres in 1996, but when he saw the company's gene licensing agreement, he refused to sign it. "I don't have any trouble with Monsanto getting their investment back, but I was disturbed by the provision giving them the right to come on my farm. I have a very hard time with that," said McClendon.[10]

Monsanto's gene licensing agreement is not limited to Roundup Ready soybeans; the company used a similar licensing agreement for its genetically engineered Bollgard cotton, and, according to Karen Marshall of Monsanto, the company will introduce a licensing agreement with all genetically engineered seeds that it brings to market, including Roundup Ready canola, maize, sugarbeets, etc.[11] The gene licensing agreements will vary from crop to crop,

According to Karen Marshall, the Monsanto gene licensing agreement for Roundup Ready soybeans will be modified in 1997, and will contain less stringent requirements relating to the inspection and monitoring of farmers' fields. Marshall says "the farmers didn't like it, and we listened."[12]

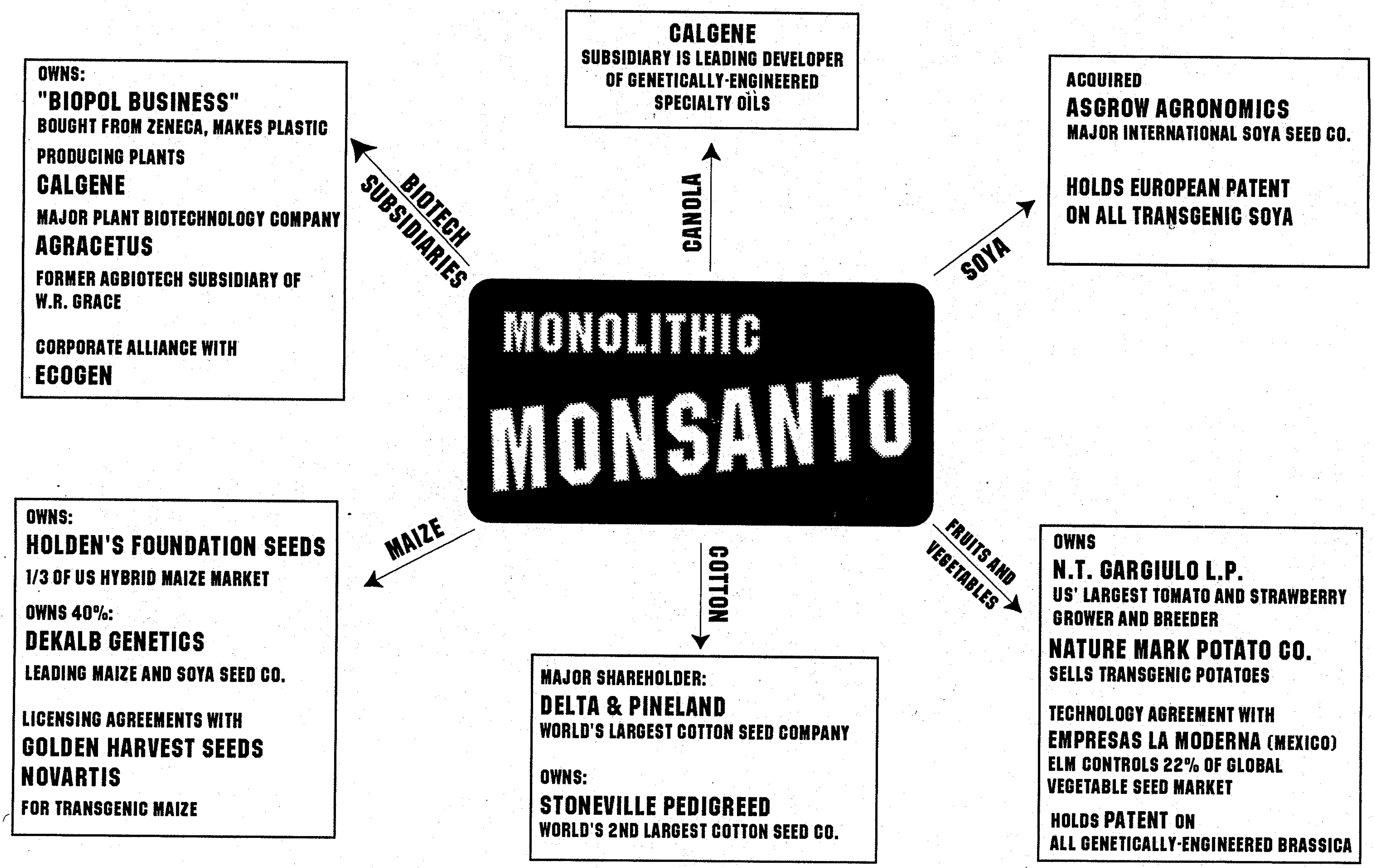
## Bioserfdom and Gene Licensing Agreements

Monsanto's role in using and developing the gene licensing agreement is particularly troublesome because the company is one of the world's major players in plant biotechnology and seeds. Monsanto is positioned to influence the sale and distribution of genetically engineered products globally. (See chart, "Monolithic Monsanto.") For example, Monsanto owns the second largest cotton seed company, and is a major shareholder in Delta & Pineland, the world's largest cotton seed company. In November, 1996 Monsanto and Delta & Pineland announced a joint venture with the Chinese Hebei Provincial Seed Industry Group to plant 500,000 acres of Bollgard cotton in China by 1998. China is the world's second largest cotton producer. In January, 1997 Monsanto acquired Holden's Foundation Seeds, a company that supplies germplasm for 35% of the hybrid maize grown in the US. Monsanto's purchase of Holden's gives Monsanto a giant platform for promoting the use of its proprietary genes (and herbicide) on an estimated 300 million acres of hybrid maize worldwide.

Monsanto's 1996 gene licensing agreement is unprecedented. In the past, other commercial seed corporations have informed their customers that it is illegal to save or re-sell proprietary seed. Plant intellectual property laws in the United States already restrict the right of farmers to re-plant or re-sell seeds protected under industrial patents or Breeders' Rights (known as Plant Variety Protection in the US). Seed corporations have also brought legal suit against farm families for infringing the company's monopoly on proprietary seed. But never before have farmers been asked to sign away their right to privacy,

**AGRICULTURAL BIOTECHNOLOGY AND SEEDS (SHOWN HERE) ARE ONE PART OF MONSANTO'S $5 BILLION LIFE SCIENCES COMPANY...**

*"What you're seeing is not just a consolidation of seed companies, it's really a consolidation of the entire food chain."* Robert Fraley, Monsanto



nor have they been legally obliged to use a brandname chemical on a specific variety. Will Monsanto's gene licensing agreement become the industry norm? Will other companies follow suit? Will they launch similar gene licensing agreements that require the farmers to give up fundamental rights? This remains to be seen.

The gene licensing agreement diminishes the farmers' role in farm-level decision-making, giving greater control to seed and agrochemical corporations. Steve Sonka, professor of agricultural management at the University of Illinois, describes the transformation underway in an interview with *Farm Industry News*: "Farmers, as individuals, will act more like purchasing managers in a large corporation. There will be many people influencing the decision. The farmer will just give the final nod.".[13]

### Use-Tailored, Identity-Preserved Agricultural Production

The gene licensing agreement is consistent with other trends in industrial agriculture, including the transformation of farm commodities to proprietary products. Instead of growing maize as a "generic" commodity, increasing numbers of large-scale farmers will use customized agronomic practices to grow a patented product that has special characteristics for the end-user (food processor and/or consumer). In some cases the farmer may be required to use pre-specified input packages that are selected for their biological and chemical characteristics.[14] Some observers predict that within the next five years, virtually all crops may be "designed" for a specific end use, such as a high starch maize hybrid grown for ethanol production, or a high protein, low-fat soybean for human consumption.[15] Examples of other use-tailored categories include starch, protein, fiber, moisture and sugar content; nutritional value; color; texture and processing properties; volume and availability; freshness and timing of delivery.[16] Purdue University agricultural economists, Michael Boehlje and Lee Schrader predict that demand for use-tailored feed, food and industrial products will grow, while demand for generic commodities will decline.

The commercialization of genetically engineered seed varieties will accelerate this process. Seed industry consultant, David Wheat, explains: "The market is not the farmers, the consumer of seed, but the farmer's customers, or even their customers."[17] As the life industry dictates more and more of the farm-level management decisions, the farmer becomes little more than a "renter" of proprietary germplasm and information, a step in the food/industrial manufacturing process. Farmers and consumers thus increasing lose control over what products they grow and consume, and which food production processes they choose to support.

## "Inch by Inch, Row by Row" ... What Will Precision Farming Sow?

### What is Precision Farming?

"Precision farming", also called "site-specific" and "prescription" farming, are terms that describe a bundle of new information technologies applied to the management of large-scale, commercial agriculture, mostly in the industrialized world. Precision farming technologies include: personal computers, satellite positioning systems, geographic information systems, automated machine guidance, remote sensing devices and telecommunications. Various combinations of these tools will enable the gathering of unprecedented levels of information about every square metre of the geographic area to be cultivated. Site-specific information can then be used to tailor the application of inputs (i.e. pesticides, fertilizers, irrigation, seed spacing, etc.) to precisely the levels needed to grow a specific crop.

How does it work? Precision farming tools are designed to give the site-specific information needed to identify variability within a field, and then manage crop production according to precise, localized conditions. For example: electronic receivers that use satellite transmissions can determine latitude, longitude and altitude anywhere on earth. Satellite images can show exactly where the farmer's crop may be suffering from weediness, lack of nitrogen, or other plant stress. Data collected by remote sensors on such variables as yield, soil type, crop moisture, topography, weed infestation, etc. can be stored in the farmer's computer, and later transferred to a chemical applicator attached to a tractor. As the sprayer or seeder travels over a field, the satellite receiver senses its position and automatically applies the chemical at the chosen rate for each area. Though still in its infancy, this type of computer-driven, automated application will be possible for all kinds of inputs--fertilizers, herbicides, pesticides, etc.

Just as the agrochemical industry grew out of military uses of chemicals during World War II, the satellite technology and global positioning systems that are now being introduced to industrial agriculture were developed by military contractors for the US Department of Defense over the past 20 years. These "star wars" military technologies made their public debut during the 1991 Persian Gulf war. Not surprisingly, military-industrial giants such as Lockheed Martin and Rockwell Int'l. are among the corporations who are promoting new, agricultural applications for former military technologies.

Lockheed Martin, the world's largest arms-producing company (1996 annual sales of US $27,000 million), proudly advertises, "Perhaps nowhere is the principle of pounding swords into plowshares being carried out more literally than with [precision farming]."[18]

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### Automating Uniformity and Control; De-Valuing Farmer's Knowledge

Precision farming technology reinforces the uniformity and chemical-intensive requirements of industrial agriculture. The essence of precision farming is the identification of variable agronomic conditions and the control of these conditions with the application of chemical and capital intensive inputs. It is an industrializing technology that builds further links of dependency between the farmer, the agrochemical industry and off-farm information providers. According to social scientists Steven Wolf (University of California-Berkeley) and Spencer Wood (University of Wisconsin), it is a technology that diminishes the traditional role of farmers by substituting capital and technology for the age-old, local knowledge of farmers.[19]

Consider, for example, the astonishing capacity of Lockheed Martin's technology to measure "variables" on a 1,000 acre potato and grain farm:

"Meteorological stations measure 13 different weather parameters every 15 minutes and telemeter the data to a computer base station. More than 430 gauges measure irrigation. Yield measurements are taken every three seconds during harvest. Crop quality samples are analyzed. Soil is tested for 18 nutrient parameters and leafstone samples are analyzed for 11 plant nutrients. Microbial communities in the topsoil are studied. And the amount and the cost of the inputs, such as seed, fertilizer and pesticides are calculated."[20]

Proponents of precision farming claim that it will improve efficiency on the farm, help reduce input costs and enhance the farmer's ability to protect the environment. In theory, if farmers are able to apply farm inputs only where they are needed, using the minimum amount required instead of a uniform rate, they may be able to reduce costs, increase yields and decrease the use of chemicals. One company claims that precision farming will: reduce fertilizer costs; reduce chemical application costs, reduce pollution; improve crop yields; provide better information for management decisions; and provide better farm records essential for sale and succession.[21]

Social scientists Steven Wolf and Fred Buttel offer a different perspective. According to Wolf and Buttel, "precision farming legitimates chemically based agriculture in an era of rising environmentalism."[22] In reality, they add, "precision farming has less to do with mitigating agricultural pollution than it does with advancing industrial modes of production."[23]

Few empirical studies have been conducted on the profitability of precision farming or any of the other benefits touted by the emerging industry.[24] Precision farming tools are expensive, and will be most easily accessible to the largest, highly capitalized farm operations. It requires approximately US $15,000-$20,000 to purchase a yield monitor, global positioning receivers, computers, software and variable controllers for application equipment.[25] Services for data management, analysis and interpretation are extra.

Due to the technical complexity of precision farming, the vast majority of farmers who use the technology will become heavily dependent on off-farm service support. A spokesperson for John Deere's Precision Farming Group explains, "The typical customer is not a very highly technical computer-science-type person. He is like your typical American consumer who doesn't want to fool around with a number of knobs to make something happen."[26]

"Precision farming has less to do with mitigating agricultural pollution than it does with advancing industrial modes of production."
– Steven Wolf and Fred Buttel

Not surprisingly, it is local seed and chemical dealers, as well as giant input manufacturers who are lining up to provide these services. Over 67 companies in North America now specialize in precision farming services, including both hardware, software and data management.[27] Although there are many locally-based input dealers and independent entrepreneurs who provide these services to farmers, large corporations are expected to dominate the market for precision farming.[28] Among these are military/aerospace contractors such as Lockheed Martin and Rockwell; farm equipment manufacturers such as John Deere, New Holland, AGCO, Terra and Case; and agrochemical/seed/biotechnology giants such as Monsanto[29] AgrEvo, Novartis, DowElanco, Rhone-Poulenc, Zeneca, etc.[30]

### Who Owns the Information? Intellectual Property and Precision Farming

Precision farming is an information-based industry. But the information it depends on is a commodity that is bought and sold, just like any other industrial farm input. Historically, US farmers obtained a great deal of assistance and information from public sector resources--including agricultural experiment stations, government extension services, and crop varieties released by public sector breeders. Today, agricultural information is increasingly a privately-held, marketable product, and it is a source of strategic competitive advantage.[31] Social scientists Steven Wolf and Spencer Wood observe that precision farming will likely "advance marginalization" of public sector agricultural research and extension, affording all farmers fewer choices.[32]

**How Big is Precision Farming?**

What role will precision farming play in US agriculture? "For mainstream agriculture, precision farming is going to be huge," says Donald Senechal, Chairman of a management consulting firm that specializes in precision farming, "We expect in 15 years to have one-half of all major field crops being grown under some system of precision farming. In some cases--especially for high-value crops such as cotton, potato and sugarbeets, that level will approach 100%," adds Senechal.[33]

Farming systems consultant Neil Havermale, sums it up this way: "Bottom line [is] this is not an insignificant industry. Site specific farming systems represent a shift in agricultural technology like fertilizer or modern genetics--it is the effect of information."[34]

One of the critical issues now being debated in US agriculture is the ownership of precision agriculture data. Agricultural economist Jess Lowenberg-Deboer describes the debate as a tension between the need for confidentiality and access to information.[35] For example, the American Farm Bureau, a conservative farm organization and insurance company, is concerned that databases generated on a farmer's land could fall into the hands of a government regulatory agency or an environmental group which might penalize the farmer for bad management practices.[36]

Site-specific data collected on a farmer's land is often considered proprietary information by the company that supplies or gathers the information. For example, Ag-Chem Equipment Co., a leading manufacturer of fertilizer and pesticide application equipment, has developed a "central data processing center" which collects all datasets used in their machines. The company claims this data as proprietary information, which is licensed to the farmer/client. According to Ag-Chem, "the database becomes the farmer's blueprint for future management decisions."[37] "One concern related to this approach," observes Purdue University economist, Jess Lowenberg-Deboer, "is that if fine tuned crop production 'recipes' are proprietary, farmers may become laborers implementing management plans created elsewhere."[38]

Agricultural economists Michael Boehlje and Lee Schrader raise additional questions about the ownership of information generated by precision farming: "For example, with respect to site specific soil characteristic information, who owns it--the grower who paid for it or the service company that gathered it? Can a grower obtain this information from one company such as a fertilizer or chemical dealer and then provide it to a competitor who might have a lower price on fertilizer or chemical products? Does it make a difference if the grower pays for the service and how much he pays, or if the information service is provided as a part of a bundled package with the product?"[39]

Crucial decisions about ownership of information will likely be made far away from farmers' fields, and with little or no input from farmers. In December, 1996 at the World Intellectual Property Organization's (WIPO) Diplomatic Conference in Geneva, a "Draft Treaty on Intellectual Property in Respect of Databases" was put forth, based on proposals made by the European Community and the United States.[40] Although the treaty was not discussed by WIPO delegates at the December meeting, it will be considered at a future meeting. The draft treaty would grant intellectual property protection to databases "regardless of the form or medium in which the database is embodied, and regardless of whether or not the database is made available to the public." It would protect any database "that represents a substantial investment in the collection, assembly, verification, organization or presentation of the contents of the database." Similar legislation will also be considered in the United States and the European Community in 1997. Like most forms of intellectual property, stronger database protection is more likely to serve the interests of large-scale enterprises than the rights of farmers.

## Conclusion

It is important to stress that not all farmers in the industrialized world are victims of "bioserfdom." There are many farmers, farm organizations and peoples organizations who are working to build an alternative food and farming system that is based on principles of social justice and environmental sustainability. The farmers' fundamental right to save seed and exchange germplasm is central to achieving these goals.

Over the past year it has become clear that Farmers' Rights is an integral part of the wider issue of the "right to food"--and should be debated by intergovernmental bodies in this broader context. Civil society organizations meeting in Rome during the November, 1996 World Food Summit developed four central elements in the "right to food." These include:

- the right of all people to have adequate, affordable and culturally appropriate food;
- the right of all people to have access to food, even in times of political unrest and natural disasters;
- the right to fair marketing of food;
- farmers' rights -- the right to produce food under equitable and sustainable conditions.

The FAO Committee on World Food Security should be discussing the right to food in this context at the first follow-up meeting to the Food Summit in April, 1997. Ultimately, these issues must go before the U.N. Human Rights Commission where it could form the basis for a legally-enforceable agreement on the right to food.

**- UPDATES -**

## Dolly: Clone or Commodity?

### Taking Care of Business

Dolly, the first cloned mammal, is living proof that viable offspring can be developed from a single adult cell. Dolly was born in July, 1996 at the Roslin Institute in Scotland. We learned about the startling feat over seven months later in February, 1997. Why the delay? Because there's a great deal of money to be made from the cloning of mammals. Before disclosing the breakthrough, patent applications were filed and research papers prepared for publication.

Dr. Ian Wilmut, who led the sheep cloning experiment at the non profit Roslin Institute, is funded in part by PPL Therapeutics, a biotechnology company that was formed in 1987 to commercialize the Roslin Institute's research. Dr. Wilmut is undoubtedly one of the primary "inventors" of the mammal-cloning technology, but PPL Therapeutics will likely be assigned the patent.

PPL Therapeutics has several human protein products in development, holds US Patent No. 5,476,995 on a method to produce therapeutic proteins in the milk of transgenic sheep, and has numerous patent applications pending. The company has research agreements with at least four major pharmaceutical corporations, including Novo Nordisk, American Home Products, Bayer, and Boehringer Ingleheim.

According to one industry observer, the cloning breakthrough "will lead to the creation of a multibillion-dollar segment within the health care sector." Cloned sheep, goats or cows offer a cheaper way to produce valuable human therapeutic proteins in animal milk, such as blood clotting proteins for hemophiliacs, or insulin for diabetics. Scientists believe that cloned animals with genetically engineered traits will become highly efficient, living drug factories because a female mammal can yield far greater quantities of protein in her milk than genetically manipulated cells grown in the laboratory. If genetically engineered animals can be cloned routinely, it will mean faster and more uniform production of profitable proteins. The market for therapeutic proteins is currently about $7.6 billion per annum, and is expected to grow to $18.5 billion by 2000.

Another potential and highly profitable use of cloned livestock is the assembly line production of "spare-part" animal organs for human transplant. Pig clones, for example, could be genetically engineered to be a source of replacement organs for humans. Pig cells could be altered genetically so that they would "look" like human cells to the human body, thus diminishing the likelihood that the human body would reject the cloned animal's transplanted organ.

There is a huge potential market in replacement organs from transgenic animals. In 1995, 35,000 patients worldwide received human organ transplants. But because of a chronic shortage of human organs, approximately 100,000 more were in demand. The immediate need for organs is an estimated $6 billion market.

### From Sheep to Shepherd? Few Technological Barriers

Remarkably, the technology and equipment Dr. Wilmut used to clone an adult sheep is relatively simple and inexpensive. His sheep cloning team worked on a budget of only (US) $300,000 in 1996. In short, there may be few technological barriers to overcome in the cloning of cows or human beings. Dr. Ronald Munson, an ethicist at the University of Missouri told The New York Times, "It doesn't require the sort of vast machines that you need for atom smashing. These are relatively standard labs. That's the amazing thing about all this biotechnology. It's fundamentally quite simple."

Just one week after the sheep cloning experiment was disclosed, an Oregon (USA) primate centre announced it had successfully produced two monkeys from cloned embryos. Don Wolf, the scientist heading the research team, pointed out that some 300 clinics in the US are already handling human embryos, "and they're doing it almost totally without regulation."

### Hello Dolly...or Goodbye Dolly?

The cloning breakthrough raises important concerns related to the loss of livestock genetic diversity. Livestock cloning is likely to become one more tool in a host of reproductive technologies (artificial insemination, embryo transfer, in vitro fertilization, etc.) that allow corporate breeders to produce elite, genetically uniform breeds that are selected solely for maximizing production of meat, milk and eggs. Worldwide, the greatest threat to domestic animal diversity is the highly specialized nature of intensive livestock production. Genetically uniform animals are especially vulnerable to outbreaks of disease and changes in environmental conditions. Industrial livestock breeds alone are an inadequate gene pool for the future.

With the spread of industrial agriculture worldwide, the rate of extinction of livestock breeds has accelerated dramatically over the past 100 years. The UN Food and Agriculture Organization concludes that domestic livestock breeds are disappearing worldwide at an annual rate of 5%, or six breeds per month.

Why worry? Because livestock diversity--like plant diversity--is the key to sustaining and enhancing the productivity of agriculture. Traditional livestock breeds often possess valuable traits such as disease resistance, high fertility, good maternal qualities, longevity and adaptability to harsh conditions. The gradual disappearance of local breeds that are able to survive in extreme environments undermines food and livelihood security, especially for the poor.

Proponents point out that animal cloning may give us the tools we need to rescue endangered breeds. In theory, yes. But these are proprietary, expensive technologies that will be applied primarily to industrial livestock breeds. Rather than becoming tools for conserving and using greater diversity, cloning will likely exacerbate the problem of genetic uniformity. No matter how skilled we become in cloning cells, transferring embryos or designing transgenic livestock, we still can't "create" diversity once it's gone. Extinction is still forever.

**WHO's on First**

On 11 March 1997 the Director-General of the World Health Organization (WHO) issued a statement condemning human cloning and announced that his agency would take the lead on debating the issue of cloning by initiating a series of national and regional consultations to define codes of good practice, guidelines and possible legislation.

WHO is to be commended for responding quickly to the urgent need for intergovernmental debate. But the "Dolly debate" should not be limited to human cloning. There are closely linked issues that must be addressed urgently. The January-February, 1997 issue of RAFI Communique, "The Human Tissue Trade," documents disturbing trends relating to the global trade in human tissue--especially that of rural populations and indigenous peoples. Dolly has focused intense attention on many of the concerns raised by the use and ownership of human biomaterials and the growing international tissue exchange routes that are developing in an almost total policy vacuum.

Gaps in international policy must be addressed by WHO and other multilateral bodies. Failure to put the appropriate policies and regulations in place will result in damage to human rights and medical research.

## Colombian Indigenous People Negotiate to get Human Tissue Samples Back

A Colombian genetics institute has offered to return its collection of thousands of samples of human tissue collected in dozens of Colombian indigenous peoples' communities. Indigenous peoples' representatives, including Colombian Senator Lorenzo Muelas and the *Organización Nacional Indígena de Colombia* (ONIC - National Indigenous Peoples' Organisation of Colombia), are currently negotiating the formal return of control and ownership of the samples, which are housed in a Bogotá human tissue bank. Universidad Javeriana, the lead insitution in collecting the cells, is being congratulated by indigenous peoples' organisations and NGOs for its decision to respect the wishes of tissue donors.

The cells were collected in the late 1980s and early 1990s by the "Great Human Expedition", a corporate and publically-supported genetics research program that criss-crossed the country collecting blood samples from remote indigenous peoples', Afro-Colombian, and other rural communities (see *RAFI Communique* March/April 1996). When first asked to return the cells in mid-1996, Universidad Javeriana officials were hesitant to do so, fearing that it would slow down their research. In the end, however, Javeriana recognised the important Human Rights concerns involved and realised it could not continue working with the tissues over indigenous peoples' objections. Meetings are continuing in Bogotá to decide precisely how the tissue will be passed to indigenous peoples' control.

Indigenous peoples' representatives have also invited genetics researchers to discuss how, through legal means, ground rules can be established so that in future genetics research, indigenous people and scientists can work together in an atmosphere of trust and mutual understanding in Colombia.

One key to creating such an atmosphere will be resolution of questions surrounding the international sharing of human tissue samples by researchers. In the past the sharing of samples of human tissue collected by Colombian genetics researchers with foreign laboratories - including ones that have patented human tissue - has provoked sharp criticism from indigenous people who were unaware of the arrangements. Trying to clear the air and assure transparency, Muelas and ONIC have requested a complete account of transfers of Colombian tissues to foreign countries.

Human tissue exchanges are an increasingly common occurance globally (see *RAFI Communique* January/February 1997). The groundbeaking work of Colombian indigenous peoples, now with the cooperation of the Colombian scientific community, is being closely followed internationally.

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[1] Statistics on fertilizers provided by The Fertilizer Institute in Washington, DC, February, 1997. Farm equipment market data provided by Equipment Manufacturers Institute, February, 1997.
[2] Information from several sources. According to Mark Wiltamuth at Nat/West Security, US farmers spend approx. $1.7 billion on hybrid maize, approx. $600 million on soybeans; and $100 million on cotton. According to James Kent of the Kent Group Inc., the total US market for seeds is approximately $5,520 million, approximately one-third of world seed sales.
[3] Source: NRDC and US PIRG press release, May 28, 1996, Summary of EPA data, May, 1996. On the internet at: gopher://gopher.igc.apc.org:70/00/orgs/panna/panups/panups_text/213.
[4] Boehlje, Michael. 1996. "Industrialization of Agriculture: What are the Implications" in *Choices*, First Quarter, 1996, p. 30-33.
[5] Biotech Reporter, "Europeans Labeling US Soybeans," January, 1997, p. 1.
[6] Monsanto Roundup Ready® Gene Agreement, 1996 Monsanto Roundup Ready® Gene Agreement for Roundup Ready™ Soybeans, Monsanto Co.
[7] Monsanto Roundup Ready® Gene Agreement, 1996.
[8] Monsanto Roundup Ready® Gene Agreement, 1996.
[9] Personal communication with John Callanan, January, 1997.
[10] Personal communication with John McClendon, January, 1997.
[11] Personal communication with Karen Marshall, Monsanto, February, 1997.
[12] Personal communication with Karen Marshall, Monsanto, February, 1997.
[13] Prof. Sonja is quoted in article by Joseph Degnan, "Technology: What's the Limit?" *Farm Industry News*, Vol. 29, April, 1996, p. 12.
[14] Michael Boehlje and Lee F. Schrader, "Agriculture in the 21st Century," Dept. of Agricultural Economics, Purdue University, p. 17.
[15] "Future Crops Will be Grown to Fit the Needs of End Users," *Poultry Times*, 4 Nov. 1996.
[16] These examples provided by Michael Boehlje and Lee F. Schrader, "Agriculture in the 21st Century," Dept. of Agricultural Economics, Purdue University.
[17] David Wheat, "How Biotechnology Has Revolutionized the Seed Trade," *Seed World*, December, 1991, p. 33.
[18] On the internet at: http://www.lockheed.com/lmtoday/0596/ideaho/html.
[19] Steven A. Wolf and Spencer D. Wood, "Precision Farming: Environmental Legitimization, Commodification of Information, and Industrial Coordination," *Rural Sociology*, forthcoming, 1997. Steven A. Wolf is in the Dept. of Agricultural and Resource Economics at the University of California-Berkeley. Spencer D. Wood is in the Dept. of Rural Sociology at the University of Wisconsin.
[20] This description on the internet at: http://www.lockheed.com/lmtoday/0596/ideaho.html.
[21] On the internet at: http://www.rinex.com.au/brochure.html
[22] Steven A. Wolf and Frederick H. Buttel, "The Political Economy of Precision Farming," A paper presented at the annual meeting of the American Agricultural Economics Association, San Antonio, TX, July 28-31, 1996. Steven A. Wolf is in the Dept. of Agricultural and Resource Economics at the Univ. of California-Berkeley. Frederick H. Buttel is a Professor in the Dept. of Rural Sociology and Institute for Environmental Studies, University of Wisconsin, Madison.
[23] Steven A. Wolf and Frederick H. Buttel, 1996.
[24] J. Lowenberg-DeBoer and S.M. Swinton, "Economics of Site-Specific Management in Agronomic Crops," Staff Paper 95-14, November 6, 1995.
[25] Additional information can be found at Pioneer Hi-Bred's web site at: http://www.pioneer.com/customer/research/precise.htm
[26] On the internet at: http://www.omnistar.com/article.html
[27] For a list of many companies that have a presence on the internet, see: http://nespal.cpes.peachnet.edu/pfscripts/cpf.idc.
[28] Steven A. Wolf and Spencer D. Wood, 1997, *Rural Sociology*, forthcoming.
[29] Monsanto is a joint developer of the Infielder computer and MAX software. The Infielder is a tiny computer that the farmer can take in the field.
[30] A consortium of 35 agricultural manufacturer and distributor companies has created Rapid Inc. The company has two primary goals: 1) The setting of network standards for electronic commerce, data and barcodes that will be suitable for the entire agricultural industry. 2) The development and operation of the PowerAg™ Network to offer a one-stop electronic network for the ag. industry.
[31] Michael Boehlje, "Industrialization of Agriculture: What are the Implications?" *Choices*, 1st Quarter, 1996, p. 33.
[32] Steven A. Wolf and Spencer D. Wood, 1997, *Rural Sociology*, forthcoming.
[33] Personal communication with Donald Senechel, Chairman, Senechel, Jorgenson, Hale & Co., February, 1997.
[34] Personal communication with Neil Havermale, Farmers' Software Association, February 1997.
[35] Jess Lowenberg-DeBoer, "Management of Precision Agricultural Data,," Staff Paper 95-5. Lowenberg-DeBoer is associate professor in the Dept. of Agricultural Economics at Purdue University, West Lafayette, Indiana.
[36] Statement of the American Farm Bureau Federation to The Working Group on IPR and the National Information Infrastructure Task Force, University of Chicago, September 14, 1994.
[37] On the internet at: http://www.agchem.com/site/ac-sslop.htm
[38] Jess Lowenberg-DeBoer, "Management of Precision Agricultural Data,," Staff Paper 95-5, p. 2.
[39] Michael Boehlje and Lee F. Schrader, Department of Agricultural Economics, Purdue University, "Agriculture in the 21st Century."
[40] World Intellectual Property Organization, Geneva, Diplomatic Conference on Certain Copyright and Neighboring Rights Questions, Geneva, December 2 to 20, 1996. "Draft Treaty on Intellectual Property in Respect of Databases." On the internet at: http://wipo.org/eng/diplconf/6dc_a01.htm

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