Case 18.2 Trait Protection System: A Case Study

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Description of the new technology
Seeds for many high yielding crop varieties are patented and farmers are legally obliged not to save and use seed from the crop that they grow, but rather to buy more seed from the company. A technique has been developed to prevent farmers from saving or re-using patented seed. This technology results in the F2 seed (offspring of the plants grown by farmers) being inviable. This technology is called the trait protection system and is covered under US patent No. 5,723,765 (Oliver et al., 1998).

How it works:
The plant genome is engineered so that it produces a protein that is toxic to the plant. The promoter that controls expression of the gene and subsequent production of the toxin is only active late in embryo development. In order to produce the transgenic F1 seed, a spacer is put between the promoter and the toxin gene so that the toxin gene is inactive. On either side of the spacer are sequences that are recognized by a "recombinase" enzyme that cuts out the spacer. This event brings the gene and promoter together so that the toxin is produced late in embryo development. A promoter that is activated by the chemical treatment of the seed sold to farmers controls the production of the recombinase. Thus, until the seed is chemically treated, the toxin gene remains inactive. The result of chemically treating seed purchased by farmers is that the farmer can buy viable seed and harvest the crop, but any seed collected from the crop will not grow. Opponents of the new technology refer to it as the "Terminator Technology".

The current state of affairs in the world agronomic seed industry:
The mode of reproduction of a crop plays a significant role in the seed industry. Hybrid crops like corn, sunflower, sorghum automatically require that farmers purchase new seed each year to maintain yield. If farmers kept their own seed of hybrids, 50% of the advantage of growing the hybrid would be lost in the next year. The incentive for farmers to buy new seed of a hybrid each year is quite large.

Self-pollinated crops, like wheat, soybean, and rice do not require that farmers purchase new seed each year. This is because the seed harvested from the crop is genetically identical to what was planted. It is common practice both in the US and the rest of the world for growers of self-pollinated crops to keep and plant their own seed. Brown bagging: The practice of farmers saving their own seed or "brown bagging" as it is usually called causes significant economic problems for commercial companies. Farmers may only purchase seed of a new variety once and in future years produce their own seed of this variety. This limits investment by the commercial sector in self-pollinated
crop breeding because there is limited potential return on investment. Much of the breeding of self-pollinated crops is done in the public sector, both in the US and the rest of the world. Brown bagging has also limited the use of biotechnology in self-pollinated crops, because it is difficult to control this practice. Hybrid crops do not have this problem and offer built in protection for intellectual property.

Patenting crop varieties and requiring farmers to sign grower agreements has been one way of circumventing the brown bagging issue in the US. Both the patents and the grower agreements prohibit farmers from saving seed to plant the following year. There are obvious enforcement issues, but US farmers have been prosecuted for brown bagging patented crop varieties.

**In the case of corn**

Even though hybrids offer a tremendous yield advantage in corn, hybrids are not grown by farmers worldwide. Hybrid seed production can be expensive and technically challenging to subsistence farmers. For example in corn, nearly 100% of the US acreage is planted with hybrids and farmers purchase new seed each year. In contrast, 62% of the corn acreage in developing countries is planted with local germplasm or open-pollinated varieties, whereas only 38% is planted with hybrids. The local germplasm or open-pollinated varieties are grown from seed saved the previous year by the farmer, purchased from other farmers, purchased from a public or government agency, or in some cases purchased from a commercial company. Forty percent of the hybrid seed planted in developing countries is of public origin. The developing countries represent a potentially huge market for corn hybrids. The primary hindrance has been that farmers in developing countries do not have the capital to purchase hybrids and intellectual property laws are weak in developing countries.

**In the case of wheat**

The situation with a self-pollinated crop like wheat is much different. Greater than 90% of the US hard red winter wheat acreage is planted with publicly (usually from land grant institutions) developed varieties. The situation is very similar in developing countries. Biotechnology has not been introduced into wheat because companies have no way to protect investment in their intellectual property. Few commercial companies breed improved wheat varieties, because the return on investment from breeding is very low.

**Controversy over this new technology**

**The case for introduction of the new technology - the industry perspective**

1. The trait protection system is essentially a means to protect intellectual property. Seed companies invest a great deal of time and money to produce new improved varieties for farmers to plant. These substantial costs can only be recovered when the seed providers can be confident that their products will not be illegally reproduced and distributed. A similar situation is seen in the illegal copying and subsequent sales of software, music CDs, and movies. It is an accepted practice for these valuable electronic media to contain embedded "poison pills" which prevent their unauthorized reproduction. The trait protection system is a conceptually identical means of protection. Seed companies have a right to protect their intellectual property and recoup the costs they incur in developing improved varieties.

2. The use of the trait protection system will increase availability of superior genetic stocks to third world farmers. Currently, seed companies are reluctant to sell their best germplasm in third world countries where there is a high probability that their lines would be illegally propagated and distributed. Because trait protection system removes the potential for subsequent illegal propagation, seed companies will have no reason not to offer their best genetic materials to farmers in developing countries. The increased availability of superior genetic stocks to
farmers worldwide will increase the choices available to farmers. Farmers will have the freedom to choose either their traditional varieties, or from the best seed offered in the commercial sector.

3. Seed protection technology will spur breeding efforts to improve genetic characteristics of many more crops than is done today. Currently, corn breeding is profitable because farmers purchase hybrid seed each year in order to get the superior performance of hybrids. Much less genetic research and varietal improvements have been achieved in other crops, partly due to the inability to recover the costs of producing improved varieties. Seed protection technology will protect investments in genetic improvement, and will thereby promote such efforts in the private sector. While it is true that such improved seed will no doubt cost more than varieties available today, this higher initial cost will be more than made up for by higher yields. Thus, the farmer will realize a greater income, and more food can be produced per acre, thereby lessening the overall environmental impacts of agriculture.

The case against introduction of the new technology

1. The use of terminator technology will result in a loss of biodiversity. First, the engineered seed will replace native seed. Second, relatively few varieties of any particular crop are suitable for engineering, so industry will be restricted in the varieties that can be engineered with the terminator technology. The result will be an increase in crop uniformity with potential increased vulnerability to pests and diseases.

2. The traditional role of farmers as plant breeders will be eliminated. Farmers that currently use traditional practices of plant breeding to produce varieties suitable for their local needs will cease to do so. In addition, the public sector that currently produces hybrids for distribution for profit in some countries will be forced to adopt the terminator technology to remain competitive.

3. The cost of the engineered seed will be more than the cost of lower-yield seed and farmers in underdeveloped countries will not be able to afford to buy seed every year.

4. There are risks associated with the use of this technology. First, there is a catastrophic risk associated with dependence on terminator technology products. If seed production were interrupted or lost, farmers would be left with nothing to plant. Second, there is a risk that the killer gene would be transmitted to related species of plants via the pollen, which would have a deleterious impact on neighboring plants/farmers.

5. Use of this new technology could result in control of global food production by relatively few companies.

International dialogue is required to address the potential impacts of this new technology on global agriculture and food production.

Questions.

1. Should it be illegal to use biotechnology to sterilize second generation seed for the purpose of preventing farmers from saving and replanting the seed?

2. Should industry be allowed to engineer seed for the purpose of protecting their intellectual property?

3. Should the United States government support this research, and if not, should this research be made illegal?
Citations:


4. Rural Advancement Foundation International web site "The Terminator Technology" by Hope Shand, Programme Officer, RAFI-USA. [http://www.rafi.ca/communique/19982.html]

5. USDA FACT SHEET. Why USDA's technology protection system (aka 'Terminator') benefits agriculture.

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