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# Value-added Land Values

*If biotechnology follows a path similar to other technological innovations in agriculture, some of the benefits will be passed on to consumers, some will be retained by agribusiness firms, and some will be captured by the surviving farm operators. Any remaining benefits will be bid into rental rates or land values.*

*by Robert W. Jolly and Sergio Lence*

This past year was not a stellar one for agricultural biotechnology. The industry discovered that consumer preferences have little to do with science and a lot to do with perceived benefits and risks. And it became increasingly clear that the technological capacity to create crops designed for specific end-users may not fit well with a marketing and transportation system designed for high volume and undifferentiated products. The problems encountered by the biotech industry in 1999 may be mere bumps in the road to be resolved in the near future. Or they may presage real limits on the application of biotechnology. What is apparent, however, is that

the future of agricultural biotechnology will rest on a much clearer understanding of its benefits and costs — on winners and losers.

In this article we explore this topic by considering how advances in crop biotechnology might influence land rental rates and land values. No attempt is made to determine what is “fair” or “unfair.” Instead, the emphasis is on understanding the likely impacts that techno-innovations may have on the distribution of returns to land. If biotechnology follows a path similar to other technological innovations in agriculture, some of the benefits will be passed on to consumers, some will be retained by agribusiness firms, and some

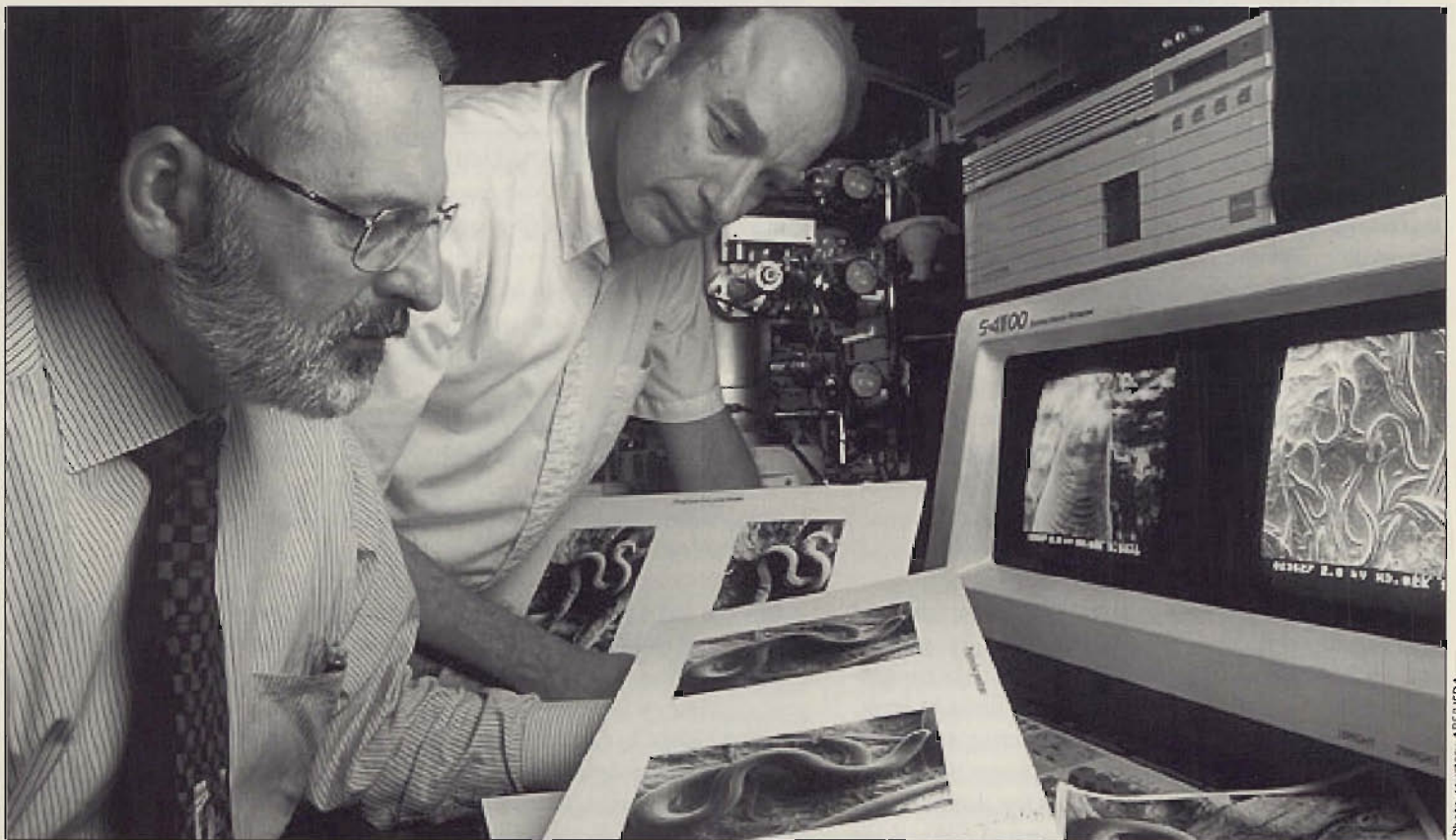


Photo courtesy ARS/USDA

**Marching on.** Studies of pest control solutions offered by biotechnology has intensified. These scientists are studying nematodes.



will be captured by the surviving farm operators. Any remaining benefits will be bid into rental rates or land values. Historically, land has been the residual claimant for gains from technology. Will biotechnology change this relationship? Will land owners be the primary beneficiaries — or will the benefits accrue to another group(s) within the food and agricultural sector?

### Determinants of Land Value

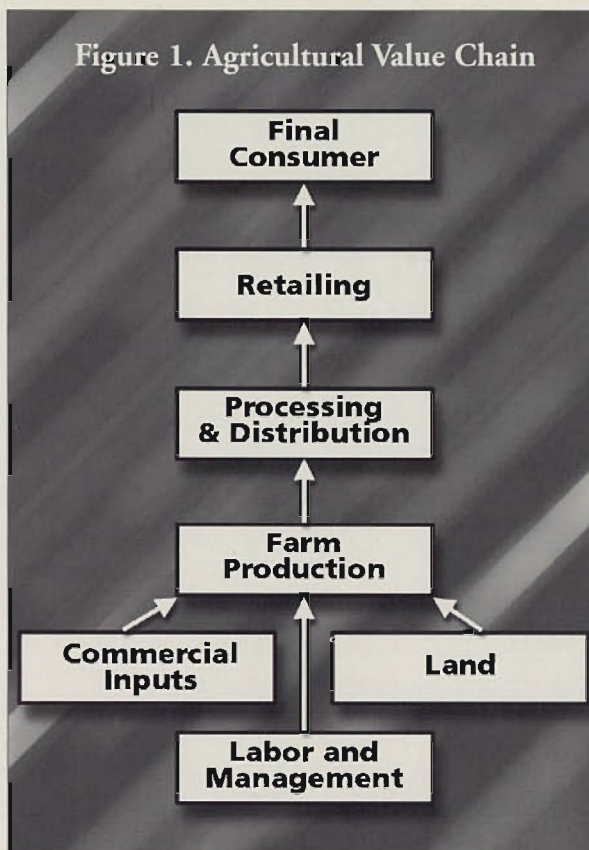
A simple model of land value determination helps. For this purpose, land may be compared to a growth stock — an asset that generates current returns (rental rates or net returns to land use), and also capital gains or losses. This is a reasonable characterization because buying land brings the rights to an uncertain stream of rental or land use returns that continues into perpetuity. Farmland will be an attractive investment as long as its expected rate of return is high, relative to other possible investments. The process of bidding for land will cause values to increase or decrease until its rate of return comes in line with other comparably risky investments (Lence and Miller).

### Technological or Organizational Changes Affect Land Values

Relatively little evidence documents the linkages between technologies, organizational changes, and land rental rates and values. A glimpse at the ownership and tenure situation in Iowa may help before continuing to some hypothetical cases about linkages to land value. Consider the information provided in the sidebar on page 20. Table 1 shows that sole owners (individuals) or husband and wife teams owned 79.8 percent of Iowa's farmland in 1982. Fifteen years later, the figure had fallen to 70.3 percent. If land prices rise, these individuals and couples will be the beneficiaries of about 70 percent of the increase in value. The remainder will go to trusts, corporations, and other forms of ownership. Table 2 in the sidebar shows that 60.4 percent of the farmland in Iowa is operated by tenants. These tenants — three-fifths of the farm operators in the state — will not likely benefit from the rise in land values. In fact, they may be asked to pay higher rents for land that is now more valuable. The other two tables can be interpreted in similar ways. The message is a familiar one: the division of the rewards to rising land values depends entirely on who owns the asset. This could distort the way in which biotechnology is adopted by farm owners and operators in Iowa. We suspect that the situation is similar in other states.

The value chain shown in Figure 1 helps explain how value is generated and distributed among those who have a stake in agriculture and biotechnology. Each stage in the chain creates value as inputs are transformed into new

Figure 1. Agricultural Value Chain



**No Missing Link.** Each stage in the chain creates value and helps transform the inputs into new materials or final goods. Although how value moves along the chain usually depends on several outside factors, biotech companies are forcing value-capture at every stage through the use of patents, contracts and licenses or through direct ownership of the supply chain.

materials or final goods. The following examples show how much of the value added at a particular stage is captured at that stage and how much is passed up or down the chain. The value moving along the chain depends on several factors, such as the degree of competition, the nature of the innovation, the bargaining position of the parties, and the nature of the property rights.

Although the above issues are relevant for any technological innovation, new biotechnology may change how value is created and distributed along the value chain. New biotechnology is characterized by high-cost, high-risk research primarily done by the private sector. The cost and risk has required the research firms to develop

*An input trait biotechnology by itself seems to allow its developer to capture most of the value it creates.*

new institutional arrangements that allow them to capture value that is added at several or all points along the supply chain. This is accomplished largely through the use of patents, contracts, and licenses — legal instruments that create a partial monopoly — or through direct ownership of the supply chain (Moschini and Lapan). These characteristics of new biotechnology are in stark contrast with those of the technologies responsible for the unprecedented crop productivity gains experienced since World



# Who Owns Farmland?

**Table 1. Farmland Ownership in Iowa, 1982 and 1997.**

| Ownership Type              | 1982                         | 1997 |
|-----------------------------|------------------------------|------|
|                             | <i>(Percent of Farmland)</i> |      |
| Sole owners                 | 41.1                         | 31.2 |
| Husband and wife (joint)    | 38.7                         | 39.1 |
| Other joint/co-owners       | 7.3                          | 5.6  |
| Partnerships                | 0.3                          | 4.0  |
| Estates                     | 3.8                          | 2.7  |
| Trusts                      | 0.8                          | 7.4  |
| Corporations                | 8.0                          | 5.3  |
| Limited liability companies | 0.0                          | 4.7  |

Source: Pieper and Harl, 1999

**Table 2. Tenure of Operators of Iowa Farmland, 1982 and 1997**

| Tenure                               | 1982                         | 1997 |
|--------------------------------------|------------------------------|------|
|                                      | <i>(Percent of Farmland)</i> |      |
| Operated solely by owner             | 54.1                         | 30.8 |
| Operated by owner with help          | 0.9                          | 7.8  |
| Operated under cash rent lease       | 21.1                         | 34.9 |
| Operated under crop share lease      | 21.1                         | 23.7 |
| Operated under other lease agreement | 1.0                          | 2.8  |
| All others                           | 2.7                          | 0.0  |

Source: Pieper and Harl, 1999

**Table 3. Percent of Iowa Farmland Owners by Principal Occupation, 1997.**

| Principal Occupation   | 1997 |
|------------------------|------|
| Farmers/farm managers  | 38.6 |
| Farmwives/housewives   | 28.4 |
| Professional/technical | 12.8 |
| Clerical               | 3.5  |
| All Others             | 16.7 |

Source: Pieper and Harl, 1999

**Table 4. Age and Gender in Iowa Non-Corporate Farmland Ownership, 1997.**

| Gender  | Age (years) |       |         |      |
|---------|-------------|-------|---------|------|
|         | Under 35    | 35-65 | Over 65 | All  |
| Males   | 1.6         | 31.0  | 19.0    | 51.5 |
| Females | 1.0         | 25.5  | 19.6    | 46.1 |
| Total   | 2.5         | 56.6  | 38.6    | 97.7 |

Note: Totals do not add to 100 percent due to omission of minor categories.

Source: Pieper and Harl, 1999

Higher farmland rental rates benefit owners by enhancing their current incomes as well as their wealth, as higher returns or higher rental rates are bid into land values. The gains to owners come at the expense of tenants and new entrants, who must pay higher prices for land. Farmland ownership and tenure, then, are major determinants of the distribution of the gains and losses arising from land value changes.

A recent study by Pieper and Harl identified patterns of farmland ownership in Iowa. Table 1 shows who owned Iowa farmland in 1982 and 1997. In 1997, 90 percent of the farmland was owned by individuals or through their estates or trusts. Corporations and limited liability companies owned 10 percent. However, Table 2 shows that less than 40 percent of Iowa's farmland was operated or farmed by its owner. The remainder was rented. Table 2 also reveals a striking shift from ownership toward land rental between 1982 and 1997.

According to Table 3, slightly more than one-third of all farmland owners considered their principal occupation to be farmers or farm managers. The next largest occupational group (28.4 percent) was women employed on the farm or in the home. Table 4 reveals that nearly 40 percent of farmland was owned by people over 65 years of age, so farmland likely is a source of retirement income.

In the future, it seems likely that farmland ownership will remain fragmented, as shown in Table 1. Given the significant trend toward more land rental and less ownership by farm operators reported in Table 2, it also seems reasonable to conclude that farm operators will likely rent significantly more land than they own. Consequently, any increase in rental rates and the increase in land values stemming from technological innovations will likely impact the majority of farm operators more as increased costs rather than as increased wealth.





### Roundup Ready and waiting.

Seed waits in an Illinois warehouse. To use this technology, farmers must agree not to save seed for the next season.

Photo: Clear Window

War II. The latter technologies increased the production of bulky, undifferentiated commodities. Further, many of them have been the result of public-funded research, and most of them were made available through simple market mechanisms.

### Input Traits

Input trait biotechnology introduces genes into crops with the purpose of modifying their input requirements. A typical example is Monsanto's Roundup Ready™ (RR) gene in soybeans. In order to use this technology, farmers must pay for the seed, agree not to save seed, and purchase only patent-protected Roundup herbicides. Farmers may also receive a lower price, because genetically modified soybeans frequently sell at a discount. In return, farmers gain simple and effective weed control at lower cost. In addition, the time and equipment required for weed control may be reduced, permitting an operator to farm more land.

An operator adopting RR soybeans may attempt to rent or buy more land if by doing so he expects a higher net return. To farm more land, he would have to bid it away from other farmers, thereby increasing rental rates and land values. After the dust had settled, the operator would pay more per acre rented, and would run a larger business as measured by volume. If a sufficient number of farmers make this decision, land values and rental rates will increase as a consequence of the new production technology. Operators whose returns for land use cannot justify the higher rental rates will eventually quit farming. On balance, the remaining operators should be

at least as well off as they were prior to adopting this technology. If not, they will adjust by bidding less for land or shifting to alternative crops or production practices. The landowners — operators as well as landlords — benefit from this technological innovation because their earnings, from farming or from land rental rates, increase.

However, the RR technology is controlled by a single life science firm with a strong incentive to keep as much of the value created as possible. Since this firm would only need to offer RR technology at prices just attractive enough to steer farmers away from alternative technologies, the increased returns to land due to RR soybeans would likely be modest, as would impacts on land values and rental rates.

An input trait biotechnology by itself seems to allow its developer to capture most of the value it creates. Land is an unlikely residual claimant in this value chain. Instead, the patent bundle protecting the trait may now play this role. If operators have a choice from among several technologies, the supplier of any one must compete against suppliers of the alternatives. The more competitive the market for new technologies, the more likely at least some of the associated value will be captured by providers of relatively fixed inputs like land and managerial skills. Competitive markets for new technologies are more likely to translate into higher rental rates and increased land values.

### Output Traits

Output traits result from genes introduced into crops to make them more attractive from the buyer's stand-



**Hopper on the GMO bandwagon.**

Planting Roundup Ready seed enables savings of time and money in weed control.

Photo: Clear Window.



point. Examples include corn with higher oil content, soybeans with altered fatty acid composition, and crops engineered to produce pharmaceuticals or other high-value compounds. Output-trait crops need to be kept separate as they move through marketing channels. One method to achieve this, identity preservation, relies on a

series of contracts to manage production and distribution of the crop along the value chain. A second method relies on testing and sorting of bulk commodities at the point of sale. In this latter approach, production contracts and monitoring are less important and would probably not be needed.

Output-trait biotechnology can bring unusual results. Suppose that a U.S. food processor identifies a foreign market for one of its organically grown food-grade soybeans with a unique nutrient composition. The company contracts for 500,000 acres within a 100-mile radius of its U.S. processing plant to meet the needs of its customers. Would

**David Orden | Robert Paarlberg | Terry Roe**

## **POLICY REFORM IN AMERICAN AGRICULTURE**

***Analysis and Prognosis***



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*The losers would be those operators who depend on rented land ...*

this innovation influence land values and rental rates? If growing these special beans meant higher production costs, the food processor would be required to offer a contract attractive enough to bid farmers away from their current conventional crop operations. In general, however, farmers would be only slightly better off than before after accounting for all production costs. Further, the acreage needed for this specialty crop is relatively small and in the example, fixed. The net impact on land values from this one innovation would likely be modest.

In another example, a seed company introduces a high-protein corn variety that is of great value to live-stock producers and requires no change in production practices. Further, the high protein level can be identified by a simple test. The seed company needs to recover its development cost, plus its usual production costs. Farmers add no more value to the chain than they do for the



prevailing corn variety. Will this output trait impact land values and rental rates? Again, farmers are unlikely to adopt this technology if they are not made better off. However, they need to be offered just enough to shift varieties. The additional value will be captured by those firms in the chain that create it — the seed company and the processing and distribution company. Land values will not be significantly affected by this output-trait innovation. In economic terms, output-trait technologies of this type are not different from traditional yield-increasing technologies, as they simply increase the yield of a component of the crop.

## Conclusion

New technologies and organizational changes will have an impact on land values and rental rates. However, it is difficult to distinguish such impacts from, for example, the overall impact of the increasing global demand for food. The former may have a negligible impact on land values and rental rates, whereas the traditional forces of growing demand, generally improved production technology, and macroeconomic conditions may continue to be the stronger forces.

It seems reasonable to conclude that, if there are few suppliers of technological innovations, most of the direct value creation will be captured by the developers and suppliers of the technology. In such instances, it is unlikely that innovations will result in markedly higher rental rates and land values. In contrast, if there are many suppliers of alternative technological innovations, the suppliers will transfer at least some of the value creation to farm operators, and eventually to the owners of the land.

If U.S. farmland ownership and tenure characteristics remain similar to those of Iowa farmland (See sidebar “Who Owns Farmland?” page 19), it may be safely concluded that those who benefit the most from land value increases tend to be elderly landowners. The operators who are most efficient in the adoption and use of the new technologies and contractual arrangements are also likely to benefit, but to a smaller extent. The losers would be those operators who depend on rented land — in most instances young or mid-career commercial farmers — and who are not efficient enough to stay in business in a new economic environment.

Whatever the ultimate impact of biotechnology and the accompanying organizational change on land values and rental rates, it is clear that untangling their benefits and costs will remain an important and essential task for agricultural economists in the foreseeable future. ■

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## ■ For More Information

Lence, S. H., and D. J. Miller. “Transaction Costs and the Present Value Model of Farmland: Iowa, 1900-1994.” *American Journal of Agricultural Economics* 81, no. 2(1999):257—272.

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