

# Investing in New Crop Varieties

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## Opinion

### Introduction

Economists continue to estimate the rate of return from public investment in the development of new crop varieties. The returns from new crop varieties have been impressive, as shown in Table 1 [1]. Take, for example, the pioneering work of Griliches [2], where the rate of return on public investment in the development of new U.S. corn varieties was approximately 4% [2]. In addition, the adoption of genetically modified soybeans, maize, and cotton, increased yields by more than 20% and reduced pesticide use and cost by 30% (e.g., Bt cotton contributed to the fast adoption of Bt cotton in India) [3].

**Table 1:** Selected economic returns to agricultural research.

Commodity	Study	Rate of Return (%)	Country
Aggregate Agriculture	Evenson et al. (1979)	65	United States
Barley	Ulrich et al. (1986)	31-75 <sup>a</sup>	Canada
Canola	Ulrich et al. (1984)	51	Canada
Hybrid Corn	Griliches [2]	35-40	United States
Rice	Scobie and Posada (1978)	79-96	Colombia
Tomatoes	Schmitz and Seckler (1970)	≥50	United States
Wheat	Zentner and Peterson (1984)	38	Canada

**Source:** Schmitz, Moss, Schmitz, van Kooten, Schmitz [1].

### Factors affecting crop yields

Many of the studies on rates of return to public investment focus on the development of new crop varieties. Crop yields are affected not only by new varietal development, but also by the use of fertilizers, pesticides, herbicides, crop rotation choice, and mechanization (including machines for planting and harvesting).

### Mechanization

Improved mechanization from planting to harvest has changed dramatically over the past fifty years [4]. Mechanization plays a major role in crop yield improvements. For example, in Florida, over 20% of the increase in sugarcane yields is a result of improved mechanization, especially in harvesting the crop [5]. Similar results have been noted for sugarcane yields in Louisiana [6]. Another example is the dramatic change in the types of crops grown in the Prairie region of Canada, along with the increase in total planted acreage. Thirty years ago, wheat and barley were the primary crops grown on the Prairies. Today, they are minor crops compared to canola, lentils, and peas. These crops are made possible because of investment in varietal development and in planting and harvesting technologies such as air drills and straight header combines [4]. Also, the development of continuous crop technologies keeps more cropland actively producing year-round, where before, at least 30% of the land was left fallow each year.

## Private investment in research and development

The private sector invests heavily in research and development, both internally and in partnership with public institutions, including universities. Monies spent for research and development by the private sector exceed that of the public sector, especially for farm equipment and new crop varieties. For example, the private sector developed the majority of new varieties of genetically modified seeds for crops such as canola. Roundup Ready canola was developed by Monsanto, and In Vigor canola was developed by Bayer for tolerance to a specific herbicide. Millions of acres of genetically modified canola are planted every year. Another example is genetically modified sugar beets, which have been genetically engineered using biotechnology to directly modify the genome [7]. Roundup Ready sugar beets developed by Monsanto make up most of the commercial sugar beet production in the United States. Biotechnology has greatly increased crop yields [3].

## Crop yields and input use

Crop yields differ greatly by country and by the management capabilities of farm operators. Optimal timing is crucial for the application of pesticides, herbicides, and fertilizers. For example, yield response of crops to fertilizer application is significant. Generally, crop yields are lower in developing countries than in developed countries [8,9]. This is in part due to lack of soil testing and low rates of fertilizer applications.

## Learning by doing

Little literature exists on the impact of "learning by doing" by individual farmers on agricultural productivity. For example, optimal crop rotations are a necessity for successful farming, and the choice changes over time are dependent, at least partly, on the learning by doing of the farm operator. This is also the case for optimal timing of the application of herbicides and pesticides. Soil testing also fits this category.

## Double cropping and joint enterprises

Considerable crop acreage is double-cropped worldwide, where two crops are grown on the same field within a given year. For example, farmers in Brazil double crop sugarcane and wheat, while U.S. farmers in Missouri double crop soybeans and wheat. The double-cropping system serves two purposes: environmental

and economic, such as controlling soil erosion while increasing farmers' cash flow [10]. Another example of double-cropping systems is joint enterprises, such as in Louisiana, where rice grows in conjunction with crawfish. In the case of rice, new varietal development for rice possibly has an impact on crawfish yields; for example, improvements in rice yields may positively affect the profitability of crawfish production.

## Conclusion

Future work on the estimation of the rate of return to research should expand the scope of the framework used by past researchers to include the factors above.

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