ECONOMIC OF EMERGING AGRICULTURAL BIOTECHNOLOGIES

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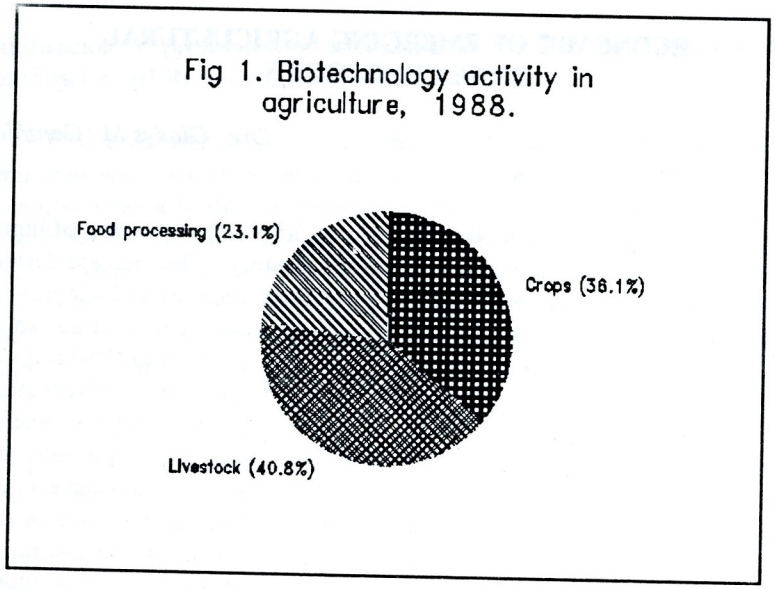
Agricultural productivity, the ratio of farm output per unit of input, has increased on a sustained basis throughout history. The increase derives from two basic sources, investment in agricultural research and adoption of new technologies. Historically, technologial advances in agriculture can be roughly divided into three periods: the first one from 1930 to 1950 and was the mechanical revolution, from 1950 to 1980 we saw the chemical revolution and since then we are in the biotechnological and information revolution. In terms of what some call the advances in electronics and others in information, we have seen in the past decade or so advances in the development and use of sensors for irrigation, planting, fertilization and pesticide application; in data storage and manipulation; in the control of marketing systems and improvement in information systems; agricultural simulation models; telecomunications systems and robotics for advanced mechanization of agriculture.

In this presentation I will try to address the issue of economic benefits and costs of the new biotechnologies. Although the revolution going on in information systems cannot and should not be ignored, my presentation will be limited to biotechnology and will only mention the other sources of technical change when strictly necessary.

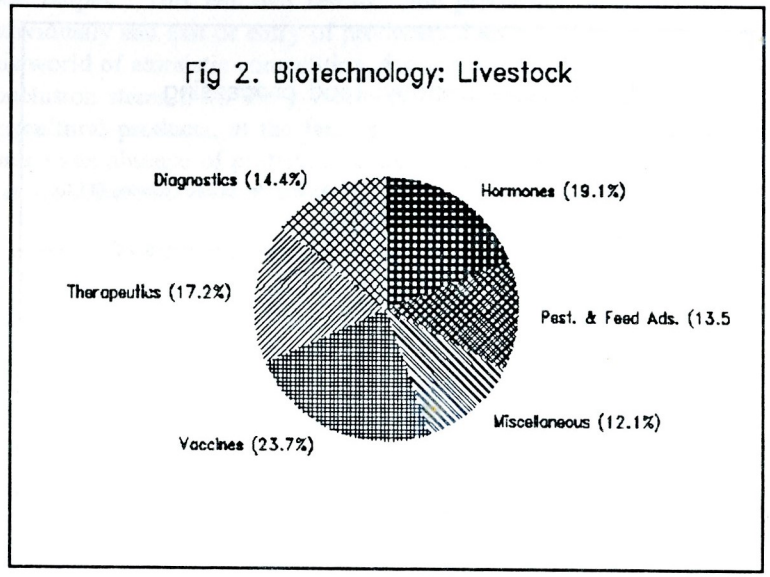
In 1988, 321 firms were involved in biotechnology research activities as follows: 131 firms in livestock and veterinary products (41%); 116 in crop research activities (36%); and 74 in food processing (23%). (Figure 1).



Source: BioScan: The Biotechnology Corporate Directory Service, Oryx Press, N.Y., Dec. 1988 Supplement.

On-going research in veterinary and livestock products includes vaccines, therapeutics, diagnostics, food additives, growth hormones, fertility and other hormones (Figure 2). Biotechnology activities in crops include improved varieties, propagation, genetic engineering, and others (Figure 3).

Most activities related to research in food processing are being conducted at the firms and involve food enzymes, sweeteners, flavors, detection of contaminants and others such as protein synthesis (Figure 4).



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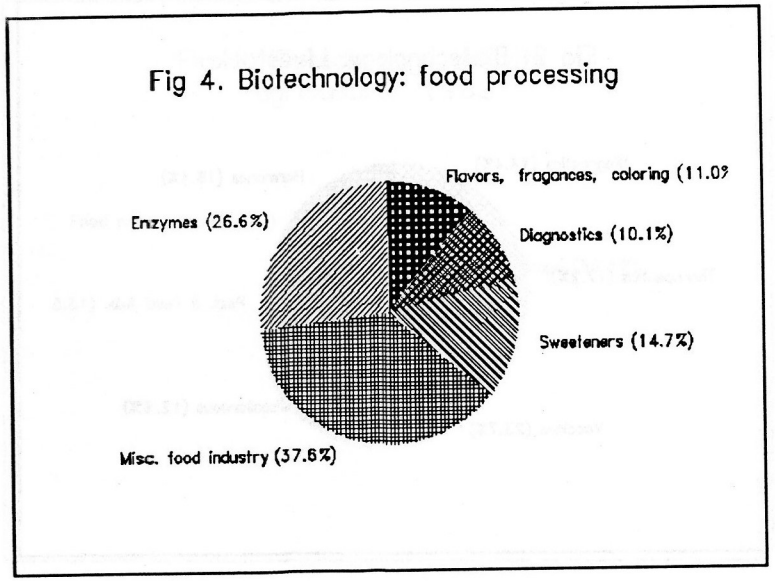
To give simple definitions, agricultural economists refer to technology as the application of accumulated knowledge and technical change as the application of new knowledge. In our profession, we prefer to talk in a generic way when making reference to technical change; that is, we are implying technical progress. New technology can be in the form of new products that replace old ones, new or improved inputs, or improvement of an established practice. In the case of biotechnology, the results of research will be mostly in the form of new or improved inputs and not so much in the development of new products.



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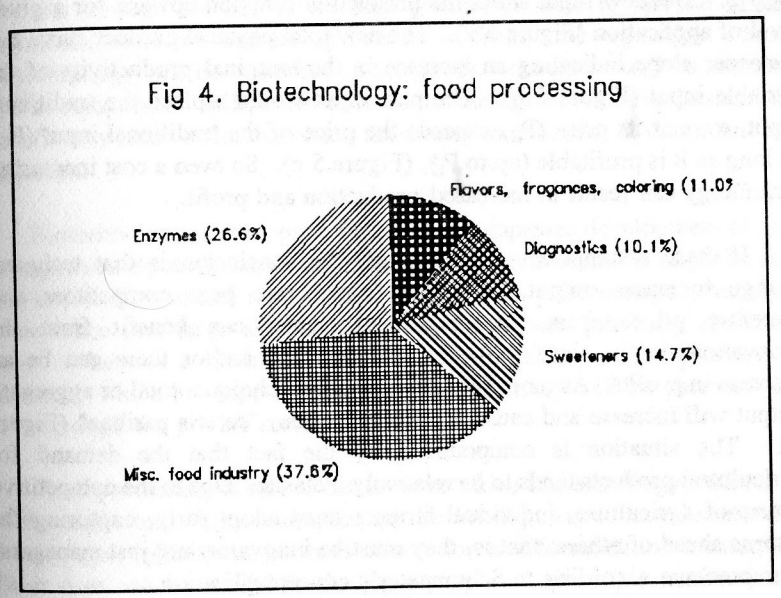
From an economists' standpoint, generally speaking, technical change has the following effects:

At the Micro level: on consumers on producers (farmers) on input suppliers on output processors.

At the Macro level: on competitive position of agricultural products in relation to the global economy on other economies, especially LDCs on the environment on the resource allocation among competing uses within the economy on the structure of the agricultural sector.

A description of the agricultural sector is necesarry in order to identify and give an idea of the possible direction or magnitude of such effects. The agricultural sector of the economy fits in the model of pure competition. This means that farming can be described as a sector composed of many independent farmers, each one of which produces a small proportion of the

total output. This has two results: the production decisions are taken individually and exit or entry of producers does not affect total output. In this world of atomistic competition, farmers are natural price takers. This conclusion stems from the previous condition and also from the fact that agricultural products, at the farm gate, are homogeneous. Homogeneity leads to an absence of preference creation contrary to the case of products that are differentiated, as in the case of processed food products.



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Let us assume that the product of biotechnology is the development of a new input which replaces the usual input (could be a new variety resistant to a disease). The new input would be adopted only if it conveys a reduction in costs. Two cases will be analyzed.

Case 1: The new input (x_1) has the same production function (input-output relationship) of the traditional input (x_o) (Figure 4.a). If the unit cost (Marginal Factor Cost) of the new input (P_{x1}), is lower than the cost of the traditional input (P_{xo}) producers will increase the application of input by

DE (Figure 4.b). That will increase output by FG (Figure 4.c) and profit by the area under the VMP (Value of Marginal Product) curve and between the two price lines. Due to the asset fixity, seasonality and other characteristics of agriculture, it might be that in the very short run, the new input decreases cost without increasing output.

Case 2: The new input shifts the production function upward for a given level of application (Figure 5.a). The new total physical product curve has a steeper slope indicating an increase in the marginal productivity of the variable input (Figure 5.b). The new input would replace the traditional input, even if its price (P_{xl}) exceeds the price of the traditional input (P_{xo}) as long as it is profitable (up to P_t), (Figure 5.c). So even a cost increasing technology can result in increased production and profit.

If these assumptions are accepted, the conclusion is that technical change increases output. Because farmers are pure competitors and therefore price takers, the individual farmer can benefit from the innovation; in the short run costs can decrease and/or there can be an increase in profits. As more farmers adopt the technique, total or aggregate output will increase and cause a price reduction, "ceteris paribus" (Figure 5). The situation is compounded by the fact that the demand for agricultural products tends to be relatively inelastic. Due to the competitive nature of agriculture, individual farmers must adopt early, capturing the returns ahead of others; that is, they must be innovators not just managers, entrepreneurs according to Schumpeter's conceptualization.

In agriculture a new technology might save the resources necessary to produce a given output, but the returns to resources might be low if the price of the product declines. The low earnings are due to a low price elasticity of the demand for agricultural products. An increase in quantity demanded (along a demand curve) decreases the total revenue received by farmers since the relative or percentage change in quantity demanded is exceeded by the relative change in price that stems from the increase in total output.

Gearing my conclusion towards the case of biotechnology, I can say that the innovation, once developed and adopted, can adversely affect farming from the standpoint of revenues received by the farmers. As Cochrane noted in 1958, early adopters may be the winners and laggers the loosers.

Consumers, on the other hand, will have more product available at a lower price. In the long run, they might be the major beneficiaries. This is especially true in a market characterized by inelastic and slow growing demand, as typical in the agricultural markets of high income countries. Consumers may also benefit from improved food quality and safety. For example, enhanced nitrogen fixation will decrease fertilizer requirements which could lead to less nitrate contamination of ground water. The control of pests through the use of resistant plants will lead to the use of less chemicals, therefore decreasing residue in fruits and vegetables. Since biotechnology will be embodied in the goods, consumers will be unaware of that component. Still, consumers do not clearly and fully understand the benefit they receive from devoting tax money to research, development and diffusion.

Biotechnology is not a product, but it encompasses development of new or improved inputs that are used in the production process. It might be said that universities started it all, small research companies emerged, but there is evidence that large agribusiness firms have been gradually absorbing them. There is a likelihood of monopolistic pricing of the products of research, which are inputs in farming, because they will be patented and sold through the private sector.

Food processing is one of the areas in which biotechnology research is being conducted. Some examples are the development of new sweeteners, preservation techniques, biomass conversion and fermentation techniques. Their case can be similar to the input suppliers' since this market is not perfectly competitive.

When the agricultural sector is viewed in a holistic fashion, benefits and costs of biotechnology can also be identified. Biotechnology adoption is not size neutral. The new technologies are more complex than past or traditional ones, therefore increasing the complexion of the management function. Another factor is that the adoption of this kind of technology will require an added amount of money and capital inputs. Larger size farms have an advantage over moderate size farms in that aspect. If smaller farms are not in an advantageous position, biotechnology adoption might lead to a higher concentration (fewer, larger farms) and, therefore, a structural transformation of the sector, giving an advantage to larger units and forcing smaller ones out of business.

Most experts are saying that the first biotechnology product to hit the market will be the bovine growth hormone (bGH). The U.S. Congress Office of Technology Assessment concluded in 1986, that bGH would increase milk production in the US by 25.6% and accelerate the trend toward more concentration.

Puerto Rico's Gross Farm Income in Fiscal Year 1988/89 was $730,957,000, of which 27% came from the dairy industry. Adoption of bGH by Puerto Rican dairy farmers will naturally have impact in our agriculture. The mechanism and the magnitude are unknown since they will depend, among other factors, on rate of adoption, public policy on production quotas and price policy.

Global issues can be divided into two categories, one dealing with Third World countries and the other with the terms of trade and competitive position of our products. Those countries that do not have the institutional set up for the development or diffusion of new biotechnologies will suffer. In terms of domestic versus adoption by foreign countries, a loss of comparative advantage can result for the non-adopting countries, thus affecting domestic income levels.

Biotechnology poses a challenge for universities, especially for extension people. How can complex technology be delivered to smaller farmers? Some adjustments will be needed or technology will be concentration-biased. In terms of economic and social research, there is a need for assessment and quantification of the adjustments anticipated. It might not be too early to start since we may already be in the threshold of a new economic order.

Some indirect or external effects as well as the process of dynamic adjustment that could take place in the markets of the whole economy should be recognized. Although I am aware of the fact that the impacts of biotechnology are likely to be far reaching, my intention was just to identify the most direct or primary Benefits and Costs of the new technologies. As economists, the most widely used normative criteria whenever a change is evaluated is that adoption is desirable even in the event or presence of costs if gainers from the change can compensate loosers and still be better off (potential Pareto improvement occurs).

IS PUERTO RICO'S ECONOMY BECOMING A LEADING INDICATOR OF U.S. RECESSIONS?

Prof. José I. Alameda Lozada

I. Introduction

For a number of years, varios researchers [Baer (1962)] Alameda and Rivera - Galindo (1975), Alameda, Rivera and Rodríguez (1988), Ayuso (198..) have examined the impact of U.S. business cycles on the economy of Puerto Rico. The seminal work by Baer addressed this impact emphasizing in particular, the lead-lag relationship between the two economies. His main conclusion was that "the two mainland recessions in the 1950's revealed a very mild [lead] reaction of the island". The main reasons for such mildness according to Baer were: (1) the vigorous expansion of investments by new U.S. firm which led to a strong rate of growth in output and employment, and, (2) the commodity export structure which was mainly dominated at the time by agricultural products characterized with a low income elasticity of demand.

Baer also agreed with local governmental authorities with respect to a lag reaction of the Puerto Rican economy. In the 1953-54 recession, for instance, manufacturing exports were hardly affected and resulted in a lag of approximately nine months. While the 1957-58 recession, reaction was felt after six months after a peak in U.S. industrial production. Given the lack of quarterly GNP figures or any aggregate index of economic activity at that time, Baer was non able to establish the lead-lag relationship between Puerto Rico and United States. Despite this, however, one can still argue that some type of lag reaction of Puerto Rico's economy might exist, given the facts previously mentioned. It is to this argument this paper is directed.

II. Are recessions in Puerto Rico and United States alike?

In general terms, a recession occurs whenever real Gross National Product (GNP) declines for two consecutive quarters. However, this is a