Biotechnology and Agriculture in Developing Countries

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This multinational project intends to identify the current and potential uses of biotechnology in the agricultural and food sector of developing regions of Central Africa, India and Venezuela. Particular attention is paid to the study of biotechnological research, its applications, and social consequences in the above mentioned regions. Selected agricultural commodities will be grouped in three categories: 1) export oriented commodities; 2) commodities for domestic consumption; and 3) commodities produced for both domestic and international markets. The study will be divided in two phases. The first involves the identification of three commodities to be included in the above mentioned groups. Commodities will be selected for each of the regions studied. The second analytical phase is aimed at understanding the current and future uses of biotechnology in the production of the selected commodities. The principal objective is to understand the social consequences that the application of biotechnology generates for various social actors in the agricultures and societies of these regions of the developing world.

Nelson Prato Barbosa, CENDES, Venezuela is the project coordinator. Cooperating investigators are **Jean-Pierre Frey**, Centre D'Etudes Economiques, Central Africa; **Rachana Bharti**, Technology and Development Group, India; **Alessandro Bonanno**, University of Missouri, USA; **Maria Fonte**, Universitá di Napoli, Italy; **Pascal Byé**, INRA, France.

Introduction

Current conditions in developing countries demand new strategies for the socio-economic development of agriculture both domestically and in terms of these countries' presence in international markets. This situation mandates the introduction of more sophisticated forms of management which, it is hoped, will lead to improvements in the quality of agricultural products and increased productivity. It is in this context that new biotechnologies have been introduced in agriculture.

In developing countries there is an increasingly evident optimism in regard to the utilization of biotechnology. This optimism has been translated into a growing infrastructural and financial support from national governments (Brenner, 1991; Byé and Frey, 1988; Costagne and Gutier, 1982; Jaffe and Zaldivar, 1992; Kumar, 1988; Agricultural and Human Values, 1988). Similarly, there is an awareness of the important role that biotechnology is playing in the new global economy which now shapes the perspectives of producers and the scientific community (see International Journal of Sociology of Agriculture and Food, Vol. 1, 1991).

These new elements have drawn the attention of members of the Research Committee on Sociology of Agriculture and Food of the International Sociological Association (ISA), which along with other individuals and groups has initiated various investigative activities in this area. For example, discussing the social dimension of scientific investigation, Busch

and Lacy (1983) indicate how the latter is related to dominant social values (other examples are Lewin, 1972; Cheney, 1974; Patterson, 1976). Others have emphasized the relationship between technical change and social transformations (Vessuri, 1981). In this context, particular attention has been paid to the effects that the adoption of new technologies have on producers and consumers (Cochrane, 1979). Similarly, important contributions have been generated in regard to the role of scientific innovations in society and their relationships with the public and private sectors. In the case of agricultural research, the role of the public sector has been identified as dominant, as private investments have generated inadequate levels of profitability for the private sector in R&D (Busch et al, 1989).

Though there are numerous ways in which biotechnology can be defined, according to the Office of Technology Assessment (1986:9; cited in Bonanno, 1991:141) this biotechnology refers to "techniques which imply the use of living organisms or portions of organisms to create and/or alter products, change the genetic make-up of plants or animals, and develop micro-organisms for specific uses. It refers to two basic genetic-molecular techniques: recombinant DNA and cellular fusion."

The biotechnological revolution is a product of genetic research. Busch et al., (1989:84) indicate that the traditional ways in which genetic research has been carried out in the past have been radically modified with the introduction of biotechnology. In this context, the authors point out that these new techniques have at least three distinct advantages over traditional techniques. First, it is possible to cultivate a significant number of different cells--each of them a potentially new plant--in a small area. Second, sexual reproduction can be replaced allowing the introduction of foreign material in the genetic make-up of species. Third, it is possible to create new and genetically improved products in a much more accelerated manner than in the past.

Numerous analyses have underscored the uncertainties associated with the use of biotechnology. Not only are the short term consequences of its application unclear, but it is almost impossible to predict the kind of long term consequences that the introduction of modified species can have on social and natural environments. Despite numerous notes of caution, biotechnology gained instant popularity and support, creating the expectation of immediate improvement in all areas of agricultural and food production (Carrizalez, 1981; Texera, 1984).

This climate generated a rush of investments in R&D. The significant intervention of private capital was later replaced by a much greater proportion of research being carried out by the public sector. Though results to date have not been as significant as predicted by some, in many cases the alteration of established patterns of agricultural and food production have been notable (Jaffe, 1991; Jaffe and Zaldivar, 1992). The creation of sugar substitutes (Van den Doel and Junne, 1986), of eatable oils (James, 1984) and of fabricated foods (Stanley, 1986) are a few cases in point. Biotechnological research also involves the use of raw materials. For instance, products which are bio-chemically similar to natural products have been generated in laboratories, severely challenging the concept of artificiality (Busch et al., 1989).

While some authors (e.g. Byé and Mounier, 1984) indicate the difficulties that transnational corporations encounter in furthering their presence in biotechnology, the impact on developing countries has already been significant, as they have the vast majority of genetic material available in the world and are economies based, to a significant extent, on agricultural production. Moreover, it has

been feared that the increased use of new biotechnology can continue to create unemployment in agriculture, the elimination of products from local markets, changes in the relationship between rural and urban areas, and increasing conflicts over property rights.

The separation between the "social" and "natural" sciences is perhaps one of the most important sources of the relative lack of discussion regarding the social consequences of biotechnology. Paradoxically, the introduction of biotechnology in agricultural production has forcefully demonstrated the social construction of nature. In fact, the possibility of "designing" new natural products clearly introduces the question of what type of nature is desirable and should be pursued through scientific investigation (Busch, 1991).

One of the new aspects proposed by this line of investigation is analyzing the social objectives implicit in the development of new biotechnologies. More importantly, the goal is to illustrate possible undesirable consequences associated with the impact of new technologies in the socio-ecological sphere. In this respect, it is important to reach an equilibrium between the fostering of democratically determined social objectives and the adoption of advanced forms of technology (Biotechnology and Development Review, 1991:6). Consequently, it is important to create a democratic consciousness which allows a greater participation of communities in the definition of the role of scientific investigation (Busch, et al., 1989).

Objectives of the Proposal

The following are the four objectives of this proposal:

1) The project will carry out historical analyses of research practices and of the introduction of biotechnological techniques in developing countries.
2) The research is aimed at the identification of the current and potential uses of biotechnology in the production of selected agricultural commodities.
3) The third objective involves investigation on the current social consequences of biotechnological research and on its applications in the production and forms of commercialization of selected agricultural commodities.
4) The final objective of the project is to forecast possible future social consequences of the use of biotechnology in the agriculture of developing countries.

Research Design

The project focuses on the use of biotechnological techniques in three countries of the developing world: Republic of Central Africa, India, and Venezuela. These countries have been selected as they are parts of three developing continents: Africa, Asia and Latin America. Furthermore, three agricultural commodities will be selected in each of the above mentioned countries. These commodities will be identified in regard to their historical and current importance for the socio-economic development of these regions.

Unit of Analysis

The unit of analysis is defined in terms of two sub-units. The first is agricultural commodities. These are identified as three commodities, one of which is produced for export, the second of which is produced for domestic consumption and the third of which is produced for both domestic consumption and export. The second sub-unit of analysis refers to the countries of Venezuela, India and the Republic of Central Africa. It is within these countries that the empirical portion of the in-

vestigation will be located.

Procedures

The procedures of the research involve the following steps.

a) The first step is to provide an exploratory analysis to identify commodities to be included in the study. As indicated above, three commodities will be selected for each of the three countries included in the project. These commodities will be analyzed using the methodology of "case study."

b) Once the three agricultural commodities for each of the countries investigated have been selected, an analysis of the past and current use of biotechnological techniques and products will be carried out. The analysis will cover all the various phases of production from the very origin of the product (genetic) to its final destination (consumption). This portion of the study will be carried out using a historical analysis methodology and the commodity analysis technique (Friedland, et al. 1981). This portion also includes the use of surveys for the elaboration of a "map" of research centers and research involving biotechnology. It will be followed by in depth interviews with researchers who carry out biotechnological investigation.

c) The third and final set of steps involves analysis of the current and future social impacts of biotechnology. Historical analysis and commodity analysis will again be employed for this portion of the study. Qualitative and qualitative data will be employed.

Some of the variables selected for the analysis are listed below.

Research

1. Research Units
2. Number of Researchers
3. Budget of the Project
4. Type of Institutional Support
5. Technical Results of the Investigation (i.e. creation of improved varieties, creation of new species, increased productivity, increased nutritional value of products, etc.)

Production

1. Centers of Production
2. Socio-economic Characteristics of Products
3. Origin of Technological Application
4. Assistance in the Diffusion of Innovations
5. Control of and Increases in Productivity
6. Technical Assistance
7. Availability of Inputs, i.e. Labor Force, Land, Credit, Equipment, etc.

Market

1. Units of Commercialization
2. Characteristics of Trading Agents
3. Prices of Products
4. Level of Competitiveness of Markets
5. Demand, i.e. Levels of Internal and External Markets, Etc.

It is important to emphasize that this research is exploratory in its first phase and an inferential research in its second. In this context, the social impact evaluation will be based on the analysis of current research projects with the objective of determining their future perspectives and trends. To this purpose (a) the intensity with which investments and implementation of projects are carried out will be considered along with (b) the socio-spatial and temporal distance between research and its direct applications in production. Finally, (c) the

quantity of investments and of the application of related results in production will be considered. Additionally, the points of view of the participating actors, i.e. researchers, producers, traders, consumers and various private and public agencies, will also determined.

Time Table

Objectives one and two of the project will be completed two years from the beginning of the study. Objectives three and four will be accomplished in the third and final year of the project.

Criteria for the Evaluation of the Results of the Project

The results of the project will be presented through annual reports. Annual reports will be prepared for each product and for each country selected in the study. The final report will contain a revised version of the annual reports and will provide an overall analysis of the project results. Efforts will be made to publish portions of the final and/or partial results in scientific journals.

Institutional Links with Other Members of the Research Group

Participants in the project include the following researchers and institutions.

Alessandro Bonanno, Department of Rural Sociology, University of Missouri-Columbia, USA. Prof. Bonanno has studied social values and ideology associated with biotechnological investigations.

Prof. Maria Fonte, Department of Agricultural Economics and Agricultural Policies of the University of Naples, Italy. Prof. Fonte has carried out studies on the application of biotechnology in agriculture in Italy and Europe. Her department has a long standing tradition in the study of regional and developmental issues.

Prof. Pascal Byé, INRA (National Institute of Agricultural Investigation) and Department of Rural Sociology and Agricultural Economics at Montpelier, France, has been working on issues related to biotechnological research for years. His well-known works on technological change in agriculture have been influential in shaping current debates on the topic. Prof. Bye's department is a leading institution in the field of international agricultural investigation.

Drs. Rachana Bharti and **Nagesh Kumar** of the Research Group on Technology and Development in New Delhi, India have worked in the past decade on the potential use of biotechnology in the agriculture of developing countries. In particular they have studied research related to state policies in India.

Members of the Department of Economics of the University of Benghi in the Republic of Central Africa have been involved in studies on biotechnologically induced change in agriculture. In particular, they have focused their attention on the study of products such as coffee, cotton and manioc. These projects have been coordinated by Professor **Jean Pierre Frey** and his associates.

The overall project is coordinated by the author of this proposal, **Prof. Nelson Prato Barbosa** of the Center for the Study of Development (CENDES) of the Central University of Venezuela, Caracas. Prof. Prato is responsible for the scientific and administrative direction of the entire project and is responsible for the Latin American component of the research.

The research tasks have been distributed among the participating members as follows.

1) Prof. Nelson Prato is the general coordinator of the project. His duties involve the general supervision of the project including the overall scientific and administrative direction of the research.

2) Other members of the research team will form a Research Council. Their primary task is to provide assistance in the supervision of the project. They will follow the development of the research from their countries of origin and will assist in the evaluation of both the implementation of the various phases of the project and the results obtained. This group is composed of Professors: Bye, Fonte and Bonanno.

3) Three research groups will be created. Each of these will be in charge of researching one of the selected regions. Their primary task is to complete the investigation in loci. Local scientific investigation will be autonomous yet subject to the directives and recommendations of the Research Council. Prof. Nelson Prato is the director and coordinator for the Latin American portion of the Project. Nagesh Kumar is the director and coordinator for the Indian segment of the study, while Jean-Pierre Frey is responsible for Central Africa.

In this division of labor the cooperative dimension of the study is fundamental as the project is based on the exchange of information among the various research group members. Accordingly, periodic meetings are scheduled for the organization of the various phases of the research and for the discussion of results.

References

AGRICULTURAL BIOTECHNOLOGY ISSUES
1988 **Agriculture and Human Values,** Vol. V (3).

BONANNO, Alessandro
1991 "Dimensión ideológica de la investigación en el campo de la biotecnología: un análisis exploratorio." **Agricultura y Sociedad**, No. 60 (Julio-Septiembre).

BRENNER, Carliene
1991 **Biotechnology and Developing Countries' Agriculture: The case of Maize.** Paris: Development Centre Studies, OECD.

BUSCH, Lawrence, William B. Lacy, Jeffrey Burkhardt and Laura Lacy
1991 **Plants, Power and Profit.** Cambridge: Basil Blackwell.

BUSCH, Lawrence and William B. Lacy
1983 **Science, Agriculture and the Politics of Research.** Boulder, CO:Westview.

BUSCH, Lawrence, Alessandro Bonanno and William B. Lacy
1989 "Ciencia, tecnología y reestructuración de la agricultura." **Agricultura y Sociedad**, No. 53.

BYE, Pascal and Jean-Pierre Frey
1988 "Les Nouvelles Technologies dans L'agroalimentaire et la restructuration de l'agriculture: les conditions de l'emergence." Paper presented at the 7th World Congress of Rural Sociology. Bologna, June.

BYE, P. and A. Mounier
1984 Les futurs alimentaires et energetiques des biotechnologies." **Economies et Societes**. Hors Serie No. 27, Paris.

CARRIZALEZ, Victor
1981 "Perspectivas de la biotecnología en Venezuela." CIEPE, XII Jornadas Nacionales de Microbiología Venezuela, Noviembre.

CASTAGNE, M. and F. Gautier
1982 "L´impact des biotechnologies dans le transfert vers les pays en voíe de development: Cas des filieres proteiques." Paper presented at the conference "L´impact des biotechnologies sur le Tiers Monde." CE/FAST, Paris, February.

CITROEN, W.W.
1979 **The development of American Agriculture: A historical analysis,** Minneapolis: University of Minnesota Press.

CHENEY, H.B.
1974 "Roles of the agronomist." **Agronomy Journal,** Vol. 66: 1-4.

FRIEDLAND, William., Amy Barton, and Robert J. Thomas
1981 **Manufacturing Green Gold**. New York: Cambridge University Press

JAFFE, Walter R.
1991 **Análisis de Impacto de las Biotecnologías en la Agricultura: Aspectos Conceptuales y Metodológicos**. San José, Costa Rica: IICA.

JAFFE, W. and M. Zaldivar
1992 **Formulación de Políticas para el desarrollo de la Biotecnología en América Latina y el Caribe**. San José, Costa Rica: IICA.

JAMES, A. T.
1984 "Plant tissue culture: Achievements and prospects." **Proceedings of the Royal Society of London**, No. 222.

KUMAR, Nagesh:
1988 **The Biotechnology Revolution and the Third World: Challenge and Policy Options**. New Delhi: RIS.

LEWIN, J.
1992 "A quantitative and qualitative case-study analysis of scientific production in agricultural research." **Israel Journal of Agricultural Research**, Vol. 22: 129-133.

PATTERSON, Fred:
1976 **Agronomic Research for Food**. Special Publication No. 26. Madison, WI: American Society of Agronomy.

STANLEY, D.W.
1986 "Chemical and structural determinants of texture of fabricated food." **Food Technology,** March: 76.

TEXERA A., Yolanda
1984 **Contribuciones al estudio de la biotecnología desde la perspectiva latinoamericana.** Caracas: UNU/ IDRC/PTAL,.

van del DOEL, K and G. Junne
1986 "Product substitution through biotechnology." **International Social Science Journal,** Vol. 37 (3).

VESSURI, Hebe
1981 **Condiciones sociales de producción y cambio tecnológico en la agricultura venezolana.** Caracas: CENDES.

RESUMEN

El Proyecto Multinacional de Investigación sobre Biotechnología y Agricultura en Paises en Desarrollo tiene como objetivo fundamental identificar el uso actual y potencial de la investigación, la aplicación y consecuencias sociales de la biotecnología en una selección de productos agrícolas en los siguientes paises en desarrollo: Centroafrica, India y Venezuela.

Los productos agrícolas seleccionados se consideran tomando en cuenta si: a) los productos son destinados a la exportación; b) son destinados al consumo interno; y c) si los productos son destinados a ambos mercados.

El estudio esta dividido en dos fases. Una exploratoria dirigida a establecer cuáles son los tres productos que se seleccionaran para los estudios de caso y a partir del cual identificar el mapa de los usos actuales de la biotecnología en cada país; y otra fase analítica, dirigida a conocer el desarrollo futuro y características de las unidades de investigación, la transferencia de la investigación a la producción y sus usos comerciales.

Se trata de evaluar las consecuencias sociales de la biotcnología para diferentes actores sociales de la agricultura en particular y de la sociedad en general, de los paises en desarrollo que se han seleccionado para el estudio.

El coordinado es **Nelson Prato Barbosa** profesor investigador (CENDES), Venezuela. Investigadores Coopereantes: **Jean-Pierre Frey**, Centre D'etudes Economiques,Centroafrica, **Rachana Bharti**, Technology & Development Group, India **Alessandro Bonanno**, University of Missouri, US, **María Fonte**, Università di Napoli, Italia, y **Pascal Byé**, INRA, Francia.