The ILO's World Employment Programme (WEP) aims to assist and encourage member States to adopt and implement active policies and projects designed to promote full, productive and freely chosen employment and to reduce poverty. Through its action-oriented research, technical advisory services, national projects and the work of its four regional employment teams in Africa, Asia and Latin America, the WEP pays special attention to the longer-term development problems of rural areas where the vast majority of poor and underemployed people still live, and to the rapidly growing urban informal sector.

At the same time, in response to the economic crises and the growth in open unemployment of the 1980s, the WEP has entered into an ongoing dialogue with the social partners and other international agencies on the social dimensions of adjustment, and is devoting a major part of its policy analysis and advice to achieving greater equity in structural adjustment programmes. Employment and poverty monitoring, direct employment creation and income generation for vulnerable groups, linkages between macro-economic and micro-economic interventions, technological change and labour market problems and policies are among the areas covered.

Through these overall activities, the ILO has been able to help national decision-makers to reshape their policies and plans with the aim of eradicating mass poverty and promoting productive employment.

This publication is the outcome of a WEP project.

Biotechnology

A Hope or a Threat?

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MACMILLAN

7 The Differential Impact of Biotechnology: the Mexico – United States Contrast

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INTRODUCTION

The purpose of this chapter is to examine the impact of two specific new biotechnologies, the high fructose corn syrup (HFCS) and the bovine growth hormone (BGH), on two totally different socioeconomic settings – Mexico and the United States. In the case of the latter, it is nearly an *ex post* assessment of the socioeconomic impact, while in the case of the former it is more of an *ex ante* analysis of possible impact as these biotechnologies have not reached the application stage.

The bovine growth hormone (BGH) relates to milk production, and high fructose corn syrup (HFCS) is a substitute for sugar from cane and sugar-beet. Both of these products are already in the American market. HFCS entered the market in the late 1970s, and BGH was approved for marketing in 1988.

It can be said that the differential impact of these technologies in general will be as follows. While HFCS will substitute much of the formerly imported sugar to the United States from Third World countries, it may not directly affect employment in that country. Conversely, the introduction of BGH will probably eliminate about 50 per cent of dairy farmers in the United States and many workers in the industry, given the usual milk overproduction in the country over the past several years. On the contrary, BGH may have a positive impact in Mexico, where the demand for milk currently exceeds national supply. On the other hand, should the use of HFCS be expanded in Mexico, the effect on the hundreds of thousands of people who depend on the sugar industry will be devastating, while the consumers might benefit. The context and issues involved in the introduction of BGH in the United States and Mexico are first taken up, followed by discussion on HFCS.

BOVINE GROWTH HORMONE

Polarisations in the United States

Cornell researchers demonstrated milk production increases up to 40 per cent with BGH-treated cows. Costs also increase, along with food intake, but they do so at a lower rate: 'Overall, with stable milk prices, farm returns over variable costs increase by 5 to 26 per cent depending on farm characteristics and the response of animals to hormone administration' (Kalter, 1985).

The secret of BGH seems to be feed efficiency. Citing Dale E. Bauman, the director of the pioneering research, Melanie DuPuis says that the hormone does not affect the cow's maintenance requirement. And because about 30 per cent of a cow's feed goes into maintaining her own body, 'producing extra milk without extra maintenance feed greatly increases efficiency'. Increased yields vary depending on the lactation stage of the cow. Treating cows 60 days after calving increased milk yields in Bauman's tests by 10–15 per cent. But in the late stage of lactation yields averaged 30–40 per cent above normal. 'The average increase in milk over the entire lactation cycle was 25 per cent' (Dupuis, 1985 and Sun, 1986).

According to studies by Cornell agricultural economists and others, it is believed that a 100 per cent adoption rate for BGH could take place in a period of three years. Some of the consequences of such a fast adoption rate will be that: non-adopters will survive, surplus lands will be released, and a 30 per cent reduction in the United States herd of cows will result by the year the 2000. These changes will also involve greater pressures on United States government policy for supply control.

Given past experience of technology adoption by the American farmers, it could be expected that they will adopt BGH in a three year period. Also, as milk prices and the herd size drop with the use of BGH, less land will be needed for dairying. Thus, the poorest lands will become redundant, and they could possibly be put to good use with the aid of other agricultural biotechnology products which become available (Kalter, 1985). A financial side effect of this is a further decline in land value in the United States, which will undercut the ability of farmers to use land as collateral for credit (Kalter and Magrath, 1985). Land values have dropped severely already during the 1980s, placing a tremendous burden on farmers, many of whom have gone bankrupt.

Moreover, Lewellyn Mix (1986) has predicted a 30 per cent cow reduction by the year 2000. Based on a number of plausible assumptions regarding population growth, growth in milk consumption and the rate of technology adoption, Mix's paper contrasts several estimates of future production based on whether BGH is adopted or not. If it is not, demand would still be satisfied by the year 2000, assuming a yearly yield increase based on other genetic and managerial improvements. Such yield increase will account for 47.3 per cent of total increase if BGH is adopted fully by 1998, and the latter will account for the remaining 52.7 per cent of total yield increase (Mix, 1986).

Because of the mixed effects expected from BGH, controversy arose in the United States over its introduction. Traditional opponents of biotechnology, like Jeremy Rifkin, allied with farmers' organisations and the Humane Society, which defends animal rights.

Nevertheless, controversy and debate have not been enough. It depends on who ultimately controls the decisions on research policy and funding. If such control is increasingly in industry's hands, no matter what the public thinks, industry will always put efficiency and profitability ahead of public interest. And, in this case, BGH has already been approved for marketing in the United States. It is also interesting that this controversy over BGH introduction had the effect of preventing adoption to a large extent. This is one important example of how public concerns can have a decisive influence on the adoption of a new technology.

It is believed that the United States could have 30 per cent or 3.3 million fewer cows, 51 per cent or 92 500 fewer dairy farms, 195 000 fewer dairy farm employees, and use 9–10 million fewer crop acres for dairy feed production. The expected *rate of change*, not the direction, is of greatest importance and concern. Dislocation is believed to be inevitable (Mix, 1986).

The above scenario is shared by most analysts in the United States. Although farmers who survive with the new BGH will better compete with foreign dairy farmers and domestic producers of alternative beverages and foods, on the whole, new biotechnologies, including BGH, will deepen the now-longstanding pattern of structural change in American agriculture towards fewer and larger farms and lower commodity prices. The reasons are that new technologies require more expensive and capital-intensive inputs, and they are management intensive (Buttel, 1986).

According to Buttel, the most vulnerable group to shifts in technological forces are medium-sized family farmers, and even some larger farms with very high debt-asset ratios. Small farms continue to be viable, and even experience some growth since the early 1970s, thanks to the subsidy of non-farm incomes. Conversely, the greatest beneficiaries are agribusiness input firms, consumers and early adopters (mostly large farmers).

Along with these changes in agrarian structure, changes in agricultural research have taken place in the United States. Indeed, the latter changes have led to increased use of purchased inputs. The shift was from a predominantly publicly-funded to a predominantly privately-funded agricultural research. Currently, public agricultural research institutions account for only one-third of R & D expenditures, and private firms account for two-thirds. This has meant that, over the past two decades, new technologies have been proprietary, thereby assuming the character of purchased inputs. The introduction of BGH will reinforce such trends.

Economies of scale are clearly biased towards larger farms. This was determined by Kalter's study of three representative farms: 'On a per cow basis, increased return is the greatest on the large farm . . . and decreases progressively with farm size. Likewise, the increase in return per hundredweight of increased milk production increases with farm size'. Moreover, management skills are crucial: 'farm management ability of individual operators will be absolutely critical to the successful economic use of a product like BGH' (Kalter, 1985: 6).

Increased skill requirements will also lead to greater need for use of other technologies such as microcomputers. Kalter's predictions on management skill requirements for good use of BGH has been supported by other analysts. It is stressed that to maximize production, dairy farmers will rely increasingly on computers to keep exact records of a cow's milk output and to monitor its feeding requirements (Sun, 1986).

All of these arguments confirm the view that BGH will enhance the need for a 'systems approach' to farming, with increased requirements for ever more expensive purchased inputs, more or less conforming 'packages'.

According to a study of BGH impacts on New York State, consumers will be the primary beneficiaries. Assuming a free market dairy policy, total output would remain essentially unchanged due to the inelasticity of demand. Thus, substantially lower milk prices would be the outcome, and processors would be largely unaffected by BGH and a free market policy (Magrath and Tauer, 1986).

There is no consensus regarding the regional impact of adopting BGH in the United States. Michael Phillips, project director of the Office of Technology Assessment report on BGH impact (OTA, 1986), is quoted as saying that California-type corporate farms will dominate the dairy scene after BGH. Kalter counters this view on the grounds that north-eastern and mid-western states could remain competitive based on their comparative advantage of growing their own feed, while California must import part of it. For his part, Mix asserts that there are more intra-regional differences due to distinct managerial skills in farming, than inter-regional differences.

Therefore, his regional impact study of BGH predicts that Wisconsin will remain as the top state in milk production, but with much fewer farmers. Other beneficiaries, though, would be early adopters and those with greater managerial skills (Dupuis, 1985).

MILK PRODUCED AND CONSUMED BY THE POOR OF MEXICO

Contrary to what happens in the United States, Mexico has suffered from an under-supply of milk for many years. The production structure in Mexico is even more heterogeneous, with vast productivity differentials. Even the most highly modernised farms in Mexico have a productivity of only 60 per cent of farms in advanced countries (SARH, 1980).

Before we try to assess the potential impacts of BGH in Mexican dairy industry, let us briefly outline its current structure. After a period of expansion in 1960–77, the dairy industry has experienced a severe crisis in the past decade. This industry is made up of two broad types of operation: one which concentrates cattle in stables – the specialised sector – and makes up 12.7 per cent of the total herd, and another which has the double purpose of producing meat and milk – the non-specialised sector – making up 87.3 per cent of the total herd. The specialised sector produces 58 per cent of milk supply in Mexico, while the non-specialised sector produces only 42 per cent. These figures clearly reflect the vast productivity differences in the two sectors (SARH, 1980).

The destination of total milk production is as follows. Forty-five per cent is consumed directly, without pasteurisation, or is used for home-made milk derivatives; while 55 per cent flows to the processing industry. Of this total, only 40.5 per cent is pasteurised, 9.5 per cent is dehydrated and 50 per cent is used for industrial production of milk derivatives (SARH, 1980).

The specialised operations have followed the technical model of large American farms, but are only about 60 per cent as efficient, according to a study by the United Nations Food and Agriculture Organization (FAO). Moreover, modern farms do not create much employment: labour costs make up only 12.2 per cent of the total bill (SARH, 1980). With regard to foreign exchange, the cattle production complex is rather import intensive, given its technological model. While the agricultural sector as a whole accounts for 20.6 per cent of total Mexican imports, the cattle complex accounts for 50 per cent of agricultural imports (Arroyo and Waissbluth, 1988).

The processing end of the dairy industry is highly concentrated. Fifteen per cent of the firms process 67.5 per cent of pasteurised milk, absorbing 61.9 per cent of employees and generating a value added of 67.6 in this branch of the industry. In 1978, the five largest concerns alone produced 55 per cent of pasteurised milk in Mexico. The market of 'condensed' and 'evaporated' milk is controlled 100 per cent by two multinational enterprises: Nestlé and Carnation. With regard to milk derivatives, such as cream, cheese and butter, 2.2 per cent of the established concerns generate 50.1 per cent of total production (SARH, 1980).

Milk consumption is also rather concentrated, in so far as 85.5 per cent of available milk is consumed by 63 per cent of the total population; while 37 per cent of the population consumes only 14.5 per cent of available milk (including imports). Cattle feed supply is also highly concentrated, with three multinational enterprises exercising an oligopolistic control: Purina, Anderson Clayton and Hacienda. They control 47 per cent of the feed market in Mexico (SARH, 1980).

Horizontal integration among producers is very low. There are only a few cases where producers are organised to store raw materials, or purchase feed, machinery, equipment, etc. Backward and forward integration, however, is often promoted by the processing firms, basically by pasteurisers.

Mexican biotechnology research related to the dairy industry is virtually nil. A recent inventory of agricultural biotechnology found only two projects related to this field: one in the Ministry of Agriculture and Water Resources (SARH) on the establishment of an embryo bank; and the other in the Autonomous University of Nuevo León on BGH. Both projects were financed by the Federal Agency CONACYT (National Council for Science and Technology), in 1985 and 1986 (Arroyo and Waissbluth, 1988).

The Mexican dairy industry has experienced the worst crisis of its modern era in the past few years. Several of its leaders think that the crisis is so great and profound that it could have irreversible consequences for the industry if no firm and quick measures are taken to save it. In fact, production fell 28 per cent in the past three years (1986–1988), the national herd decreased from 950 000 heads in 1984 (in the specialised sector) to 700 000 in 1988, and much of the installed capacity is idle. Dairy leaders think that all of these problems can lead to a further decapitalisation of the industry, a loss of cattle grazing culture, unemployment in the countryside, and a massive drain of foreign exchange to import milk and other dairy products. On the nutritional end, FAO recommends a per capita daily allowance of 250 millilitres. Hence Mexico needs a total of 20 million litres daily for its 80 million people, but it is only producing 7.5 million in 1988, down from 10 million in 1984. The milk deficit for 1988 will be 12.5 million litres per day, some of which will have to be imported (Reyes and Neme, 1988).

What could happen if modern dairy farmers adopt BGH in their operations? It seems to us that, given the described situation of crisis in the dairy industry, two crucial things could happen. First, the new technology might become a factor in making the Mexican dairy industry more cost efficient, and thus be able to survive its current crisis. Second, this industry might be able substantially to increase milk supply locally, so that the drainage of foreign exchange through imports of dairy products may be reduced.

The problematic side of adopting BGH in Mexico is that it could have a further polarising effect in the current production structure of dairy farmers. This should be expected for those farmers who are immersed in the formal market and directly compete with modern operations. However, those who produce the 45 per cent of milk which is sold directly to consumers might be able to sustain their markets. Nevertheless, they will suffer the impact of decreased prices in the formal sector, should they emerge at some point. For many years milk prices have been controlled by the government, as part of the basic diet for Mexicans. However, dairy farmers are better organised than most agricultural producers, and they have exercised a strong influence in determining 'controlled' prices for milk. Their usual argument is that current prices fail to cover production costs. Perhaps the new technology might help them reduce costs so that prices become more stable or decrease *vis-à-vis* other prices.

Another problematic aspect of adopting BGH is that it would probably involve full dependence on importing the technology. However, the foreign exchange costs for the import of the technology would probably be rather small, compared to the costs of importing milk.

HIGH FRUCTOSE CORN SYRUP

Who benefits in the United States?

With the aid of new enzyme technology, new sweeteners have been produced which could profoundly change the sugar industry as we know it. The impact on employment in Third World countries, including Mexico, could be somber. This is all related to the international patterns of trade for sugar and its substitutes (Ahmed, 1988).

In the United States, for instance, between 1982 and 1987, 44 per cent sugar has been replaced by high fructose corn syrup (HFCS). Any vegetable with a high starch content may be used to make new sweeteners with modern enzyme technology. Like sugar, they also contain calories and are usually sweeter than sugar. Thus, we are not talking about dietetic substitutes for sugar, such as saccarin or asparthamus (one commercial name for the latter in the United States is nutrasweet). These substitutes also constitute a problem for the sugar industry, but this is a matter for a separate study.

The production of new sweeteners from high starch crops has taken place mostly after 1978. By 1985, world production was 6300 million tons of dry material, of which 4600 million tons, more than 66 per cent was concentrated in the United States (Arroyo and Arias, 1987).

Over 30 soft-drinks bottling companies in the United States (such as Coca-Cola, Pepsico and 7–Up) have shifted from the use of sugar to HFCS. As a direct result the sugar imports of the United States plunged from 4.6 to 2.5 million tons between 1978 and 1985. This change has lowered the cost of production processes, for the United States usually produces large quantities of corn in its Midwestern region. However, many Third World countries are suffering the consequences (Ahmed, 1988; Buttel and Barker, 1985).

In fact, such a change in the global pattern of trade relations has affected incomes and employment in the Third World. For instance, Caribbean income from sugar exports to the United States dropped from US$686 million in 1981 to US$250 million in 1985. On the other hand, the Philippines experienced a reduction of sugar exports to the United States from US$624 million in 1980 to US$246 million in 1984. One of the results has been the replacement of the sugar crop by others that are not as labour intensive. With this substitution the Philippines has lost half a million jobs (Ahmed, 1988).

The sugar industry in Mexico: Threats to employment

At this point, we should ask ourselves: what might happen if the new sweeteners are substituted for sugar from cane in Mexico. One of the dilemmas that would have to be faced, in the first place, is that Mexico does not even produce enough corn for human consumption, and corn is one of the most important components in the Mexican diet. Thus, there are no corn surpluses to produce HFCS.

Some features of the sugarcane production structure in Mexico are as follows. Its contribution to Mexican GNP decreased from 7 to 5 per cent in the 1970–80 period. Employment decreased in the same period from 4.1 to 2.6 per cent. Sugarcane accounts for 3 per cent of agricultural land in Mexico (Arroyo and Arias, 1987). With regard to land tenure, *ejidos* account for almost 69 per cent of land dedicated to sugarcane, while private farms, only 31 per cent. Most of this land, 60.5 per cent, is dependent on rain for its water supply, while only 39.5 per cent is irrigated. Yet, Mexico is the fourth largest producer of sugarcane, after Brazil, Cuba and India.

By 1986, the Government controlled over 81 per cent of total sugar production. This proportion grew steadily since 1975, when the Government began to purchase many of the ailing sugar mills. The remaining mills are either privately or cooperatively controlled (Azúcar, S.A., 1987: various tables). The economically active population engaged in the sugar industry has evolved as shown in Table 7.1. Due to a price policy which kept sugarcane prices artificially low, and to consumption patterns encouraged by advertisement campaigns from the bottling companies, Mexicans consume more than 14.5 million litres of bottled beverages per day. In fact, Mexico is the second largest per capita consumer of such beverages in the world (after the United States).

Currently, industry in general processes 55 per cent of total sugar produced in Mexico and the rest is for household use. Of the grand total, though, just the bottling industry consumes 30 per cent. And from this, 75 per cent was controlled by two multinational enterprises in 1979: Coca-Cola and Pepsi-Cola. Therefore, much of the future control of the sugar industry in Mexico is in foreign hands.

In January 1988, the Mexican Government announced that it would sell 17 of the 56 sugar mills that it then controlled (out of a total of 66 mills). Pepsi-Cola soon expressed an interest in three of them: the most productive ones. Despite protests from sugarcane producers and sugar mill workers, who were bidding to purchase the mills, the Government has resolved to sell those mills to Pepsi-Cola. Another company comprising several soft-drink bottlers was established, but Pepsi-Cola owns a controlling interest in the new company.

If the sugar mills re-privatisation drive continues to transfer their ownership to multinational bottling enterprises, this could be a guarantee that they will not import HFCS from the United States. However, it will be inevitable that they restructure the plants, which are said to contain at least 30 per cent of redundant personnel. It remains to be seen how the new owners deal

TABLE 7.1 *Mexico: Economically active population dependent on the sugar industry*

Labour situation	1983	1984	1985	1986
Field Personnel	249537	254039	239798	240805
Plant Personnel	52940	56914	57180	52327
TOTAL	302477	310953	196978	293132

SOURCE: Azúcar, 1987.

with the problem of restructuring the plants, for sugar-producing regions are highly dependent on the sugar mills for income and employment.

One alternative for the new owners will be to try and develop other sources of employment locally for displaced workers in the sugar industry. Promising prospects exist in rationalising the use of by-products from sugarcane. The fact remains though, that an increasing number of crucial decisions for development are being transferred not only to private hands, but also to foreign hands. The question is thus whether this trend will be beneficial or detrimental for the majority of the people.

CONCLUDING COMMENTS

The dismal picture of biotechnology in Mexico leads one to believe that, should more Mexican entrepreneurs be interested in the emerging industry, they will at best seek joint ventures with American enterprises. At worse, multinational enterprises will attempt to transfer the required technology directly or through subsidiaries, with all the costly implications in terms of patents, royalties and higher forms of scientific, technological and, therefore, financial dependence of the Mexican people.

If decision makers in Mexico and Latin America have the will to intervene in this process, towards a national development of biotechnology, it will be necessary to act soon with firm measures of scientific and industrial policy. Of course, it would be illusory for Third World countries to attempt to develop the whole range of biotechnologies internally, with local scientific and financial resources. Nevertheless, there is a significant knowledge base in Mexico, as well as in Brazil, Cuba and Argentina. With this limited appropriate policy decisions and attempts at regional integration, such knowledge could be translated into indigenous technological developments. But the question would still remain whether biotechnology, as it is being developed today, is the right bandwagon for the Third World to jump onto, and whether the Third World has the choice to make this decision.

8 Biotechnology to Combat Malnutrition in Nigeria

G. U. Okereke

NUTRITION AND BIOTECHNOLOGY

The overall food demand in Nigeria is estimated to be growing at the rate of at least 3.5 per cent per annum due to the combined effects of population and income growth, while available data concerning the protein requirements of the Nigerian population show that the present production of food protein falls far short of demand (Idachaba, 1983). The intake of protein in Nigeria is 20–25 per cent below the satisfactory level (Nelson, 1972), while the average per capita total daily protein intake in Nigeria was 54 grams out of which only 8.3 grams were of animal origin (Norris, 1981). The value of animal protein intake is much below the 25 grams recommended out of a total protein requirement of between 65 and 75 grams. It is estimated that 1.68 million tonnes of beef would be needed annually to raise animal protein intake in Nigeria to 25 grams per capita per day (Olubajo, 1976). This is hardly possible in view of the present stationary or even declining cattle population, low productivity and small body size of indigenous livestock.

In recent years the expansion of meat production in Nigeria has been mainly in poultry production. The poultry industry has a greater contribution to make in filling this wide gap of protein requirement in the Nigerian diet. This is because poultry has a relatively shorter 'gestation' period than the other classes of livestock. Also poultry products are more accessible and acceptable to Nigerians of different income brackets. Nigeria in recent years has entered a period of increasing food shortage. Thus protein as an animal feed component will indeed become increasingly scarce and expensive. Abnormal climatic conditions are largely responsible for the sharp fall in protein availability. It was the abnormal protein supply conditions prevailing in the mid-1960s that led to rapid development of the technology of Single Cell Protein (SCP) production (Norris, 1981). SCP is a rich source of protein which can be used as a supplement to animal feed for chickens (broilers and laying hens), calves, sheep and