TECHNOLOGICAL CHANGE AND SUSTAINABILITY OF AGRICULTURE IN BARBADOS

by

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INTRODUCTION

In November 1992, I delivered a paper entitled *"Recent Biotechnological advances and possible implications for Barbados"* at our independence series of Lectures. The main thrust of that paper was to flag a critical area of agricultural development which, in my view, needed to be addressed to allow agriculture to make a significant contribution to Barbados economy and way of life in the 21st century and beyond. A number of revolutionary developments in Biotechnology were listed and some of the threats and opportunities posed to our agricultural system by these developments were pointed out and a National strategy proposed to allow us to exploit these technologies and manage the significant technological change envisaged.

We are now 5 years closer to the beginning of the 21st century and many of the biotechnological developments that were hinted at in that paper are now in the marketplace but very few of the elements of the strategy which I enunciated have been put in place.

I therefore welcome the opportunity afforded me by this Agricultural Economics Conference to update some of the facts given in the 1992 paper and to once more make a call for a coordinated strategic approach to managing technological change so as to ensure the sustainability of Agriculture in Barbados into the 21st Century.

EXAMPLES OF TECHNOLOGICAL CHANGE

Agricultural technology is an extremely broad-based concept and encompasses all the methodologies used to produce crops and livestock and, indeed, to market and improve the inputs and outputs of agriculture. The use of the hoe is therefore agricultural technology, so too is the use of computers in agriculture. Agricultural technologies remained relatively static in the early years of this century but blossomed out following the first World War and the development of chemical pesticides and continued in the nineteen sixties with Borlaug's Green Revolution where high yielding varieties of staple crops were introduced to Third World countries. Over the past decade, agriculture has been experiencing another boom in technological change with the development of revolutionary products using recombinant DNA technologies.

The pace of technological change in agriculture and its related disciplines has been increasing exponentially over the past decade or so. I would just like to list for you a number of the advances that have been developed, or are now very close to

development that were only gleams in the eyes of their inventors a decade ago.

Genetic engineering involves changing the genetic makeup of an organism. Moving genes to different locations, removing them altogether or adding genes from other organisms does this. When the gene transfer is from one unrelated species to another, the resulting organism is called transgenic. Genetic engineering or recombinant DNA technology uses enzymes to break the host DNA at a particular point. DNA from another location or species is spliced in thus forming new recombinant DNA.

The most famous example of genetic engineering, at present, is Dolly. Dolly is the adult ewe that Scottish scientists recently announced they had cloned by transferring the genetic material from one ewe into the egg of another. This new technology promises to accelerate agriculture's ability to produce animals with valuable traits: e.g. cows that produce milk that can be used for medicinal purposes, or livestock that can withstand diseases better. It has also triggered many debates, and, I understand experimentation into human cloning.

There are a number of less well-known examples of biotechnology advances and I will briefly list some of them here.

Biotechnology is now allowing scientists to create a diverse range of products from plants, e.g., ink used in daily newspapers; plastic parts for car engines; drugs that help fight infection; new fuels and lubricants; cosmetics; colorings- dyes and adhesives.

Canola, a temperate plant, is a variant of rapeseed, which was developed using traditional plant breeding methods in Canada. It is relatively easy to alter genetically and biogenetic researchers have created a variety of new uses for that crop. For example, plastic-producing genes have been transferred from bacteria into canola to "grow" plastic. Canola has been genetically engineered to produce high levels of long chain fatty acids for the manufacture of detergents, surfactants, soaps, cosmetics, photographic film constituents, greases, and lubricants, using as gene sources, such tropical plants as castor oil seed.

Changing the fatty acid composition in canola has resulted in a numerous actual and potential uses for this crop. Inks, cosmetics, creams and lotions, anti-dandruff shampoos, chocolates, lubricants, fabric softeners, candles, resins, and drugs to fight infections, including AIDS, are just a few. Indeed, over 1,000 patents have been taken out for new industrial uses of canola oil.

Researchers have also created a bio-diesel fuel from canola oil called supercetane. This fuel produces fewer air pollutants than normal diesel fuel and though expensive to produce, this fuel might be ideal for use in environmentally sensitive areas.

Transgenic varieties of canola, incorporating herbicide resistant genes, are already in use. These include varieties resistant to the popular herbicide Roundup. Some 40,000 acres of such varieties were grown in 1995.

Researchers at Zeneca Seeds are introducing anti-fungal genes into selected canola varieties to control fungal diseases.

Research aimed at producing interleukin, an immune-system booster and cancer fighter, from genetically engineered canola is in progress. In addition, a gene for the production of hirudin, an anti-coagulant extracted from leeches has been transferred

into canola. Hirudin could be produced from canola at one-tenth its current price.

Work is progressing on transforming canola and other crops with Bt genes. Bt genes cause plants to produce natural proteins that protect them against insect damage.

By creating bio-products from genetically engineered plants, or finding new uses for waste products, biotechnology is helping in the fight against pollution by providing environmentally friendly alternatives that can reduce man's reliance on fossil fuels; e.g., bio-degradable pesticide packaging made from corn starch improves the safety of pesticide container disposal.

A new wood preservative has been developed from vegetable tannins. Wood treated with tannin is resistant to decay, weathering, and insect or fungal attack.

Stronger, whiter paper can be made from kenaf, a bamboo-like crop. This paper takes less energy to produce, is "tree-free," and user-friendly (because the ink does not rub off on your hands.)

A biodegradable plastic is being developed from lignin, a major waste product in pulp and paper mills and researchers are also trying to genetically engineer plants with low lignin levels so that higher-quality paper can be made.

Researchers recently identified a cell protein that is necessary for rubber production and is now developing methods for inserting the genes from commercial rubber trees into domestic plants.

The previous examples are all, with the exception of Dolly, related to agricultural crops. The following are some examples of livestock technologies:

A recent advance in animal transgenics is the production in England of a litter of pigs whose genetic makeup has been altered with human genetic material. Because the sow's embryos have been injected with human genetic material, the piglets create human proteins. This means that organs from the mature pigs could some day be used for transplantation into humans. This technique is in its infancy, but could in the future provide a solution to the chronic shortage of hearts, lungs, and kidneys available for transplant.

Researchers are also developing transgenic pigs that produce red blood cells that could be used in humans. This would reduce the risk of infection from diseases like AIDS or hepatitis. Transgenic pigs, with faster growth rates and meat quality, have been produced, as have sheep that grow more wool.

One of the more common uses of recombinant DNA technology is to produce human insulin. For many years the insulin that diabetics need to support life was extracted from pigs. Many diabetics develop strong allergies to pork because of the minute quantities of pork proteins left in the insulin after it was extracted. By splicing human DNA into the bacterium E. coli, scientists have produced Humulin, a variant of insulin that is cheaper and safer than pig derived insulin.

Scientists are also using recombinant DNA technology to produce drugs other than insulin. Transgenic animals are producing drugs for arteriosclerosis, haemophilia, emphysema, cystic fibrosis, and other infections including AIDS.

Biotechnology has even been used to transfer genes from animals into plants. Some species of fish (Carp) make a protein that allows them to survive in frigid Arctic waters. The "antifreeze" gene that codes for this protein has been introduced into wheat and tomatoes to produce crops that can survive cold temperatures or high altitudes. Researchers have also transplanted the antifreeze gene into other species of fish so they can survive in cold waters.

The biotechnology revolution has also led to the development of several new techniques in animal reproduction. One such technique is superovulation in which, for example, a cow with superior genetic characteristics can be induced to produce more than 10 embryos. These embryos can then be transferred into other less valuable cows, instantly creating numerous offspring of the same age. Superovulation allows the breeding of animals with superior characteristics and the production of valuable offspring much more quickly.

TECHNICAL PROBLEMS

The developments in biotechnology have not been without technical problems. There have been some near calamities along the way. Last year, Montsano's commercial *Bacillus thuriginiensis*, enhanced cotton seed, was a major flop. It failed to control the major cotton pests and, indeed, environmentalists are claiming that its widespread use could have contributed to a buildup in resistance of the insects to the biological insecticides that have been in common use over the last decade or so, for a number of crops.

SUMMARY

Such developments as enumerated above are very exciting from a scientific standpoint and appear to herald the way for a "brave new world" where man's control of all types of germplasm seem more in the realm of science fiction than a logical offshoot of Gregor Mendel's seminal experiments with peas in the 19th Century. The new technologies offer a number of practical advantages to plant breeders. In addition, they presage, on a global scale, the possibility of mankind being able to get closer to the ideal of eliminating worldwide hunger.

On the other hand, the new technologies could have serious negative impacts on the agriculture of many of our Caribbean countries unless strategic decisions and actions are quickly taken on how our countries should monitor, participate in, and selectively utilize such technologies.

These technologies, as indicated earlier, have been used to design crops that effectively produce a number of products under temperate conditions that formerly had to be imported from the tropics or sub-tropical areas, e.g., transgenic corn which can now thrive in practically frigid climates. Such projects are not designed to develop scientific oddities but are calculated to allow the First World countries to be self-sufficient.

One common, and perhaps, frightening feature of many of the recent important products of technological change in agriculture is that they have been primarily funded and implemented by large multi-national private sector companies and not by the traditional university or Government agency where the profit motive is not a paramount motivating factor. One such

company is Monsanto. For years, Monsanto has been a major player in the global food system as a pesticides input supplier. Now that company is expanding its product range to include seeds, vegetables, and industrial oils and, in some cases, acquiring businesses that allow control of product life from seed to consumer. In the last decade, the company moved aggressively not only to develop its own new engineered crop varieties of cotton, corn, potatoes, and soybean, but has recently purchased interests in businesses in other parts of the food system. Below is a crop-by-crop outline of some of **Monsanto's** growing agricultural holdings:

Canola	Owns a majority interest in Calgene, which produces canola seeds and contracts with farmers to grow engineered canola for crushers and end users
Corn	Owns 40 percent of and has licensing agreements with De Kalb GenetiCorp., a major corn seed company. Has licensing agreements with Golden Harvest Seeds Sandoz to commercialize transgenic corn
Cotton	Owns part of and has licensing arrangements with Delta and Pine Land, the largest US cotton seed company. Owns a majority interest in Calgene, which owns Stoneville Pedigreed Seed Co., a cotton seed company
Potato	Owns Nature Mark, a seed potato company
Soybean	Is purchasing Asgrow Agronomics, a major soybean seed company
Tomato	Owns Gargiulo, a tomato breeding and fresh tomato market company and a controlling interest in Calgene, which produces tomato seeds and fresh tomatoes
Other Fruits and Vegetables	Will provide bio-technologically derived vegetable traits to Empresas La Moderna, a seed company with 22 percent of the world market share in vegetable seeds.

I would like to suggest that this trend should send some danger signals to our agricultural planners in Third World countries.

UTILIZATION OF NEW TECHNOLOGIES IN BARBADOS

Barbados has not stood still in terms of adopting new technologies. Barbados was perhaps the first of the anglophone Caribbean countries to set up a tissue culture laboratory and to utilize that Caribbean Agricultural Development and Research Institute (CARDI) laboratory for the development of virus tested yam-planting material. The Biotechnology Group at the University of the West Indies (UWI), Cave Hill Campus, has been at the forefront of regional efforts to develop expertise in recombinant DNA techniques, especially in relation to diagnostic biotechnology applications. The group also has some experience in the genetic engineering of drought and salt stress tolerance in plants.

I would wish to suggest, however, that we in Barbados and perhaps the region generally,

have not gone far enough to have access to and to exploit the rDNA technologies I have so exhaustively alluded to earlier. When we talk of high technology in Barbados we are usually referring to developments that are now, to some extent, commonplace in Barbados, such as:

- Computerized feeding systems for livestock
- Utilization of Drip Irrigation
- Utilization of Tissue Culture Plantlets, e.g. in Bananas and Plantains
- Hydroponics systems
- Greenhouse systems for Anthurium and Orchid production
- Utilization of Eliza systems for identification of microorganisms
- Use of proprietary microbial pathogens like Bt for controlling crop pests
- Production of clean Yam planting material, etc.

The intrinsic technologies in the above systems are to some extent dated. Barbados and the Caribbean generally have not tried to access the new rDNA technologies in any significant way. There are of course good reasons for this, not the least of which is cost and the inherent difficulty of accessing technologies that are owned by large private sector transnational companies. However, it is my contention that current trends in the North suggest that these new technologies are designed, inter alia, to ensure self sufficiency in the developed countries in respect to products that were formerly only available from tropical developing countries. Our access to their markets is likely to be significantly compromised. Gabrielle Persley indicated in her book on technological change that several private companies are actively working on different possibilities for the displacement of plant-derived products presently grown in the Third World. She intimated that biotechnological advances poses a threat to our agricultural well being if we depend totally on the benevolence of our Northern neighbours and have no clear strategy for active self involvement. It is time that we take the threat seriously and develop opportunities from the situation.

SUSTAINABILITY OF AGRICULTURE IN BARBADOS

Sustainable agricultural development is a concept which implies a developmental policy that maximises the use of renewable, locally available, resources and utilises farm practices which ensure that existing farmers pass on their farming enterprise to their progeny in a productive, economic and environmental condition that is not inferior to the state in which they inherited that farm. The sustainability of agriculture in Barbados will depend on the satisfactory resolution of a number of overarching current problem areas. Some of these areas are: -

The competition between Agriculture and other Sectors for Resources - This competition is most clearly seen in current initiatives for the allocation of some of our best arable lands away from sugar cane to golf courses. The major issue here is whether agricultural land should be treated in a special way or whether the allocation of such land should be based on purely competitive market and economic considerations. This is also tied in with the issue of a vision of Barbados being predominantly a golf destination that appears to be gaining some currency in influential quarters. Barbados is now recognized as a water scarce country by UN agencies. During the last few years a

trend of longer dry seasons and less well distributed rainfall seems to be on the way to being established. There is likely therefore to be reduced availability of water to agriculture. 9

Trade Liberalization and Improving the Competitiveness of Local Farmers - The mid-1990's have seen the institution of significant regional and international trade agreements which have already begun to impact negatively on the markets of Barbadian farmers. The net effect of these agreements is that produce from our neighbours, and even farther afield, will be available to local marketers at prices that are likely to be lower than the traditional prices from our local farmers. Our farmers therefore have to increase their efficiency of production, through the use of some of the new technologies, in order to effectively compete with these imports.

Diversification of Production of Agricultural Crop - Sugar Cane has historically been the major crop of Barbados. However, the statistics indicate that Sugar has been supplanted by non-sugar agriculture in terms of contribution to the GDP during the 1990's. Current trends also seem to suggest that its continuing sustainability may depend more on the outcome of trade negotiations and relationships between super powers than with environmental and edaphic factors in Barbados. Alternative crops to replace sugar cane are constantly being sought, but with relatively little success at present.

COPING WITH THE NEW BIOTECHNOLOGIES

I would like to repeat the prescription I gave 5 years ago for a national strategy to exploit technological change for the benefit of agricultural sustainability in Barbados.

Our politicians and policy makers must be sensitized to the opportunities and threats posed by the new developments in technology. They should be provided with a portfolio of information for use in all the available fora to press the case for the development of significant biotechnology capacity in the CARICOM region.

National and regional biotechnology strategies must be developed, that make more efficient use of both domestic and external resources and involve regional and international networking. The work of such entities as the biotechnology groups at UWI, (Cave Hill and Mona), should be supported and encouraged.

The national and regional capabilities for genetic engineering should be augmented and strategically channeled into projects of recognized national and regional importance. That strategy could include the following features:

- Identify crops / livestock which should be good candidates for research and development
- Ensure that our crop and livestock germplasm are properly registered or patented with the relevant
- International agencies to ensure that we do not have to pay Northern entrepreneurs dearly to utilize our own crops in the future
- Identify and prioritize niche products from the select crops for development

- Develop policies on patents, tax incentives, contract research and sharing of resources and personnel between public and private sector institute which would facilitate the rapid development of strategically identified products and ensure our rights to the exploitation of such products

- Ensure that there is an adequate allocation of resources for biotechnology as compared with traditional R&D on a national as well as a regional basis

- Incorporate modern biotechnology into the teaching of agricultural and biological sciences and enhance the capacity of the University to provide training in Molecular Genetics, Biochemistry, Physiology, Immunology, Chemical Engineering, and Information Technology

- Encourage meaningful collaboration between UWI biotechnologists and traditional agricultural scientists in the Government, international institutions and private sector agencies

- Train a critical mass of scientists and technologists at local and overseas universities; using private sector attachments at biotech companies; structured attachments at international development agencies; refresher courses and any other available means.

- Decide on the optimal deployment of trained personnel. It may be necessary to retain some Caribbean scientists and technologists at Northern universities and biotech agencies to maintain a watching brief for the various governments on important new developments in biotechnology which could be exploited by the region.

I will like to leave with the quote from Gabrielle Persley: *"The message for the Third World is clear: not to apply the new technologies for the improvement of their food and export commodities will put them at a competitive disadvantage in the international market".*

REFERENCES

Agbiotech Infosource: *Canola: Biotechnology's Powerhouse Crop,* Issue 21 May 1996 Published by Ag-West Biotech Inc **

Agbiotech Infosource: *DNA Technology In Animal Agriculture,* Issue 14, May 1995 Published by Ag-West Biotech Inc **

Gabrielle Persley 1992: *Technological Change*. A CABI paper

The Gene Exchange: *Genetic Engineering of Crops - Bacillus thuringiensis (Bt)* Dec. 1996, Volume 7, Number 1 **

Komen, J. and G.J. Persley. 1993. "Agricultural Biotechnology in Developing Countries: A cross-country review." *ISNAR Research Report No. 2.* The Hague: International Service for Agricultural Research.

Winston Small. 1992. *Recent Biotechnology Advances and Possible Implications for Barbados.* Feature paper for the November 1992 Independence Seminar Series, MAR, Barbados

** Sourced on the Internet.
URL:Http://www.lights.com/agwest/insource.html