DRAFT NATIONAL POLICY

ON

BIOTECHNOLOGY, BIOSAFETY AND BIOSECURITY

FOR

GUYANA

1 July 2005

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### Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ABS</td>
<td>Access to Genetic Resources and Benefit Sharing</td>
</tr>
<tr>
<td>CARICOM</td>
<td>Caribbean Community</td>
</tr>
<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
</tr>
<tr>
<td>CIP</td>
<td>Cleaning in Place</td>
</tr>
<tr>
<td>COTED</td>
<td>Council for Trade and Economic Development</td>
</tr>
<tr>
<td>DDL</td>
<td>Demerara Distillers Limited</td>
</tr>
<tr>
<td>DNA</td>
<td>Deoxyribonucleic acid</td>
</tr>
<tr>
<td>ELISA</td>
<td>Enzyme-Linked Immunosorbent Assay</td>
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<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organisation</td>
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<tr>
<td>FPD</td>
<td>Food Policy Division, Ministry of Health</td>
</tr>
<tr>
<td>GA/FDD</td>
<td>Government Analyst/Food and Drugs Department, Ministry of Health</td>
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<tr>
<td>GBC</td>
<td>Guyana Biotechnology Corporation</td>
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<tr>
<td>GE</td>
<td>Genetically Engineered</td>
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<td>GFC</td>
<td>Guyana Forestry Commission</td>
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<td>GM</td>
<td>Genetically Modified</td>
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<td>GMOs</td>
<td>Genetically Modified Organisms</td>
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<td>GNBS</td>
<td>Guyana National Bureau of Standards</td>
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<tr>
<td>GoG</td>
<td>Government of Guyana</td>
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<td>GSA</td>
<td>Guyana School of Agriculture Corporation</td>
</tr>
<tr>
<td>GUYSUCO</td>
<td>Guyana Sugar Corporation Inc.</td>
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<tr>
<td>HACCP</td>
<td>Hazard Analysis Critical Control Point</td>
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<tr>
<td>IICA</td>
<td>Inter-American Institute for Cooperation on Agriculture</td>
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<td>IPPC</td>
<td>International Plant Protection Convention</td>
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<tr>
<td>IPR</td>
<td>Intellectual Property Rights</td>
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<tr>
<td>LMOs</td>
<td>Living Modified Organisms</td>
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<tr>
<td>MDG</td>
<td>Millennium Development Goals</td>
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<tr>
<td>MFCL</td>
<td>Ministry of Fisheries, Crops and Livestock</td>
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<tr>
<td>NARI</td>
<td>National Agricultural Research Institute</td>
</tr>
<tr>
<td>NBAP</td>
<td>National Biodiversity Action Plan</td>
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<tr>
<td>NBBCC</td>
<td>National Biotechnology and Biosafety Council</td>
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<td>NBBIU</td>
<td>National Biotechnology and Biosafety Inspection Unit</td>
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<tr>
<td>NBF</td>
<td>National Biosafety Framework</td>
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<tr>
<td>NCC</td>
<td>National Coordinating Committee</td>
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<tr>
<td>NEAP</td>
<td>National Environmental Action Plan</td>
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<tr>
<td>NDS</td>
<td>National Development Strategy</td>
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<tr>
<td>OAS</td>
<td>Organisation of American States</td>
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<tr>
<td>OECD</td>
<td>Organisation of Economic Cooperation and Development</td>
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<tr>
<td>PAHO</td>
<td>Pan American Health Organisation</td>
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<tr>
<td>PRS</td>
<td>Poverty Reduction Strategy</td>
</tr>
<tr>
<td>PRSP</td>
<td>Poverty Reduction Strategy Paper</td>
</tr>
<tr>
<td>UG</td>
<td>University of Guyana</td>
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<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
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<tr>
<td>WTO</td>
<td>World Trade Organisation</td>
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Chapter 1
Relevance of Biotechnology, Biosafety and Biosecurity

1.1 Relevance of biotechnology, biosafety and biosecurity issues in national development

1.1.1 What is biotechnology?

In the Convention on Biological Diversity (CBD), biotechnology is defined as: "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use". This definition does not distinguish between traditional biotechnology and modern biotechnology. On 29th January 2000, the Conference of Parties to the (CBD) adopted a supplementary agreement to the CBD; known as the Cartagena Protocol on Biosafety and commonly referred to as the Biosafety Protocol. Three years later, on the 11th September 2003, the Cartagena Protocol was entered into force.

The Biosafety Protocol is more concerned with modern biotechnology and defines it as “the application of in vitro (in a test tube or other laboratory environment) nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or fusion of cells beyond the taxonomic family that overcome natural, physiological, reproductive or recombinant barriers and that are not techniques used in traditional breeding and selection”.

1.1.2 What is biosafety?

Biosafety or biological safety is the term used to describe efforts to reduce and eliminate the potential risk resulting from biotechnology and its products1. The Biosafety Protocol embraces the precautionary approach, whereby the lack of full scientific certainty should not be used as an excuse to postpone action when there is a threat of serious or irreversible damage. The precautionary approach is reflected in many of the provisions of the Protocol and has as its focus the protection of the environment: “Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective

1 CBD website at http://www.biodiv.org/biosafety/faqs.asp
Public concerns about the potential risks from the use of modern biotechnology have led to the formulation of biosafety policy guidelines.

1.1.3 What is biosecurity?

Biosecurity or biological security is the exclusion, eradication or effective management of risks posed by pests and diseases to the economy, environment and human health.² It covers all activities aimed at managing the introduction of new species and managing their impacts once introduced. Indeed, given the extant and emerging global threats, the definition of biosecurity has been expanded to include a more strategic and integrated approach that encompasses the policy and regulatory frameworks (including instruments and activities) that analyse and manage risks in the sectors of food safety, animal life and health and plant life and health including associated environmental risk.

Biosecurity covers the introduction (intentional and unintentional) of plant pests, animal pests and diseases and zoonoses, the introduction and release of Genetically Modified Organisms (GMOs) and their products and the introduction and management of invasive alien species and genotypes.

1.1.4 Guyana’s national development thrust

Guyana is part of the Guiana Shield³ of north-eastern South America and is richly endowed with natural resources including fertile coastal and riverine agricultural lands, vast tropical hardwood forests of various ecosystems, rich biodiversity; abundant fish, and a wide variety of minerals, including gold, diamonds, a range of semi-precious stones, bauxite and manganese. However, it is Guyana’s rich biodiversity heritage that makes the CDB important to Guyana. Guyana’s commitment to the conservation and sustainable utilisation of biodiversity is embodied in two action plans: the National Biodiversity Action Plan (NBAP); and, the National Environmental Action Plan (NEAP). In recognition of the benefits of biotechnology coupled with the need for biosafety guidelines to protect the natural biological and cultural resources, Guyana implemented

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³ The Guiana Shield covers an area of 2.5 million km² and accounts for more than 25% of the world’s remaining tropical rainforests with some 80-90% of it still in pristine condition. It contains an estimated 20,000 vascular plant species, 2200 freshwater species, 975 bird species, 282 mammal species, 280 reptile species, and 272 species of amphibians. (Source: Conservation Priorities for the Guayana Shield, Conservation International, Washington. 99p).
the National Biosafety Framework (NBF) Project. This present document is a component of the general framework provided for wise and safe use of the rich natural resources of Guyana for national development.

Guyana’s economy is dependent on the production and export of its natural resources, with agriculture (sugar, rice, fishery, non-traditional crops), gold, diamond, timber and bauxite, accounting for most of the output of the productive sectors. The National Development Strategy (NDS) of Guyana indicates that Guyana is vulnerable to environmental pressures, which include fragile forest ecosystems; continuous threats to the narrow coastal belt from inundations from the Atlantic Ocean, rivers and inland water conservancies; dependence of the entire economy on coastal plantation type agriculture, and the exploitation of the country’s forest wealth and minerals; and, poverty. Further, exploitation of natural resources for national development must take cognisance of these vulnerabilities. The role of biotechnology, biosafety and biosecurity to the use of the rich natural resources for national development assumes greater importance. A look at the demography and distribution of current exploitable natural resources towards the national good shows severe pressure on the populated low coastal plains and comparatively greater opportunities in the sparsely populated hinterland or interior regions (Table 1).

Table 1. The demographic and economic profile of Guyana by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Population</th>
<th>Area (sq. miles)</th>
<th>Population density</th>
<th>Main economic activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18,294</td>
<td>7,853</td>
<td>2.3</td>
<td>Fruit (avocado, citrus), agroprocessing (palmheart), biodiversity conservation</td>
</tr>
<tr>
<td>2</td>
<td>43,139</td>
<td>2,392</td>
<td>1.8</td>
<td>Rice, coconuts, fishing, fruits</td>
</tr>
<tr>
<td>3</td>
<td>95,276</td>
<td>1,450</td>
<td>65.7</td>
<td>Rice, sugar, ground provision, fishing</td>
</tr>
<tr>
<td>4</td>
<td>294,493</td>
<td>862</td>
<td>341.6</td>
<td>Rice, sugar, forestry, fishing, vegetables, livestock, forest products, processing, coconuts, craft</td>
</tr>
<tr>
<td>5</td>
<td>51,274</td>
<td>1,610</td>
<td>31.8</td>
<td>Rice, sugar, logging, ground provision, vegetables, fruits, coconuts</td>
</tr>
<tr>
<td>6</td>
<td>141,455</td>
<td>13,998</td>
<td>10.1</td>
<td>Rice, sugar, cattle, logging, vegetables, fruits, mining</td>
</tr>
<tr>
<td>7</td>
<td>14,682</td>
<td>18,229</td>
<td>0.8</td>
<td>Mining (gold), small scale farming, balata, ecotourism</td>
</tr>
<tr>
<td>8</td>
<td>5,574</td>
<td>7,742</td>
<td>0.7</td>
<td>Mining (gold, diamonds), biodiversity conservation</td>
</tr>
<tr>
<td>9</td>
<td>14,947</td>
<td>22,313</td>
<td>0.7</td>
<td>Livestock, craft, peanuts, biodiversity conservation</td>
</tr>
<tr>
<td>10</td>
<td>39,271</td>
<td>6,595</td>
<td>6.0</td>
<td>Mining, logging, farming, bauxite, livestock</td>
</tr>
</tbody>
</table>

Guyana’s NDS is predicated on the basic principle that “Guyana’s development must not threaten the integrity of the environment”. In other words, the approach to development must be based on the “prevention of environmental degradation, rather than on the application of remedial measures of doubtful efficacy, after the damage has already been done”. In another important State Paper, the Poverty Reduction Strategy Paper (PRSP) of the Government of Guyana (GoG) identifies reduction of poverty as an important pillar of national development. The PRSP reminds that despite abundant resources, Guyana is one of the poorest countries in the western hemisphere. This paper identifies constraints to agricultural production and productivity as partly responsible for limited economic opportunities in Guyana. Low levels of manufacturing and value added, underdevelopment of eco-tourism, and inequities in the tax system were the other reasons of non-agricultural origin identified. At the macro-level, the Poverty Reduction Strategy (PRS) identified seven pillars, including broad-based, jobs-generating economic growth, and environmental protection as important to the reduction of poverty.

The PRS is consistent with the NDS and the UN Millennium Declaration in 2000 that committed countries – rich and poor – to inter-alia, do all they can to eradicate poverty and achieve environmental sustainability, two of the Millennium Development Goals (MDG). Biotechnology offers an opportunity to strengthen links between growth and poverty reduction.

1.2 Relevance of biotechnology, biosafety and biosecurity in the emerging global paradigm

Chapter 16 of Agenda 21 asserts that biotechnology promises to make a significant contribution in enabling the development of, for example, better health care, enhanced food security through sustainable agricultural practices, improved supplies of potable water, more efficient industrial development processes for transforming raw materials, support for sustainable methods of afforestation and reforestation, and detoxification of hazardous wastes. Juma and Konde (2002) suggested three factors that would allow for wider participation of developing countries in scientific biotechnology:

- Growing recognition that current patterns of globalisation must be changed around to increasingly include developing country products;

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4 The entire text of Agenda 21 is available at www.un.org/esa/sustdev/agenda21text.htm/
Many of the techniques used in biotechnology research are becoming readily available; much of the initial research and development expenditures have already been borne by the industrialised countries.

Biotechnology has become a cutting edge technology that is steadily increasing in its importance to economic development. This can readily be seen in the fields of, food, agriculture and forestry, food processing, industry, health and the environment. Modern biotechnology enables scientists to increase the efficiency of breeding for some traditionally intractable agronomic problems such as drought resistance and improved root systems. Tissue culture has produced plants that are increasing crop yields by providing farmers with healthier planting material. Rice has been genetically engineered to contain pro-vitamin A (beta carotene) and iron, which could improve the health of many low-income communities.

In health, genetic engineering (GE) is helping to reduce the transmission of human and animal diseases through new vaccines. It makes possible the customisation of organisms or biological molecules for industrial or other practical purposes, such as the use of enzymes in washing powder. In industry, biotechnology is used in such varied contexts as producing drugs, bleaching paper pulp, extracting minerals, cleaning up oil spills and heavy metals in fragile ecosystems. Marker-assisted selection and DNA fingerprinting allow a faster and much more targeted development of improved genotypes for all living species. They also provide new research methods, which can assist in the conservation and characterisation of biodiversity.

1.2.1 Agricultural and food processing biotechnology

Biotechnology has the potential to help increase production and productivity in food and agriculture, forestry and fisheries. It could lead to higher yields on marginal lands especially in poor developing countries. In a recent survey, the OECD (2005) reported that over the last eight years, there was more than a 47-fold increase in the area grown with GE crops (also known as transgenic crops), reaching 81 million hectares. In 2004, 14 countries grew 50,000 ha or more: the US grew 59% of the world total, followed by Argentina (20%), Canada (6%), Brazil (6%),

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5 This is consistent with estimates of the International Service for the Acquisition of Agri-biotech Applications (ISAAA).
China (5%), Paraguay (2%), India (1%) and South Africa (1%). In addition, Uruguay, Australia, Romania, Mexico, Spain and the Philippines each had smaller scale cultivation of less than 1% of the total. Most of this cultivation has focused on soybean (60%), maize (23%), cotton (11%) and rapeseed (6%). According to the OECD (2005) GE has involved two traits: insect resistance (the so-called Bt crops) and herbicide tolerance (the Round-Up Ready crops).

Developing countries such as Cuba, Brazil, India, Thailand and China have been quick to identify the potential benefits of modern biotechnology and have established measures both to develop such industries and to extract value where possible and relevant. Seven developing countries cultivate genetically modified (GM) crops commercially (FAO).6 Asia and Latin America and the Caribbean account for over 88% of the number of GMOs in developing countries (IICA 2005); most of which are in experimental phase or field trials. Only 24 GMOs or 3.92% are commercialised.

Transgenic organisms are used to improve crop production, nutritional value, and disease resistance and prevention. In biodiversity application, transgenic crops may be able to help preserve uncultivated habitats through increasing yield on land already under cultivation and by reducing pressure to exploit additional uncultivated land. Their use may also help reduce the amounts of pesticides and herbicides released into the environment. At the same time, transgenic crops can pose threats to biodiversity. Use of these organisms may interfere with endemic species, pollinators, and ecological processes. Transgenic crops could potentially breed with wild varieties and have harmful effects on animals that feed on them. For example, a crop with enhanced vitamin content may be targeted at alleviating certain vitamin deficiencies in humans, but the altered vitamin content may be lethal to wild fauna, including pollinators (USAID 2003).

1.2.2 Industrial biotechnology

Industrial biotechnology includes such developments as the use of renewable raw materials (biomass) to replace raw materials derived from fossil fuels, use of biological systems such as cells or enzymes (used as reagents or catalysts) to replace conventional non-biological methods. The mining sector uses bioprocessing techniques such as bioleaching of sulphide ores.

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6 Biosecurity for Food and Agriculture, programme website, URL: http://www.fao.org/biosecurity/
Technology is being developed to inhibit organisms involved in mine acid generation. Bio-filters for sulphides are under development. In the textile and leather industry many enzymatic products (amylases, lipases, cellulases, isomerases) are being marketed. In paper manufacturing, biopulping (using fungi) results in saving on electricity, treatment with cellulase and hemicellulase reduces wood drying time and bioleaching of pulp reduces chemical requirements considerably (Juma and Konde 2002).

1.2.3 Medical biotechnology

Biotechnology has had many successful applications in the field of medicine. A recent study identified the top 10 biotechnologies for improving health in developing countries. Successful applications and/or emerging technologies include: GM plants to produce pharmaceuticals (so-called biopharming); GM animals to find cures for diseases. Drugs and vaccines produced in this way have been on the market for nearly 20 years. Diagnoses based on antibodies and genetics have become increasingly important tools in medicine. The mapping of human genetic material increases the opportunity of reducing side effects and improving treatment results. Drug treatment can be made more efficient by being customised according to each patient’s capability to absorb and metabolise drug substances. New drugs to combat cancer can be developed with improved knowledge about how cancer cells appear. Knowledge of the genetic makeup of infectious agents can allow the development of new vaccines and antibiotics to prevent, and cure, diseases such as AIDS, malaria, tuberculosis and cholera. Genetic testing will become routine and will increase the possibilities of avoiding illnesses in the future and adjusting one’s lifestyle to one’s genetic makeup. New organs and tissues can be produced with the help of stem cells from the body.

1.2.4 Environmental biotechnology

Environmental biotechnology is primarily based on the methods of traditional biotechnology. Biotechnology is used to clean air, wastewater and polluted soil. It is also used to produce bio-energy in the form of ethanol and biogas, and to replace chemicals harmful to the environment with biodegradable alternatives based on renewable resources. Using bio-energy can slow the greenhouse effect. Plant and forest tree breeding can encourage the chemical industry to replace

7 www.utoronto.ca/jcb/genomics/documents/toptenreportfinal.pdf
petroleum with environmentally friendly fuel such as bio-diesel and hydrogen gas. These can be produced through biotechnology, and would help to cut the release of carbon dioxide.

1.2.5 Opportunities for commercialisation of biotechnology

The commercialisation of biotechnology in Guyana should seek to follow the model of other developing countries such as India, Cuba and Brazil, which provide good examples of political leadership on technology matters, domestic funding for research activities, creation of appropriate research institutions and international alliances for product commercialisation. Some important commercial starting points include the production of enzymes (world market value of US$1.6B), amino acids and vitamins (world market value of US$3B), digestive enhancers (world market value of US$1.3B) and disease preventing agents (world market value of US$480M) (Juma and Konde 2002). It is predicted that the market for probiotics, amino acid and digestive enhancers will grow.

According to Juma and Konde (2002), potential market gains can be had from:

- **Bio-fertilisers** – an affordable industry, cheap to manufacture and suitable for small-scale farmers if produced locally (eliminates distribution costs) and investment in technology is far lower than that of inorganic fertilisers
- **Body and health-care products (nutraceuticals)** – demand is likely to increase. It presents a market for Guyana with its endowment of rich biodiversity
- **Bio-preservatives** – The food industry has failed to expand due to continued use of chemical preservatives many international markets are unwilling to accept. Use of natural products to inhibit bacteria and fungal growth will improve acceptability of products such as fruits and vegetables, fish and meat products. Most of the enzymes involved are easy to prepare in house and can be obtained on the international market as a fair price.
- **Mining** – could increase share of earnings if appropriate technology is developed. Use of bio-leaching technology can improve quality of final products and reduce waste associated with mechanical cracking. Biotechnology solutions to mercury and cyanide will increase value and earnings and reduce environmental degradation.
Consistent with Guyana national policy statements would be approaches that add value to raw materials and present a means of indirectly marketing products that are currently difficult to sell. Examples are:

- Conversion of cassava into export-products such as plastics, sweeteners, and fibres. Fibres or polymers can be used to make bags, plates and other utensils;
- Conversion of wastes into useful products. Food wastes can be broken down into amino acids, fuels and fertilisers that will benefit rural and urban poor. Use of microbes and enzymes are key to this.

There are a number of current biotechnology products that are more expensive than traditional equivalents and care should be exercised in exploring them for commercial development (Juma and Konde 2002):

- Bio-pesticides – are still largely behind chemical pesticides due to target specificity (bad for business, good for the environment), instability and batch (potency) variation. Bio-pesticides are worth US$380M (or US$74M without Bt) out of an estimated US$8B pesticide market;
- Bio-plastics and bio-fuel – are more expensive than traditional plastics and petroleum derived equivalents in developed countries.

The provision of an enabling environment is key to allowing Guyana to participate effectively in new biotechnology economy. The key determinants include market access, international biotechnology alliances, intellectual property protection, and regulation and risk management. Given the richness of Guyana’s biodiversity, there ought to be a concerted effort to pursue activities that link biodiversity conservation and biotechnology such as: support for an open dialogue and consultation between stakeholder groups at the early planning stages of any activity involving transgenic organisms to identify potential environmental issues; build the capacity of in-country institutions to undertake regulatory research and environmental monitoring of biotechnology; and promote research to identify potential risks of biotechnology on specific aspects of natural biodiversity.
In addition, it is important for the public sector to retain enough capacity, resources and freedom of action to provide the services on which the national private sectors can build. They will also need to build their policy and regulatory capacities with regard to transgenic crops that originate elsewhere\textsuperscript{8}. Cohen and colleagues (2004) posit the view that adequate research capacity is key to the appropriate development of biotechnology, including GM crops. Early evidence on farm-level impacts confirms that biotechnology applications may help poor farmers increase their productivity when, research is focused on smallholder problems, undertaken together with research to improve agronomic practices, and focuses on improved access to markets.

A recent report by the World Health Organisation entitled “\textit{Modern Food Biotechnology, Human Health and Development}” notes that “pre-market assessments done so far have not found any negative health effects from consuming GM foods”. However, the need for broader and continuing evaluation is emphasised as was illustrated in 2002 when several southern Africa countries facing food shortages did not permit GM food aid, citing socio-economic, ownership and ethical concerns rather than health or environmental ones.\textsuperscript{9}

\textsuperscript{8} In this area, the International Plant Protection Convention (IPPC) is establishing practical cooperation with the Convention on Biological Diversity and its Biosafety Protocol. It is also developing a detailed standard specification for an International Standard for Phytosanitary Measures that identifies the plant pest risks associated with Living Modified Organisms, and ways of assessing these risks.

2.1 Overview of existing national policy statements on biotechnology, biosafety and biosecurity

Modern biotechnology is a sophisticated technology. It requires major inputs of resources, in the form of skills and capital. The industrialised countries and the major chemical and drug companies, have dominated the biotechnology sector up to now. In developing countries, there are fears that the new technology will widen further the gap between rich and poor countries – the fear of technology exclusion. In the debate on biotechnology, specialists and the public often take differing viewpoints. Specialists emphasise the opportunities, and the public focuses on the risks. It is generally assumed that general opposition to certain biotechnology applications is based on a lack of knowledge. Opposition could, therefore, be reduced if there was improved information about, and awareness of, biotechnology. However, there is the perception that lack of access, participation and influence, as well as ethical considerations, rather than lack of knowledge, that influence people’s attitudes to various biotechnology applications. This was the overwhelming view of persons interviewed during this present survey (Appendix 1).

In Guyana, there is no existing national policy on biotechnology, biosafety or biosecurity. Neither the NDS nor the draft policy on science and technology makes reference to biotechnology and its role in national development. There have not been many national policy statements on biotechnology, biosafety and biosecurity. The most recent and profound statements were made on the occasion of World Consumer Rights Day 2005, when several policy makers and Government Departments outlined their positions on these issues (Appendix 2)\(^\text{10}\). On the occasion of World Consumer Rights Day 2005, Consumer International adopted the theme ‘Say NO to GMO’. The few public statements suggest that a policy on biotechnology, biosafety and biosecurity must address the following areas and support relevant legislation:

- Public awareness
- Labelling policy for GM foods (including Codex Alimentarius safety guidelines)
- Consumer protection bill

\(^{10}\text{Source: Guyana Chronicle March 15, 2005, Guyana National Printers Ltd., Lama Avenue, Bel Air Park, Georgetown, Guyana. pp 14-15.}\)
• GMO policy (not at the exclusion of organic agriculture)

2.2 Overview of existing national initiatives in biotechnology, biosafety and biosecurity

2.2.1 Agriculture

Plant tissue culture is the main form of biotechnology practised in Guyana at the Biotechnology Unit of the National Agricultural Research Institute (NARI)\(^{11}\). The Unit provides micro-propagated plants of plantains (*Musa* spp.), pineapple (*Ananas comosus*), sweet potato (*Ipomoea batatas*), cassava (*Manihot esculenta*) and yam (*Dioscorea* spp.). The first four are included in the FAO biotechnology inventory as being in the commercial phase.\(^{12}\) The Unit serves as the repository for the *in-vitro* storage of germplasm of these food plants. Research projects have included, the development of laboratory protocols for *in-vitro* micropropagation and storage of cassava, pineapple, yam, sweet potato, plantains, tropical forest timber species and orchids; radiation treatment of *in-vitro* cultures of plantain to induce mutants with tolerance to Moko disease (*Pseudomonas solanacaerum*) and inducing salt tolerance in rice (*Oryza sativa*) lines.

NARI has a Virology Unit that utilises a molecular (immunological) diagnostic procedure, ELISA (Enzyme-Linked Immunosorbent Assay) in the diagnosis of the Citrus Tristeza Virus. There is a Soil Microbiology Laboratory that has developed *Rhizobium* inoculant for use in legume biological nitrogen fixation (e.g. Octive et al. 1993) and in the not too distant past, Azolla (10 strains) and blue green algae (nine strains) were maintained and characterised for nitrogen nutrition in rice.

Munroe (1994) reported on work done on bio-control in integrated pest management by NARI, Guyana Sugar Corporation (Guysuco) and the University of Guyana (UG).

- In rice, control of stem borers *Diatraea* spp. and *Rupela albinella* Cramer, with the parasitoid *Allorhogas pyralophagus*;

\(^{11}\) The work of this Unit is temporarily interrupted owing to the January 2005 floods. With the help of financial assistance from the Governments of the USA (through USAID) and Guyana, the unit will be re-built as part of a project entitled “Management of plant genetic resources for food and agriculture”.

\(^{12}\) http://www.fao.org/biotech/inventory_admin/
• In sugarcane, control of giant moth borer *Castnia licoides* with the parasitic nematodes, *Beauveria* sp. and *Metarhizium anisopliae*; control of the small moth borer *Diatrae centella* Moschler with parasitoids e.g. *A. pyralaphagus*, *Cotesia flavipes* and *Pediobus fervus*; control of the froghopper *Aeneolamis flavilatera* Urich with *M. anisopliae*; and control of the grass species *Echinochloa pyramidalis*, using a fine grass *Leersis hexandra* Swartz;

• In coconut, control of coconut caterpillar *Brassolis sophorae* using the entomopathogen *Beauveria* sp.

• In various fruits and flowers, the control of the pink or hibiscus mealybug *Maconellicoccus hirsutus*, with the predator, the ladybird beetle, *Cryptolaemus montroaeiri* and the parasitic wasp *Anagyrus kamali* (Munroe 1997);

• In vegetables, aqueous extraction of neem (*Azadirachta indica*), mammey seed (*Mammea americana*) and jackbean (*Canavalia ensiformis*) for testing as anti-feedants;

Both UG and NARI have successfully cultivated edible mushrooms, *Pleurotus ostreatus*, *Lentinus* spp., *Ganoderma* spp., and *Auricularia* spp., under laboratory conditions on a range of locally produced substrates such as sawdust and coir or coconut fibre (NARI 2000).

There isn’t currently or historically, direct use or application of biotechnology at the Guyana Forestry Commission (GFC) or by private forestry operators in Guyana. The only project that may have some bearing or relation to biotechnology is the plantation project, which entails replanting of seeds and seedlings from trees that were logged or deforested. Biotechnology in the form of plant tissue culture would help to genetically alter the particular type of plant needed and the quantity as well. There is interest in setting up a forest seed bank as well as storage and regeneration of forest plants using plant tissue culture techniques (Raquel Thomas, personal communication). FAO biotechnology inventory lists one entry, *Vouacapoua americana*, as being in the experimental phase (http:www.fao.org/biotech/inventory_admin/).

### 2.2.2 Food processing

In the livestock industry, if a disease is detected, test samples are sent abroad for testing due to inadequate testing facilities in Guyana. At commercial poultry farms such as the Bounty Chicken
Farm, HACCP (Hazard Analysis Critical Control Point) is in use and aids in securing good quality food products for consumers. Biosecurity is taken seriously especially at the hatchery. At the Guyana School of Agriculture Corporation (GSA), there is a well-established history of use of local herbs and spices in the preservation of meats, fruits and vegetables (e.g. David and Archibald 1987). Traditionally, the Amerindians and indeed other Guyanese, use casareep, an extract of bitter cassava, to preserve meats.

2.2.3 Industry

Biotechnology is used in the distillery and winery at Banks DIH and DDL. Alcohol is produced in two steps, fermentation and distillation. Fermentation relies on the use of yeast cells of Saccharomyces cerevisiae to ferment 80 °Brix sugarcane molasses. At DDL, biosafety is especially applicable to the juice plant (TOPCO) to aid in the prevention of contamination by native microorganisms. While the company aims to introduce the HAACP system, a Cleaning in Place (CIP) system is in use and involves general sterilisation along with pasteurisation as a means of food safety. At the National Milling Company (NMC) and Guyana Stockfeeds Ltd., no modern biotechnology is applied. At the NMC, a bake test based on fermentation is used. GM wheat research is being monitored as a possible source of raw material for the flour industry.

Both UG and the Iwokrama International Centre for Rain Forest Conservation and Development have done some work done on natural products chemistry. At the UG Faculty of Natural Sciences, several M.Sc. theses were produced including titles such as “The manufacturing of paper from bagasse”, “The investigation of edible oils quality sold in a Georgetown Market” and “Developing a protocol for increasing the shelf-life of coconut water”. It is not certain whether any of this research was converted to projects or enterprise for commercial gain, or otherwise used as the basis for further research.

2.2.4 Health

Until recent times, no biotechnology was applied at the Ministry of Health or its departments FPD (Food Policy Division FPD) or GA/FDD (Government Analyst/Food and Drugs Department). With the help of USAID and PAHO, the GA/FDD now has the molecular diagnostic capability to test for aflatoxin in peanuts and other crops and the diagnosis of
organisms of microbiological important such as *Salmonella*, *Escherichia coli*, *Enterococci*, *Pseudomonas*, *Listeria monocytogenes*, *Vibrio* spp., *Bacillus*, yeasts and moulds. In addition, at FPD, advice is given to personnel on safe disposal of waste products and to ensure product safety. At the GA/FDD, consumers are educated and provided information on foods produced by biotechnology or gene transfer. In nursing, there is no knowledge or technique of biotechnology currently in use.

2.2.5 Environment

The Iwokrama Rainforest Centre has done work and offered training in bio-pharmaceuticals intellectual property rights (IPR), and access to genetic resources and benefit sharing (ABS). There is a draft policy document on IPR and ABS.

It is evident that lower-end biotechnology is applied in Guyana, now with lesser intensity and extent given the current situation at NARI, the public institutional leader in biotechnology. There is definitely scope and numerous opportunities for application of biotechnology to agriculture, health and the environment. Increased application of biotechnology would necessarily increase demand for biosafety and biosecurity. The unofficial introduction of GM tomato and corn to Guyana presents direct and indirect threats, the risks of which are yet to be assessed.

2.3 Existing capacity building in biotechnology, biosafety and biosecurity physical and institutional infrastructure

The National Biosafety Framework (NBF) Project of the Environmental Protection Agency (EPA) is ongoing and will “take Guyana from a zero stage where national biosafety and biotechnology policies, biosafety laws and regulatory regimes are non-existent, to a stage where a draft national biosafety framework document with related draft biosafety legislation would have been prepared”. The GoGi/UNDP Project on Capacity Building for the Management of Natural Resources and the Environment is currently implementing the outcomes of focus group discussions on pollution prevention and sustainable use of biodiversity. The Iwokrama International Centre has capacity in intellectual property rights, access to genetic resources and benefit sharing; these are important challenges in biotechnology.
A former Assistant Dean of the Faculty of Agriculture and Forestry, University of Guyana, returned to Guyana after a six-month sabbatical attachment to Kew Gardens learning molecular techniques. Annually, at least 21 final-year B.Sc. Biology students take a one-semester course in molecular biology and biotechnology. At NARI, the approved USAID PL 480 project “Plant Genetic Resources for Food and Agriculture” will build capacity in scientists and technicians in molecular biotechnology, a follow-up to a national course on DNA techniques held from 2-4 May 2001 at NARI. The Animal and Plant Health Units of the Ministry of Fisheries, Crops and Livestock (MFCL) operate border and coastal surveillance programmes for pests and diseases of agricultural animals and crops; essential to its statutory biosecurity function. There is no in-country quarantine facility and the veterinary diagnostic facilities are not presently in use. The GA/FDD has recently acquired the equipment and training for laboratory technicians in testing for aflatoxins and other mycotoxins in peanuts and other foods.

2.4 Overview of active research programmes in biotechnology, biosafety and biosecurity

Currently, in biotechnology, research on commercial trait selection in sweet potato germplasm using conventional methods is ongoing on-farm at Kurukuru by NARI scientists. Also ongoing at NARI is bio-control activities for control of Acoushi (Atta spp.) ants on cropland in the excessively drained white sand ecosystem at Mainstay in Region 2 and thrips of boulanger (Solanum melongena) using plant extracts in bait preparation are ongoing. At GUYSUCO, routine bio-control of froghoppers and sugarcane stem borers is ongoing as part of integrated crop management.

2.5 Overview of existing administrative mechanisms for biotechnology, biosafety and biosecurity initiatives in Guyana

While there exist administrative mechanisms at the EPA with respect to the handling and fate of biological specimens from approved scientific explorations conducted in Guyana, there are no known mechanisms, coordinated or otherwise, at other state institutions for biotechnology, biosafety or biosecurity. The National Coordinating Committee (NCC) under the auspices of the EPA is coordinating the NBF Project, of which this draft policy is one component. Another national committee prior to the NBF Project examined the Cartagena Protocol. NARI has responsibility for advice on and development of technology and systems for agricultural
development. In this regard, NARI developed the laboratory and human resource capability to use biotechnology as a tool in the micropropagation of important food plants as well as a repository for collections of in-vitro food plant germplasm, and reference collections of insects, diseases and weeds. The Plant Quarantine Unit of MFCL with assistance from the Inter-American Institute for Cooperation on Agriculture (IICA) maintains a surveillance programme for pests of quarantine importance at the border locations and ports of entry locations. An inventory of plant pests and diseases of quarantine importance is available (Appendix 3).

At the industry level, several localised initiatives are in place. Health industry defaulters are corrected through workshop and on-the-spot training. At Banks DIH, there is a policy on corrective action, which encompasses a wide range of actions such as inter-auditing, incident management, managing and calibration. At DDL, there is a quality control laboratory for each processing department. At Bounty Farms, an animal health assistant makes weekly visits to all farms incorporating an all-in, all-out system. Records are kept in conformity to HAACP and there is an operations manual to identify monitoring areas. At the University of Guyana, there is the teaching of molecular biology and biotechnology (BIO 423) to final year biology students in the Faculty of Natural Sciences.

2.6 Overview of existing legislative framework for biotechnology R&D, biosafety and biosecurity

No such legislation exists in Guyana. However, both GA/FDD and EPA have their own laws which they implement and which may directly or indirectly deal with the issues concerning the use of biotechnology in producing all kinds of products. The Seed Act, the Plant Protection Act and the Animal Disease Act contain some elements of protection but would have to be updated to include reference to biotechnology, biosafety and biosecurity.

2.7 Overview of the existing human resource capacity in biotechnology, biosafety and biosecurity

There are a few persons directly trained in biotechnology and some have attended training workshops or given presentations on the subjects. Others have used biotechnology as a tool in research. However a large number of persons have received formal training in related sciences. The majority of these persons are employed by the State at the University of Guyana, National
Agricultural Research Institute and the Environmental Protection Agency. At the sub-professional level, individuals trained in or otherwise exposed to biotechnology, biosafety or biosecurity are employed at NARI, in the main. Caesar (2002) has presented a list of research partnership domains in biotechnology. A separate component of the NBF Project presents an inventory of human resources in science and technology in Guyana.

The present survey results are presented in Appendix 4.
3.1 Overview of the policy

The Guyana policy on biotechnology, biosafety and biosecurity aims to strengthen Guyana’s capability to take advantage of the opportunities offered by biotechnology, for the benefit of the individual, industry and the environment. The biotechnology policy aims to promote the accumulation and use of knowledge in the sector, to facilitate the conversion of the results of research projects to practical applications, under ethically acceptable conditions, with the risks overcome and protection to the traditional sectors from the negative effects of some aspects of biotechnology. The policy encourages public-private sector partnerships and foreign direct investment. Guyana is an attractive country to do business in because of its rich biodiversity and indigenous resources.

The four main policy issues for Guyana are how pervasive or strategic is biotechnology to the economy, dissemination of knowledge (public participation), human resources and social acceptance of the technology and/or its products. In the public interest, policies can be positive, neutral or negative. In the case of biotechnology, the general lack of knowledge, present limited application of the technology and high degree of suspicion suggest that a precautionary policy might be preferred at this stage. Adopting this approach means that the anticipated economic effects will be modest; but with application, effects on environment and quality of life can be much larger. Later, a promotional or permissive policy can be considered.

Earl (2003) reports that the odds currently favour increasing consumer resistance to GMOs. In the present survey, respondents were adamantly cautious and rejected outright, some types of biotransformation. Zoning of a country for crops on the basis of genetic modification allow positioning to take advantage of both GM and non-GM markets. Such a policy will produce results only if there is low cost, quick and reliable testing of the presence of GM germplasm at every point of the crop. A certification programme of the type developed by Iowa State University “Uniform Certification Procedure” offers an interim solution (Earl 2003).

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13 Countries such as Kenya, Brazil and India have highly precautionary biosafety policy.
OAS (2004) advises that countries of the Americas must increase their commitment to R&D, establish collaborative effort at the hemispheric level, develop human resources and infrastructure, establish a legal framework within which biotechnology development may occur in order to achieve proficiency in biotechnology.

The present Guyana policy identifies opportunities for wealth creation and national well being in the sectors of agriculture, food processing industry, health and the environment. The policy encompasses five pillars, which underline the direction and measures towards developing biotechnology and protecting the nation from the effects of GMOs and GE. The five pillars are:

I. Create and sustain public awareness of biotechnology, biosafety and biosecurity and increase the nation’s human capital in biotechnology via education and training. There is no doubt biotechnology is built from the power of research and human intellect;

II. Establish biotechnology centres of excellence in selected parts of the country, where multi-disciplinary research teams work in coordinated initiatives, leading to the transformation of the productive sectors and commercialisation of the rich biodiversity;

III. Apply incentives to encourage committed participation from academia and the private sector;

IV. Review the legal and regulatory sectoral framework to protect traditional sectors;

V. Establish a dedicated and professional agency to spearhead the development of Guyana’s biotechnology sector. The key aspect here is to employ an approach that moves away from an infrastructure focus to one that builds on the capabilities of existing institutions.

3.2 Pillars of the biotechnology policy

3.2.1 Public awareness, education and training

Biotechnology is knowledge based and its applications appear to be concentrated in a few industrialised nations. The form of biotechnology practised in Guyana is traditional and lower-end biotechnology with very little risk to humans and the economy. This policy advocates that Guyana adopts a pro-biotechnology approach. Implicit in this is the requirement to responsibly inform, educate and train Guyanese in the various aspects of biotechnology, biosafety and biosecurity. There is need to link knowledge generation with enterprise development. Academic institutions would have to work closely with industry for research purposes.
3.2.2 Biotechnology centres of excellence

In order to ensure the beneficial use of the trained critical mass, resources should be allocated to developing three centres of excellence in biotechnology. There should be a centre of excellence for genomics and molecular biology at the University of Guyana. A second centre of excellence should be set up in the Intermediate Savannahs and its focus should be on health-related natural products (nutraceuticals) and bio-generic drugs. A concerted effort should be made to capitalise on the strengths of Guyana’s rich biodiversity to commercialise discoveries in health-related natural products. A third centre of excellence should examine industrial biotechnology at a suitable site in the mining belt. The applications ought not to be commercialised in commodities where Guyana’s international trade may be affected.

3.2.3 Incentives

Government should consider providing matching grants for research R&D, 15-year tax-exempt pioneer status, and exemption of import duties on approved equipment and materials. To increase access to funds for biotechnology companies, venture capital participation should be strengthened and entry to capital markets enhanced. Entry must allow for the special characteristics of biotechnology companies with its long gestation periods and high-risk profiles. Some other incentives are concessional electricity rates for the first five years, the provision of infrastructure (water, access roads, broadband internet connectivity) initially at nominal costs. The offer of the incentives is premised on the notion that a biotechnology policy must plan for the future and any immediate expenditure on supporting biotechnology industry must be regarded as an investment for the future.

3.2.4 Legal and regulatory framework

It is essential to protect the traditional sectors particularly the food and agriculture sector from the innovations of modern biotechnology. In addition, regulatory changes are required to give researchers a share in the ownership of intellectual property and in the monetary rewards derived from their work, together with their institutions and investors. Regulation and procedures pertaining to employment of knowledge workers will also be reviewed to increase the biotechnology ‘brain-gain’ into the country. There is need for legal regulation of biotechnology
applications to humans such as conditions for gene therapy, cloning and pre-implantation genetics.

Experiences from the rest of the world clearly show that coexistence (non-GMO vs. GMO) is impossible. A Guyana policy must not threaten sectors of importance to Guyana. This rules out the application of certain types of biotechnology in zones where rice, sugar and organic agriculture are practised. The absence of a domestic policy on GM crops and GMOs necessitates that a duly authorised body handle all proposals on a case-by-case basis. There will be need for a Patent Act in keeping with provisions of WTO/TRIPS agreement as well as a plant variety protection and farmers’ rights act to ensure the delicate balance between the interests of plant breeders and farmers. Also, the Seed Act, Plant Protection Act and the Animal Disease Act would have to be reviewed and updated, accordingly.

The demand of consumers for free and informed choice of foods must be fulfilled. This requires compulsory labelling for all products resulting from genetic technology at all stages of the production process.

3.2.5 Lead agency for rapid development and use of biotechnology

The merit of any policy can only be seen in its execution and therefore the “Guyana Biotechnology Corporation (GBC)” will be set up under the oversight of an implementation council consisting of members of the present NCC of the NBF Project. The GBC has to work closely with all relevant agencies and ministries such as the Ministry of Agriculture, Ministry of Health, Ministry of Trade, Tourism and Industry as well as the environment and mining sector agencies. The capability of existing institutions will be built through centres of excellence from existing institutions around the country to be known as BIOVISION 2015 Guyana.

3.3 Overview of policy indicators

An indicator system that includes public goals and public benefits is necessary for charting a strategic orientation for the policy. For ethical, political and practical reasons, poverty reduction must be a priority for the emerging strategy, based on the policy. Public policy should ensure that
biotechnology meets its promise to improve quality of life. This draft policy articulates indications of public benefits.

### 3.3.1 Indicators for biotechnology capacity development

Biotechnology can help in the following ways:

- Urban poor benefit from lower food prices and improved nutritional and health characteristics of food;
- For the rural poor, benefits will concentrate on those in better endowed areas who are already in the market for technological inputs;
- Some benefits will come from cash crops like cassava, cocoa, and indigenous vegetables, where small farmers are involved;
- Landless or subsistence farmers will benefit only through multiplier effect;

#### Application or use indicators

- Number of biotechnology firms by field/sector increased from zero to five;
- GM crop area identified and regulated;
- GM crop area by trait quantified and monitored;
- Biotechnology revenues by field increased;
- Type of biotechnology used by firms documented;
- Trade in biotechnology and biotechnology exports increased;
- Number of biotechnology specialists by discipline identified and documented

#### Indicators of social benefits

- Field trials by trait identified and documented;
- GM crop area by trait increased and monitored;
- Biotechnology revenues/sales by field increased;
- Biotechnology employees by field increased and protected;
- Type of biotechnology used by firms documented;
- Trade in biotechnology exports increased and monitored;
- Number and type of organisations involved in biotechnology documented.
Pre-commercial indicators

- Data on research by production constraint (productivity, health, quality, etc) documented;
- Field trials data documented;
- Field trials by trait documented.

3.3.2 **Indicators for biosafety capacity development**

- Number of trained persons in biosafety increased;
- Number of incidents involving biosafety issues minimised;
- Number of persons making use of protection under the law increased;
- Number of referrals to international arbitration minimised.

3.3.3 **Indicators for biosecurity capacity development**

- Frequency of use of extreme measures such as prohibition or restriction;
- Number and intensity of use of post-entry quarantine facilities increased;
- Number of new, invasive or emerging pests and/or diseases minimised;
- Number of persons trained and/or retained in biosecurity increased;
- Number of incidents involving biosecurity issues minimised.
Chapter 4
Recommendations and National Strategic Vision for 2005-2015

4.1 Principles of a national policy

A national policy on biotechnology, biosafety and biosecurity for Guyana shall have the following seven principles:

1. Sovereign rights over natural or native (including genetic) resources in its areas of jurisdiction, and authority to control activities which exploit or may have negative impacts on such resources;

2. Endeavour to strike appropriate balance between biotechnology promotion and regulation in sustainable development pathway vis-à-vis organic agriculture and conservation of biodiversity;

3. Use, output, export, sale or transit of biotechnology applications, practices, products must conform fully to all existing or anticipated national legislation;

4. Formal regulation of biotechnology shall be a competent authority advised by a technical body independent of both government and industry whose decision making process is transparent, takes full account of environment, public health, socio-economic, and socio-cultural concerns is based on locally applicable scientific data and applies the precautionary approach;

5. Biotechnology applications based on or inspired by the knowledge, innovations or practices of communities or individuals of Guyana shall be subject to national legislation(s) related to community or individual intellectual property rights and shall incorporate contractual agreements to share financial or other benefits arising from such applications with these communities or individuals. The state shall facilitate community access to appropriate advice for the purposes of negotiating and concluding such contractual agreements;

6. Guyana shall endeavour to cooperate with other states particularly its neighbours, to ensure the safe use of biotechnology within its borders and protection from illegal trans-boundary movements;
7. Guyana shall not permit the importation and use of biotechnology products and procedures which do not meet minimum safety standards identified by the competent authority as stated in this policy document;

4.2 Objectives of a national policy

1. To guide the judicious use of modern biotechnology in Guyana for sustainable development in ways which do not jeopardise human or environmental health including Guyana’s biodiversity and genetic resources. In particular, this should include:
   i. Detailed inventory of biological resources of the State;
   ii. Promote conservation of biodiversity and sustainable use of natural resources, including organic agriculture;
   iii. Provide special incentives to protectors of traditional technology and resources;
   iv. Create enabling environment for research and development in biotechnology through development of infrastructure and appropriate incentives, and regulatory framework for research;
   v. Human resource development in biotechnology, biosafety and biosecurity;
   vi. Develop coordinated required support services;
   vii. Develop bio-informatics;
   viii. Facilitate flow of capital funds;
   ix. Address issues such as IPR, access to genetic resources, and benefit sharing.

2. Ensure effective control of trans-boundary movement of GMOs or products thereby resulting from modern biotechnology through exchange of information and a scientifically based, transparent system of advance informed agreement. In particular, the national policy shall
   a. Provide for the establishment of a permanent pre-border, border and post-border regulatory system for control of the trans-boundary movement of GMOs;
   b. Support development of regulatory capacity to assess, test, monitor and control biotechnology applications in accordance with agreed biosafety guidelines;
c. Support development of research and industrial capacity to safely apply biotechnology techniques for enhancement of Guyana’s socio-economic and environmental well being;

d. Provide institutional framework for national decision-making and international cooperation.

4.3 Guyana biotechnology vision 2015

4.3.1 Scope

This policy covers all GMOs and their products, all LMOs and all elements of genetic materials used in genetic manipulation. This national policy covers in detail:

1. Laboratory and field applications of biotechnology within Guyana whether currently known to science or those developed in future;

2. The fields of agriculture, environmental management (including bioremediation of mining, industry and domestic wastes) food/beverage processing, health (including human and veterinary medicine) and industry, and other fields of current or future applications;

3. The regulatory processes, including notification, information transfer and review, risk assessment including socio-economic impact, ethical considerations, monitoring and enforcement measures pertaining to import or export of the products of biotechnology or laboratory or field use of biotechnology in Guyana including handling, disposal, containment, control, monitoring and release;

4. The biotechnology research and development process, including academic, agriculture, health, industrial and other research;

5. Occupational safety at work places where biotechnology procedures are used or products handled;

6. Labelling of GMOs in feedstuffs and feeds sold in or imported to or through Guyana;

7. Any other measures to ensure public safety or health or environmental safety with respect to the use of biotechnology in Guyana or its neighbouring territory or waters.

4.3.2 Thrust areas

14 Includes some elements of biosafety and biosecurity.
The thrust areas will be as follows:

- Agricultural biotechnology
- Environmental biotechnology
- Food (processing) biotechnology
- Health biotechnology
- Industrial biotechnology

4.3.3 Institutional framework

The competent body shall be the National Biotechnology and Biosafety Council of Guyana (NBBC), a semi-autonomous body that shall be set up initially as a semi-autonomous body within the EPA. All appointments to the sub-Committee shall be for a five-year term. The Presidential Adviser on science and technology shall appoint members. The composition of the NBBC shall reflect the present representation on the NCC of the NBF Project. However, efforts must be made to include persons from the private sector. Members of the NBBC shall include expertise in human and veterinary medicine, agriculture, plant breeding, microbiology, molecular biology, environmental protection, food production and processing, social science, economics and military science. The NBBC will provide oversight to the Guyana Biotechnology Corporation (GBC), which shall be legitimised by an act of Parliament. The GBC shall be established at either IAST (Institute of Applied Science and Technology) or NARI after an assessment of institutional mandate and ease of alignment.

The mission of the Council must be based on the principles outlined in section 4.1 above. The functions of the NBBC shall be as follows:

- Coordinate research and development;
- Receive and process applications;
- Ensure public education and awareness on relevant issues pertaining to biotechnology, biosafety and biosecurity in a timely manner;
- Promote accumulation of knowledge, dissemination of information, create active dialogue between researchers and other specialists, politicians and other citizens;
- Draw up, implement and monitor appropriate occupational safety protocols at workplaces where biotechnology procedures are used or products handled;
• Advise on appropriate labelling of GMOs in feedstuffs and feeds sold in or imported to or through Guyana;
• Defend the image of the country in the field of biotechnology, biosafety and biosecurity;
• Create and maintain a bio-informatics database as well as an information and promotion website;
• Representing the biotechnology industry overseas

The GBC shall regulate the biotechnology industry under the appropriate national legislation and with respect to the international protocols and conventions to which Guyana subscribe. The GBC shall be answerable to the NBBC. There shall be within the GBC, a National Biotechnology and Biosafety Inspectorate Unit (NBBIU) to carry out inspection activities. Initially, the NBBIU shall be set up within the Guyana National Bureau of Standards (GNBS) but shall come under the purview of the GBC at the time of it coming into being. Greater institutional coordination is desirable in view of the opportunities and risks involved in biotechnology. There primary function of the Inspectorate would be to monitor fundamentally important and new applications, and conduct supervision. It should have a special responsibility to ensure that ethical assessments in connection with biotechnology issues are considered.

Regulation and administration by the GBC, and assisted by NBBIU shall include, but not limited to the following:
• Agricultural law enforcement, crops and livestock disease control, registration of livestock importation and agricultural products;
• Environmental impact assessment and food safety review functions;
• Industrial practices review and import/export management functions;
• Occupational food safety standards review functions;
• Customs and excise functions with respect to GMOs;
• Border control and forensic science with respect to GMOs;
• Policy integration and institutional coordination functions;
• Marine research management, stock assessment and impact assessment processes;
The GBC will develop a regulatory framework for GMOs. One of the key elements to consider when developing the regulatory framework is public involvement in the decision-making processes. Once a regulatory framework for GMOs is in place, requests for commercial approval of individual GMOs can be processed. The decision making process needed to provide an entry point for consultation with the public, and provisions for taking into account feedback from groups of the public. That entry point could take a number of forms: such as a committee containing representatives of the public, feedback through a focal point, or a formal process of submission of a decision to the public. In addition, there had to be a recourse procedure for appeal of a decision, as well as access to justice.

The decision making process includes a risk assessment, which according to Codex Alimentarius, is defined as "a scientifically based process consisting of the following steps: (i) hazard identification, (ii) hazard characterisation, (iii) exposure assessment, and (iv) risk characterisation. After individual GM products have been approved, the regulatory framework may include provisions for post-release monitoring of the impacts of GMOs, where feedback from the public, especially those in rural areas where they are produced, would be of particular importance.

All GMOs must be identified and labelled such that they can be traced. Products thereof must also be labelled stating the fact that there is evidence of the presence of GMOs in the product. Labelling is also required to indicate that the presence of GMOs in a product cannot be excluded, if this were the case. Further, the label must forewarn of any allergies, reactions or other side effects that the GMOs or products thereof may cause. The GNBS in collaboration with the GA/FDD can convene a select committee to draft and have ratified, labelling standards for GMOs in Guyana.

This policy proposes that the Organisation for Economic Cooperation and Development (OECD) system of unique identifiers for transgenic plants be used when referring to GE crops. A unique nine-digit letter and number code is given to each new transgenic plant that is approved for commercial use and becomes its name worldwide. So, for instance, a maize developed by Monsanto to be resistant to insect pests has a unique identifier of MON-00810-6 while DD-O1951A-& denotes a cotton developed by DuPont. OECD countries are already using the
system. The EU recently adopted it as its system for generating unique identifiers and it has been recognised as a mechanism for unique identification to be used within the context of the Cartagena Protocol. The OECD is now considering how the identifier tool can be extended beyond crops to micro-organisms and animals.

4.4 Guyana biosafety vision 2015

Given the experience of many developing countries, this policy adopts initially, a precautionary approach to biosafety. Later, a more promotional or permissive option can be considered. Under a precautionary approach there is case-by-case screening for scientific uncertainties owing to novelty of GM process. The promotional approach does not require careful screening and in fact is based on approval in other countries (Paarlberg 2000). A primary source of caution is the Biosafety Protocol, which requires labelling, precautionary barriers and advanced informed consent. A secondary source is the amount of funds from the donor community to build scientific, technical and infrastructure capacity to implement policies. Both sources support the consensual recommendation of respondents in this present survey for the adoption of the precautionary approach to a policy on biosafety.

4.4.1 Purpose

To establish policies and procedures to ensure that national and local activities consistent with the Cartagena Protocol are safely conducted; to protect the public, researchers and the environment from biohazards; to assure a favourable environment for the conduct of scientific enquiry and to protect the interests of Guyana.

4.4.2 Biosafety sub-Committee

A Biosafety sub-Committee shall be established within the NBBC and charged with reviewing all activities of a potential bio-hazardous nature. Its primary responsibilities are to:

- Review all approved projects involving, the use of recombinant DNA molecules, carcinogens, infectious disease agents, and other potentially dangerous materials which are not exempt from such reviews;
- Report approvals and non-compliance in accordance with established guidelines;
- Recommend training and approve personnel engaged in such activities.
The Biosafety sub-Committee shall consist of a minimum of five members and a maximum of 10 voting members. Collectively, the membership shall have experience and expertise in research with microbial pathogens, chemical toxicology, and recombinant DNA and be aware of any potential risks to public health and the environment. All appointments to the sub-Committee shall be for a three-year term. The Presidential Adviser on science and technology shall appoint members. A designated person from the EPA shall provide administrative support to the sub-Committee, serve as Coordinator/Secretary to the sub-Committee, and maintain the official records.

4.4.3 Specific procedures

1. Recombinant DNA
   a. For projects involving the use of recombinant DNA\(^{15}\), a research biosafety protocol must be submitted to the Biosafety sub-Committee for review;
   b. All approved experiments employing recombinant DNA technology must be registered with the Biosafety sub-Committee;
   c. The Principal Investigator shall be responsible for complying fully with guidelines in conducting any recombinant DNA research

2. Chemical carcinogens
   a. A research protocol form involving the use of regulated carcinogens must be submitted to the Biosafety sub-Committee for review and approval;
   b. Investigators shall be required to file a safety plan for use of the regulated carcinogens.

3. Infectious disease agents
   a. Any experiments or bio-assays involving cells, tissues or body fluids obtained from humans or animals known to contain, or suspected of harbouring, infectious disease agents are to be handled and disposed of in accordance with internationally accepted standards
   b. The Biosafety sub-Committee must approve experiments involving animals that are carriers of infectious agents.

4. Blood borne pathogens exposure control
   a. The Biosafety sub-Committee shall provide education and exposure-prevention guidelines to persons who may be exposed to blood borne pathogens;
   b. Human blood, primate blood and/or body fluids from primates, and clinical samples, shall not be used unless approved by the Biosafety sub-Committee.

4.5 Guyana biosecurity vision 2015

Biosecurity is one of the most critical issues in shaping of Guyana’s future well being so the need for public support cannot be underestimated. The carambola fruit fly detected in 1993 at Orealla was eradicated in 1998 with the combined use of IPM, quarantine restrictions and public awareness campaigns. The biosecurity focus ought to be on pre-border, border and post-border activities designed to keep out new pests, to maintain and monitor framework for pest management agencies, industry and individuals take collection action against pests as well as a framework for managing intentional introduction of new organisms including GMO’s. Government should have overall responsibility for funding biosecurity in particular border management, surveillance and incursions.

4.5.1 Contribution of biosecurity

- Protecting marine and terrestrial primary industries and facilitating exports and tourism;
- Protecting indigenous biodiversity – native species, natural habitats, ecosystems and landscapes;
- Enabling sustainable use of natural resources and protection of natural environment;
- Maintaining relationship between indigenous peoples and traditions with ancestral lands, waters and sites;
- Protecting health of Guyanese from zoonotic and pest-borne diseases and from venomous species;
- Reducing the damage caused by pests and diseases introduced in the past.

4.5.2 Goals of the biosecurity policy
1. Prevention and exclusion – preventing entry and establishment of pests and unwanted organisms capable of causing unacceptable harm to the economy, environment and people’s health;
2. Surveillance and response – early detection, identification and assessment of pests and unwanted organisms capable of causing unacceptable harm and where appropriate, deployment of a rapid and effective incursion response that maximises likelihood of eradication;
3. Pest management – effective management (including eradication, containment and control) of established pests and unwanted organisms capable of causing harm to the economy, environment and people’s health.

To achieve these goals, the biosecurity system needs to have these elements:
1. Strong, global, and regional relationships to identify and manage emerging risks;
2. Identify all risk pathways and high risk organisms and implementation of pre-border and border measures to prevent pests and diseases entering Guyana;
3. Comprehensive, competent surveillance programme and diagnostic services to detect and identify arrival and spread of pests and diseases;
4. Sufficient capability to conduct timely assessment of the threats for new or expanding species;
5. Rapid response capability to eradicate new pests and diseases before they establish and spread;
6. Seamless integration between the appropriate agencies of central, regional and local government, each with clear roles and accountabilities;
7. Effective strategies in place for eradicating, containing and controlling pests and diseases already established;
8. Effective eradication and awareness programme to encourage compliance with biosecurity rules and regulations;
9. Strong enforcement of our biosecurity laws;
10. Strong input of scientific advice at all levels of policy, planning and decision making;
11. A strong culture of continuous improvement.
4.5.3 The biosecurity system

The pathways of pest transport to Guyana can be as follows:

- Imported goods
- Ships and aircraft
- Ship ballast water
- Vessel hull fouling
- Shipping containers
- Used vehicles and machinery
- Passenger’s effects
- Mail and courier packs
- Smuggling
- Wind and ocean currents

Pre-border activities:

Honour all international commitments under multi-lateral environmental agreements such as the CBD, the UN Convention on the Law of the Sea and the Convention on persistent Organic Pollutants (POPs). Pre-border activities shall include:

- Testing
- Inspection
- Treatment or quarantine

Border (marine and terrestrial) and post-border activities:

The objective of regulatory control is to prevent entry and establishment of new pests in a country or area and to destroy or prevent further spread of those already present. Plant/animal quarantine is concerned with prevention of spread of pests from country to country. It is the first line of defence against pest introduction and establishment. Such a system is based upon a combination of some or all of the following measures (Kellman 2003):

- Prohibition or complete embargo
- Restriction or partial embargo
- Inspection and treatment at point of origin
• Inspection and certification at point of origin
• Inspection at point of entry
• Utilisation of post-entry quarantine facilities especially for plant propagative or animal reproductive materials, the greatest risk from a plant/animal quarantine point of view.

4.5.4 Mitigating risks

Effective and sustained programmes can mitigate risks to the biosecurity system through:

• Changing behaviour;
• Getting the public to listen; and,
• Public support.

4.5.5 Institutional arrangements

A Biosecurity sub-Committee of the NBBC shall be established. This sub-Committee shall comprise specially trained and equipped team from the Plant and Animal Protection Unit of the MFCL and shall be made responsible for the biosecurity system. This will require amendments to the Plant Protection Act and Animal Disease Act to treat with GMOs and biosecurity issues identified in this document.

4.6 Harmonisation

Harmonisation of mechanisms, whether it is for food safety or standards, is a strategy often applied internationally to facilitate trade at all levels. Hollingsworth (2004) indicated that there are benefits to developing a Caribbean regional mechanism to harmonise biosafety systems in the Caribbean. These benefits include pooling of resources, facilitation of trade regionally and internationally, protection of human health, the environment and biodiversity and development of common standards for food safety.

The areas within national regulatory guidelines on GMOs that can be harmonised across the region are:

• Standards and testing
• Risk assessment, management and communication
• Documentation
• Issuing of licences
• Public awareness policy
• Legal and policy framework
• Technology transfer
• Monitoring and compliance
• Enforcement

Guyana can consider the advantages of harmonising any of the provisions of the biotechnology, biosafety or biosecurity mechanisms only after they have become effective in Guyana.
References


## Appendix 1

### List of persons contacted during the survey

<table>
<thead>
<tr>
<th>CONTACT</th>
<th>POSITION</th>
<th>ORGANISATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexander, Eustace</td>
<td>Manager, Protected Area Planning</td>
<td>Conservation International</td>
</tr>
<tr>
<td>Barry, Adjua</td>
<td>Environmental Officer II</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>Caesar, Sandra</td>
<td>Head, Environmental Health Unit</td>
<td>GAHEF, Ministry of Health</td>
</tr>
<tr>
<td>Cameron, Juanita</td>
<td>B.Sc. Biology Graduate</td>
<td></td>
</tr>
<tr>
<td>Collins, Marilyn</td>
<td>Director</td>
<td>GA/FDD, Ministry of Health</td>
</tr>
<tr>
<td>DaSilva, Phillip</td>
<td>Dean, Faculty of Natural Sciences</td>
<td>University of Guyana</td>
</tr>
<tr>
<td>Davis, Harold Jnr.</td>
<td>Director – Agricultural Research</td>
<td>Guyana Sugar Corporation Inc.</td>
</tr>
<tr>
<td>Dyal, Pat</td>
<td>Chairman</td>
<td>Guyana Consumers Association</td>
</tr>
<tr>
<td>Fernandes, David</td>
<td>Assistant Managing Director</td>
<td>Bounty Farm Ltd.</td>
</tr>
<tr>
<td>Forde, Brenda</td>
<td>Head of Unit</td>
<td>National Agricultural Research Institute</td>
</tr>
<tr>
<td>Fraser, Peter</td>
<td>Director, Planning and Coordination</td>
<td>Customs and Trade Administration</td>
</tr>
<tr>
<td>George, Cassandra</td>
<td>B.Sc. Biology Graduate</td>
<td></td>
</tr>
<tr>
<td>Guyana Nursing Association</td>
<td>PRO</td>
<td>Guyana Nursing Association</td>
</tr>
<tr>
<td>Haralsingh, Indranauth</td>
<td>Marketing Manager</td>
<td>Guyana Tourism Association</td>
</tr>
<tr>
<td>Hassan, Nizam</td>
<td>General Manager</td>
<td>New Guyana Marketing Corporation</td>
</tr>
<tr>
<td>Hawker, Marva</td>
<td>Public Relations Officer</td>
<td>Nurses Association</td>
</tr>
<tr>
<td>Jafferally, Deidre</td>
<td>Wetlands Field Researcher</td>
<td>Iwokrama Rainforest Programme</td>
</tr>
<tr>
<td>Khan, Abdool</td>
<td>Technical Manager</td>
<td>Torginol Paints Inc.</td>
</tr>
<tr>
<td>Lawrence, Winston</td>
<td>Veterinarian</td>
<td>DIDCO Trading Company</td>
</tr>
<tr>
<td>McLennon, Peggy</td>
<td>Foreign Service Officer</td>
<td>Ministry of Foreign Affairs</td>
</tr>
<tr>
<td>Merchant, Henry</td>
<td>Quality Assurance Manager</td>
<td>Banks DIH Ltd.</td>
</tr>
<tr>
<td>Morrison, Bridgette</td>
<td>Director of Industry</td>
<td>Ministry of Tourism, Industry and Commerce</td>
</tr>
<tr>
<td>Persaud, Bal</td>
<td>Executive Director</td>
<td>Private Sector Commission</td>
</tr>
<tr>
<td>Rai, Manichan</td>
<td>Finance Control Manager</td>
<td>Guyana Stockfeeds Inc.</td>
</tr>
<tr>
<td>Singh, Araf</td>
<td>Group Chemist</td>
<td>Demerara Distilleries Ltd.</td>
</tr>
<tr>
<td>Thomas, Raquel</td>
<td>Head, Planning and Research Development</td>
<td>Guyana Forestry Commission</td>
</tr>
<tr>
<td>Williams, Nicola</td>
<td>Senior Veterinary Health Inspector</td>
<td>GAHEF, Ministry of Health</td>
</tr>
<tr>
<td>Younge, Melissa</td>
<td>Quality Control Chemist</td>
<td>National Milling Company of Guyana Inc.</td>
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</tbody>
</table>
Appendix 2
Public policy statements on biotechnology


“Consumers International focus this year on the issue of GMO, which have both benefits and disadvantages. While the international scientific community continues to research and debate GMOs, it is important that all consumers be made aware of what they are exposed to and what they might be consuming in order to make better choices, reduce unnecessary risk and safeguard their health and lives. Where GMOs are concerned, consumers have a right to be educated, a right to be informed, a right to safety, a right to be heard in this unsettled debate.

The Consumer Affairs Division of the Ministry will continue to work assiduously to ensure that Guyanese consumers are educated about their rights and responsibilities. Since April 2001, the Ministry has held monthly statutory meetings with the Consumer Organisations. In October 2001, the Ministry established a 24-hour consumer hotline, which has proven to be a valuable tool in terms of public education and consumer redress. In 2002, the Ministry initiated a week of activities to celebrate the annual World Consumer Rights Day on March 15. The Ministry is presently advancing work on a Draft Consumer Protection Bill, which may be presented in the National Assembly. This is a forward-looking legislation, which seeks to enhance the condition of the Guyanese consumer in line with the objectives of the CARICOM Single Market and Economy”.

Ministry of Agriculture: Hon. Minister Satyadeow Sawh

“There are two main arguments in the debate on GM crop production. Proponents argue that GM foods are safe and that there is a myriad of benefits to be obtained from the application of biotechnology to agriculture and food production. Opponents argue that there is greater threat from their use that the promise of benefits. Among potential benefits of genetic engineering are increased resistance to drought and to disease and pests, which together with storage problems, cause losses of up to 40% of some harvests in some countries. The very idea of decreasing reliance on pesticides not only promises less pollution of soils and ground water; it also opens the way to enhancing biodiversity. At the consumer end of the chain, as well as possibilities of adding dietary supplements to certain plants, crop quality improvement will have the potential to reduce losses in transport and to prolong shelf life.

These persuasive benefits are weighed down by potential risks – often presented to the public as fact, despite the very considerable lack of experimental evidence. There is a risk of genetic pollution where GE crops contaminate neighbouring non-GE crops. Here the fear of small farmers is that GE crops will destroy their own traditional seed supply systems, a concern that must be addressed. Behind the debate on seed supply is the issue of ownership of indigenous intellectual property rights. This goes beyond current GMO concerns, and is being resolved at global governance level, through multi-party stakeholder dialogues under United Nations auspices.

It is well known that Guyana imports foodstuff from the USA and also receives donated corn and wheat from the same source, which probably means that GMOs of GM products are already finding their way into the market here
although they are not labelled as such. The Government of Guyana (GoG) has developed a policy on organic agriculture. The organic movement globally is in consensus that the use of genetically engineered processes, materials or seeds is not appropriate in organic production, or in the manufacture of organic products. Recently, a CARICOM Regional Working Group on GMOs has been established. This was after Guyana tabled a document titled “A need for a Regional Policy on GMOs” at the 13th Meeting of COTED.

H.E. President Bharrat Jagdeo in his presentation ‘A Framework for the Repositioning of Caribbean Agriculture’ at the 25th Meeting of the Conference of Head of Government of CARICOM in July 2004 made reference to GMOs. President Jagdeo mentioned that in response to advancing science and technological application in agriculture and food production, one of the actions Caribbean countries has been taking on is aimed at the pursuit of initiatives towards defining a regional policy on agricultural biotechnology and biosafety, including the use of GMOs.

In Guyana we have taken cognisance of the developments in GMO technology. Further, the issue of trade in GMOs has been and continues to be a very controversial issue. This is especially so with the different positions taken by the EU and the USA on this issue. It is for these reasons that the GoG is in the process of developing a coherent policy on GMO”.

**Guyana National Bureau of Standards**

“The GNBS wishes to remind consumers of their right to choose and to have access to correct and accurate labelling information on all products including GM foods. Consumers have the right to know what is contained in the foods, which they are eating since more and more food produced in the world is being genetically modified. Already there are genetically modified soyabean, papayas, maize, animal feed products and squash potatoes and in addition to raw foods such as grains and vegetables, consumers have to be on the look out for the presence of GM material in the form of additives to processed foods such as chocolate bars, oil packed canned tuna and sardines, soft drinks with glucose sweeteners and all processed food with emulsifiers and starch.

GM foods are different from conventional foods because genetic material has been added to them. It is prevalent in five major GM growing countries (USA, Canada, Argentina, Brazil and China). These countries together account for 96.5% of global cultivation and would have consumers believe that genetic modification is a small matter of minor importance and that labelling requirements should be voluntary or not necessary but nothing is further from the truth.

As the National Standards body and the National CODEX contact point, we have a role to play in this debate and in the interest of consumer safety would want to advocate the labelling of GM foods. Labels give vital information about the ingredients in our food and consumer need to know what they are purchasing and more so, what they are eating. When products are appropriately labelled, consumers are able to make informed choices regarding their safety, environmental, ethical and religious concerns. On the other hand, producers of GM foods and some
governments who are involved in the engineering of foods prefer that the labelling information is, voluntary, obscure, vague or non-existent. However, this approach would border on dishonesty and constitute an interference with the right of the consumer to be informed.

At least, one third of the world’s population live in countries where there are mandatory labelling requirements for GM foods. These include: Brazil, China, the European Union, Japan, South Korea, Australia and Thailand and as the debate rages, developing countries through their consumer groups, Codex Contact Points and National Standards Bodies are becoming involved so their voices can be heard. The GNBS believes that the subject is important enough to warrant urgent action and together with members of the National Codex Committee, policy makers and regulatory bodies will seek to address the question of Guyana’s policy on the labelling of GM foods subject. The GNBS, whose function is protection of the consumer, will together with other key stakeholders endeavour to be in the forefront, in seeking to have a labelling policy established in Guyana for GM foods.

In the interim, we want to urge that the Codex Alimentarius safety guidelines be used and because this subject may be new to the majority of our Guyanese consumers, there is need for educational programmes and dissemination of information on the subject so that they can make informed choices regarding the foods they eat”.

Other statements made:

- Victor Pires of Caribbean Chemicals says the fears surrounding GMOs are unfounded. He says in the case of tomatoes grown locally they are not strictly GM foods because the scientists have simply removed the gene that began the process of breaking down the fruit’s cells. He has two clients who are using them (Pik Ripe tomato) in remote locations where it takes some time to transport produce to the coast. The only drawback is that the seeds are five times more expensive than regular hybrids;

- Eileen Cox of the Guyana Consumers Association recently wrote that among concerns related to GM products are whether the new genes or proteins might produce toxins that can cause harm in the long or short term and whether the new gene might produce a protein that triggers an allergic reaction in a person who eats the food;

- Other than tomato, the other GM crop being grown in Guyana is a variety of corn that is informally imported by Amerindians from Brazil and Venezuela where it is widely available. Such corn has a naturally occurring bacteria inserted into its gene makeup that resists caterpillars. This means yields are much higher and there is no need for pesticides that can themselves be harmful.

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17 A tomato that can be picked ripe and then lasts four to six weeks. It is imported by Caribbean Chemicals and is the first of what might become a range of GM food that can increase yields while actually decreasing dangerous pesticide use (Source: Stabroek News, GM tomatoes at vanguard of second green revolution. January 14, 2005, Georgetown, Guyana).
• In the same article, John Caesar, Guyana’s Bio-diversity Project Coordinator, is reported to have said that ‘Guyana could benefit from biotechnology which should still be seen as a tool that allows for the development of plants, animals and human health beyond the traditional methods.

• Prime Minister Sam Hinds is reported to have said in declaring open a workshop on July 28, 2004 to launch the Guyana National Biosafety Project\(^\text{18}\) said ‘…. while biotechnology could be used for human development, Guyana needed to be conscious of its reactions with regard to food safety and health. He said the relevance of biosafety is evident in the potential trade value of GM foods and the framework would help to ensure that Guyanese are better informed about exports, imports and in-transit genetically enhanced foods. He opined that the workshop on biosafety is a strategic starting point for awareness among the public who are the relevant stakeholders in the success of the project’.

### Appendix 3

**Some Major Plant Diseases of Quarantine Significance to Guyana**

<table>
<thead>
<tr>
<th>CROP/HOST</th>
<th>DISEASE/PEST</th>
<th>KNOWN DISTRIBUTION</th>
<th>ECONOMIC IMPACT/DAMAGE</th>
<th>OTHER KNOWN HOSTS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>Hoja Blanca a/k white leaf (virus)</td>
<td>Asia, USA, Central America, South America, Caribbean.</td>
<td>Severe reduction in yield, over 50% losses reported. Death of plants depending upon stage or severity of infection. Cost of control procedures</td>
<td>Wheat, Barley, Millet, Rye, Oats</td>
<td>Not reported in Guyana to date.</td>
</tr>
<tr>
<td></td>
<td>Bacterial blight <em>Xanthomonas campestris pv. Oryzae</em> (bacterium)</td>
<td>Asia, Europe, Africa, Central and South America</td>
<td>Over 50% losses reported. Death of plants depending upon severity of infection. Cost of control</td>
<td>Several weeds, species particularly <em>Leersia sayanuka</em>, <em>Leersia japonica Cyperus rotundus</em>.</td>
<td>Not reported in Guyana. Biotype has been reported.</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>Smut <em>Ustilago Scitaminea Sydow</em> (fungus)</td>
<td>Africa, Asia, Central and South America, Caribbean, USA.</td>
<td>Destroys fields of plants. Kills entire plant. Direct yield loss 50-100% have been reported.</td>
<td></td>
<td>Present in all sugarcane growing areas in Guyana but is well managed by use of resistant varieties.</td>
</tr>
<tr>
<td></td>
<td>Leaf scald <em>Xanthomonas albilineans</em> (bacterium)</td>
<td>Pacific, Africa, Asia, South and Central America, Caribbean</td>
<td>Reduces yield Affects juice quality Death of plants Cost of control</td>
<td>Maize (Corn) Bamboo grass Lemon grass Guinea grass</td>
<td>Different pathotypes have been reported. Reported in Guyana at low incidence.</td>
</tr>
<tr>
<td>Banana/ Plantain</td>
<td>Black Sigatoka (BS) a/k Black Leaf Streak diseases (BLSD) <em>Mycosphaerella fijiensis</em> (fungus)</td>
<td>Asia, Africa, Pacific, Central and South America, Caribbean (1933-34)</td>
<td>Damage to foliage Death of entire plant Severe field losses Serious yield loss Cost of control</td>
<td></td>
<td>Not reported in Guyana</td>
</tr>
<tr>
<td></td>
<td>Panama Disease a/k Fusarium wilt <em>Fusarium oxysporum</em> (fungus)</td>
<td>Asia, Africa, South and Central America, Caribbean</td>
<td>Death of plant Reduction in yield Severe field losses Cost of control</td>
<td><em>Heliconia sp.</em></td>
<td>Not officially reported in Guyana but is suspected to be present in Guyana. Investigations are ongoing. Two races of fungus reported.</td>
</tr>
<tr>
<td>Papaya</td>
<td>Papaya mealybug <em>Paracoccus marginatus</em></td>
<td>St. Marteen, US Virgin Islands; Haiti, Dominican Republic, St. Kitts Nevis, Antigua, Mexico</td>
<td>Damage to foliage and fruits. Fruits are small, deformed and unmarketable</td>
<td>Cassava sour sop Guava Frangipani Eggplant Etc.</td>
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</tr>
<tr>
<td>Wide variety of Crops</td>
<td>Giant African snail (<em>Achatina fidelica</em>)</td>
<td>East Africa, Japan, Madagascar, Korea, South East Asia. Islands in India and Pacific Oceans, Brazil, Guadeloupe, Martinique, St. Lucia, Barbados</td>
<td>Destroys up to 90% of crops attacked.</td>
<td>Wide host range</td>
<td></td>
</tr>
<tr>
<td>Citrus</td>
<td>Citrus Tristeza a/k Quick Decline Citrus Tristeza Virus (CTV) (Virus)</td>
<td>USA, South &amp; Central America, Caribbean, Asia, Africa, Pacific.</td>
<td>Death of entire plant. Severe field destruction Yield loss over 75% losses reported. Cost of control procedures.</td>
<td>This disease is reported in Guyana, in citrus producing areas eg. The Intermediate Savannahs, but a mild strain is believed to be present. Several strains reported worldwide.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Citrus Exocortis Citrus Exocortis viroid (Viroid)</td>
<td>USA, South &amp; Central America, Caribbean, Asia, Africa, Pacific.</td>
<td>Death of entire tree, 40-50% yield loss, Cost of control.</td>
<td>Reported in Guyana probably in the North West Region at low incidence.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Xyloporosis (suspected to be caused by a virus).</td>
<td>Asia, South America, USA</td>
<td>Death of infected trees. Yield reduction. Cost of control</td>
<td>Not reported in Guyana.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Citrus Canker a/k (Cancrosis B) <em>Xanthomonas citri</em> (bacterium)</td>
<td>USA, Asia, South Africa, Pacific.</td>
<td>Death of entire tree. Yield reduction. Cost of control</td>
<td>Not reported in Guyana.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Foot rot a/k Collar rot <em>Phytophthora spp.</em> (Fungus)</td>
<td>USA, Europe, Pacific, South and Central America, Caribbean.</td>
<td>Death of entire plant. Yield reduction. Cost of control</td>
<td>Reported in Guyana in some citrus producing areas but not widespread</td>
<td></td>
</tr>
<tr>
<td>Coconut</td>
<td>Lethal yellowing Micoplasma-like organism (MLO)</td>
<td>Central &amp; South America, USA, Caribbean.</td>
<td>Severe yield loss, Death of entire plant, Cost of control.</td>
<td>Probably reported in Guyana at</td>
<td></td>
</tr>
<tr>
<td>Plant Part</td>
<td>Disease</td>
<td>Pathogen</td>
<td>Affected Areas</td>
<td>Symptoms</td>
<td>Control Efforts</td>
</tr>
<tr>
<td>------------</td>
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</tr>
<tr>
<td>Cadang Cadang</td>
<td>Suspected to be a virus.</td>
<td>Asia</td>
<td>Devastating to palms in field. Severe yield loss. Death of entire palm. Cost of control.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yam</td>
<td>Anthracnose Colletotrichum gloeosporoides (Fungus)</td>
<td>Africa, Asia, Central &amp; South America, Caribbean</td>
<td>Can have devastating effects depending upon severity of infection. Severe yield loss. Up to 100% losses reported. Cost of control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pineapple</td>
<td>Yellow spot (Virus)</td>
<td>USA, Hawaii</td>
<td>Yield loss. Cost of control</td>
<td>Weed: Emilia sonchifolia</td>
<td></td>
</tr>
<tr>
<td>Soft fruits</td>
<td>Carambola fruit fly Barrocerca carambola</td>
<td>Asia, Suriname, French Guiana</td>
<td>Severe yield losses. Premature ripening of fruits.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mediterranean fruit fly Ceratitis capitata</td>
<td>Africa, South &amp; Central America, Hawaiian Islands and Australia, Spain, Algeria, Italy, Tunisia, Brazil, Costa Rica, Nicaragua, Honduras, El Salvador, Guatemala, Saudi Arabia, Venezuela</td>
<td>Severe yield losses. Premature ripening of fruits.</td>
<td>All soft fruits</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 4
Survey Results

The survey targeted respondents in the agriculture, environment, food processing, health, and industry sectors. Of the 25 respondents interviewed, more than 90% knew something about biotechnology and indicated that it was very important, relevant or beneficial for Guyana. Generally, respondents agreed that biotechnology would probably have its greatest impact on agriculture and health. Compared to their knowledge on biotechnology, the respondents knew even less on biosafety and biosecurity.

In general, Guyana needs this technology and guidelines to ensure its smooth operation because it is a developing country. It is important for the livelihood of citizens. Biotechnology can open doors for cheaper production of goods, financially and with respect to human resources. It is very relevant to the progress of the nation. We have to come up to standard with the world today. This will ensure that “we are marketable and will benefit both the private and public sectors…. we need new systems of making products e.g. in farming which will greatly benefit our economy and society”.

In agriculture, although no substantial technology has been developed in this area in Guyana, it is needed especially for food production. Biotechnology plays a key role in the food industry since people are looking to newer things in an effort to enhance their lifestyle. Biotechnology is very relevant since our economy depends on mainly agriculture. It can help to improve crop/livestock variety, yield, and quality to ensure competitiveness. Improved food production, plant and animal using genetic engineering Biotechnology can benefit Guyana in that it may provide better food, better health and security of the people. They will enhance food production (quality and quantity) bringing it to better international standards and this can bring more revenue into Guyana.

More development of certain food products and organisms, the assurance of protection for native resources and their proper use are just some benefits of biotechnology. There is need for more specific identification of trees (because of similarities); it would eliminate confusion with speciation. It would help to improve Guyana’s produce and food exports quality and quantity also helps to cure medical problems locally.

In health and the environment, biotechnology is essential for the practice of proper waste disposal e.g. waste water and smoke which might result in pollution e.g. eutrophication It can help develop cures for diseases, or better produce (livestock, medicine). However, for Guyana to get maximum benefits:

- Markets for the products must be established;
- The new techniques practiced and implemented must be relevant to Guyana’s situation;
- Neither outdated applications nor too advanced ones must be adopted.
- Since the risks cannot be divorced from advancement, all efforts must be made to accommodate the changes;
- Monitoring systems must be in place.
- Public awareness must be carried out to ensure Guyanese people are fully aware of what biotechnology is and all its ramifications so as to ensure proper safety and balance is maintained; It would or should promote clean healthy environments.

Biosafety serves to protect consumers from the dangers of consumption of products. Also, the knowledge and application in industry would result in the consumers being offered a safer and wholesome product. One respondent felt that we must be very careful when considering this kind of science. “Biotechnology is good but it has major side effects for animals and consumers”. This has caused the European nations to revert to natural production “Green manufacturing”. “If we as a country are going to function on the world market we have to take all precautionary steps particularly where human lives are concerned. We must take and implement as many safety measures to ensure safe and sustainable use of resources in industry. The potential use of biotechnology as biological weapon is a threat”.

Educating the general populace of the dangers and benefits of biotechnology is important. With better understanding, productivity, sales, revenue can be increased for a country such as Guyana. Industries must have proper systems in place for proper testing in field and of finished products. There is currently inadequate biotechnology infrastructure e.g. veterinary testing. This is important with regards to consumer health especially in
food safety. Protection of health at the farms in terms of the products used. It is important for Guyana to safeguard itself from the harmful effects of biotechnology.

If Government does not become more aware of the need for protection then, Guyana’s natural resources will continue to be misused and claimed by others. There needs to be legislation in place to facilitate this. Biosafety is fast becoming an issue of concern globally as a result of increase use of GMOs/LMOs and Guyana therefore needs to develop credibility and capability in dealing with the issues. As a developing dependent on agriculture for revenue, Guyana can potentially benefit tremendously from biotechnology, which promises to improve crop yield and pest resistance, increase use of marginal lands and reduce environmental impact. Biosafety is relevant because Guyana is a vulnerable developing country, which lacks certain mechanisms to guard against negative impacts of GMOs/LMOs. Biosecurity is important as a form of proactive management in order to protect human health and biological resources from contamination by GMOs/LMOs.

Should there be any problems arising with food security, Government may want to develop certain products in the country to enhance crop yield and quality. There should be in place strict laws and measures to safeguard against invasion and pollution. These laws must be enforced and implemented by Government and other agencies. Once you understand it, take a proactive role to inform the general populace about benefits and dangers.

Biotechnology and its applications can greatly benefit this country now. It can help to improve our economy create job opportunities and offer newer areas of expertise. This is specifically relevant in areas such as agriculture, medicine, landscaping, food processing. These are some of the areas, which Guyana can incorporate. The profitable use of biotechnological applications if we begin to use biotechnology, then biosafety protocol and biosecurity will be immediately implemented and its relevance will speak for itself. If thoroughly researched biotechnology can greatly benefit our country in the creation of jobs, investment opportunities can generate more revenue for the government and is a good study area.

The results of this survey show remarkable similarity to one carried out in the Caribbean and reported to the Capacity Building Workshop on Biosafety for the Caribbean in Trinidad in January 2004 (Hollingsworth 2004). The purpose of the Caribbean survey was to identify and characterise the most relevant opinions to develop a research agenda in biotechnology applied to the production of genetically modified organisms (GMOs) in agriculture in the countries of the Caribbean. This survey allowed research issues to be ranked and to identify the perceptions on the effects that applied biotechnology may have on Caribbean societies.

The region has a small pool of individuals with knowledge in all subject areas. The majority was acquainted with specific knowledge in their field of work. Among those polled biotechnology and natural resources, followed closely by biosafety was given prime importance in developing a research agenda on biotechnology in the region. Regarding the research agenda, all subjects evaluated were considered as relatively important. Informants proposed that regional integration and economic blocs integrated by regional countries, along with the implementation of intellectual property rights, which the majority thought would facilitate biotechnology in the Caribbean region (Hollingsworth 2004).

Emphasis was placed on allocating more resources to train human resources and to update legal regulations. However, in general informants thought that more resources needed to be allocated throughout the various aspects of biotechnology. There was the perception that the development of biotechnology currently in the Caribbean region has a neutral impact to most aspects of societies.

**Gene therapy:**
Gene therapy is any of a number of experimental treatments in which cell genes are altered. Some gene therapies attempt to provoke new immune activity; some try to render cells resistant to infection; and other involve the development of enzymes that destroy viral or cancerous genetic material within cells.

Most of the respondents knew very little on gene therapy and accordingly, expressed the need for more information on the technique, as well as acquiring in country capacity, and proper laboratory facilities for its practice. Some opined that gene therapy could help in finding cures for terminal diseases, for correcting errors in replication, for improvement of plant and animal breeding for resistance to disease but cautioned that prior informed consent is a prerequisite for in-vivo experimentation. If gene therapy could enhance nutrition or food and protect agricultural products and health products as well, then no work should be done outside safe boundaries. Natural balance must not be tampered with and all gene alterations must be carefully explained. In general, the practice must not impact
negatively on environmental health. As far as possible, Guyana must work in collaboration with those countries that have succeeded in this field.

A few respondents thought that gene therapy is not a safe technique, and expressed major concerns with its use. Any policy must consider the ethics, morality, and impact it has on organisms and its general relevance to Guyana. The development of a test protocol is important to ensure development and proper use of methodologies. There must be proper consultation before implementation of the acts/policy on gene therapy.

**Immuno-chemistry**

Immuno-chemistry is the study of the chemical basis of immunological phenomena; the application of antibodies as chemical agents.

The major concern expressed was the fear of environmental pollution and safeguarding against spillage. The need for precaution and clear motives was mentioned. There should be clear protocols to protect persons and animals and side effects should be limited to reduce fatal health risks. Immuno-chemistry is particularly pertinent to pharmacology and should be seriously considered as a new application in this field in Guyana. The establishing of cancer research units and greater attention to the treatment of existing threats are examples where immunochemistry can be applied in Guyana. However, with adequate research and considering all the potential risks, immuno-chemistry can be accommodated to some extent. While there is and can be scope for this activity in the future, there is need to identify the resources needed to fund the activity. Ownership to the products must be acknowledged as belonging to Guyanese people, especially the indigenous people.

**Vaccines**

Vaccines are biologically active materials derived from bacteria and viruses, which can stimulate an immune response in the body in order to prevent future infection with similar microorganisms. Vaccines may consist of living or killed organisms or chemical substances derived from organisms.

There is support for the use of biotechnology research to improve existing vaccines as well as development and use of new ones. Research and development should commence as early as possible since this is an extremely important area of our health care system. In this regard, the protection of discoveries is important. Guyana should not venture into independent research at this time, thus avoiding potential risks. Respondents caution that a lot of artificial products should not be used and persons using them must have a proper and sound knowledge of using vaccines. Specifically, proper safety measures to prevent health hazards in their preparation and proper knowledge of organisms/viruses being treated are important. Biotechnology ought to be used to provide immunity but care should be taken not to overuse or abuse the liberty we have. Vaccines developed using this technology should be available to all. There is need for assessment of potential risks for companies and advice provided on what should be bought. Clearly defined manufacturing procedures should be outlined and certain ethical laws need to be maintained as it relates to testing vaccination protocols. Culturing of viruses and bacteria must be done in a safe environment and proper knowledge is needed, reiterated the respondents.

**Diagnostic tests**

Diagnostic kits are analytical test kits packaged for use on a single-test basis to test for a wide variety of substances. They bring diagnostic testing capabilities to a variety of end-users. Usually they include all tests and methods to identify a disease or the predisposition for a disease.

Respondents hold the view that diagnostic kits are not widely available and are necessary for Guyana, especially in the field of agriculture. However, persons must be well informed or skilled to use kits, and disposal of wastes must be done professionally and based on medical standards. Proper knowledge of the kits will ensure correct usage hence minimise potential risks. Culturing of viruses and bacteria must be done in safe environment. There must be knowledge of hazards in their preparation and proper knowledge of organisms/viruses being treated. Monitoring and regulating the importation of these kits are important as well as the need for law permitting Government to have more test kits available for all areas including, tuberculin test kits. Protection of discoveries is important, as are ethical laws on the use of the diagnostic kits.

**Bio-sensing**

Bio-sensing is advanced instrumentation for characterisation, stimulation, diagnosis and monitoring of biomaterials and biological processes.
There is lack of knowledge concerning bio-sensing and its relevance to Guyana. Respondents felt that the importance of bio-sensing should be known to the public and there should be consensus on its use, so as to ensure ethical rights are maintained. “We should first concern ourselves with informing the public so that we can learn their opinions on such new practices and processes”. In this regard, research and development are important, particularly in industries where it is applicable. In deciding on its applicability, Guyana should seriously consider the general importance, specific relevance and cost effectiveness of bio-sensing and weigh it against regular chemical analyses for efficiency. Those few respondents who know of bio-sensing thought that it would help with quality control e.g. chemical contamination that is critical for food safety, quality and security. Environmental pollution is an issue that can stem from bio-sensing and the biosafety policy must be clear as it relates to safety and maintenance of the environment and human health. Invasion must be prevented at all costs and for this, a proper system of monitoring and adequate equipment of international quality must be used at points of entry.

**Pheromones**

These are chemical substances emitted by an organism as a specific signal to another organism, usually of the same species. These substances play an important role in the spawning of many species, used to attract mates and signal to others that they are spawning. The majority of respondents felt that biological manipulation of pheromones can be permitted but the authorities need to carefully and deliberately monitor all operations and processes involved to avoid direct pollution and species invasion. Assessment of potential risks to animals and careful monitoring of the risks are all part of a conservative approach to the use of biological pheromones that Guyana should adopt. Benefit sharing should be made known so as to ensure adequate compensation just in case there is a large production. A few respondents felt that Guyana should not advocate a policy of manipulation of molecular structures that might cause detriment to God’s creation. Hormonal interference is a very risky business, said one respondent.

**Monoclonal antibodies**

These are antibodies produced in the laboratory by a hybridoma or antibody producing cell source for a specific antigen. Monoclonal antibodies are useful as tools for identifying specific protein molecules. Very few respondents knew of monoclonal antibodies. Some were not in favour of this kind of technology and suggested training and information were required before a proper assessment of the usefulness of the technology becomes apparent. Some felt that it is a cloning procedure that should be used when and if necessary. If approved for use, the technology should be applied to research and entry-level testing. Some respondents felt that monoclonal antibodies can be beneficial to society if it helps in the improvement of human health as long as there are no major threats. Guyana can use it once it is safe and advantageous in improving the quality of medicines and treatment. However, efficient monitoring system and ethical rights must be maintained to limit pollution of the environment. Proper laws need to be in place to ensure man’s health is not tampered with. Good safety measures should be in place to prevent outbreaks. Protection of discoveries is important. The right equipment for using sources of antigen is very important and working knowledge a plus.

**Biomaterials**

Biomaterials are biological materials such as proteins and complex sugars used to make medical devices, including structural elements used in reconstructive surgery. There was a lot of perplexity on the importance and relevance of biomaterials. The confusion appears to be about its use in making medical devices. Biomaterials might be useful in medical practice in treating burn victims. Some respondents felt that biomaterials should be allowed for testing only with regards to recombinant DNA testing. There is need to carefully and seriously scrutinise the cost. Respondents felt that its importance to the public should be known and use decided on a consensus basis, so as to ensure ethical rights are maintained. In this regard there is need for proper knowledge of handling and use, safeguarding regulations for experimenting and transporting. Proper knowledge of the materials must be had and intellectual property right and benefit sharing agreements must be put in place. Disposal of these materials especially after experimenting is also important.

**Bio-reactors**

Bioreactors are vessels in which cells, cell extracts, or enzymes carry out a biological reaction. Often refers to a growth chamber (fermenter, fermentation vessel) for cells or microorganisms. Very few respondents ventured an opinion on bioreactors due to lack of knowledge. Its importance to the public should be known and on a consensus basis, so as to ensure ethical rights are maintained. There is need for strict and efficient monitoring system. Some respondents felt that Government should facilitate the use of bioreactors for
environmental purposes but there is need to consider the cost and if feasible, implement in the relevant industries/sectors. There is need for proper knowledge of the materials and intellectual property rights and benefit-sharing agreements must be in place.

**Bio-remediation and phyto-remediation**

This is a process that uses living organisms to remove contaminants, pollutants, or unwanted substances from soil or water. Respondents felt that these are potentially environmentally safe procedures but some opined that trials should be conducted in remote areas first since pollution needs to be avoided and as well as harm to human health and the environment. The use of bioremediation and phyto-remediation may be a good thing if people understand what is involved as well as to the advantages and disadvantages. Bioremediation should be an alternative method in place if all existing mechanisms become inefficient and ineffective. Industry should gear towards this because it is much less harmful to the environment but it should be cost effective. The EPA should play a leading role. They should set up systems that regulate this kind of practice, and be prepared to impose fines on environmental violators. One must take into consideration plants being moved from one place to another so as to prevent invasion or out competing of native plants. All efforts must be made to avoid invasion. Pollution when noted, must be acted upon and careful selection of animals and plants is important, as is excessive growth to point of threatening other species.

**Cell, tissue and embryo culture**

This is the science of growing isolated cells, tissue or embryo on artificial media. The culture of fertilised eggs in the laboratory for example, allow them to develop into early cleavage stage embryos and progress through to the pre-implantation blastocyst stage. One must ensure people are aware of potential risks involved once experimenting on them and there must be consideration of materials being used, in terms of how they are disposed. We need to understand what these studies are and where they are applied. We should not run to be a part of things we have little knowledge of. If it improves the quality of life, then we should be in favour of this but in limitation. There is need for continual trial and error testing until success is achieved. However, ethical laws are needed to prevent unnecessary tampering with nature and man’s health by unscrupulous practitioners.

Some respondents felt that if cell, tissue and embryo culture is directed in the right areas, such as stem-cell research, and for the right reasons, this can be a very useful study. One respondent cautioned that it should only be encouraged if it creates a better product and benefits the human race primarily, and does not destroy. Ethical laws need to be in place and enforced and we need to be wary of health risks involved. The need for balance and safety is very important. Magnitude of risks should be understood.

**Cell, tissue and embryo manipulation**

Embryo manipulation can be simply removing an embryo from the donor animal and immediately transferring it to a surrogate mother, or it can be more complicated involving microsurgery on the embryo and maintaining the embryo in special culture systems before transferring the embryo to the surrogate mother. Invasive procedures such as embryo splitting, blastocyst injection, pronuclear injection and nuclear transfer (cloning) understandably create circumstances that may perturb or derail embryo development. Most respondents emphatically disapproved of this kind of research as it allows for cloning and cloning is not good at all. One respondent even went as far as saying that Guyana’s official position should be **anti-cloning**. A few respondents support cloning in extreme moderation, such as for stem culture for organs, under the strictest of controls. This is a cloning procedure that should be used when and if necessary. In other words, cell, tissue and embryo manipulation should be a very restricted field because it is perceived as a major potential risk to people. One must ensure people are aware of potential risks involved once experimenting on them and there must be consideration of materials being used, how they are disposed. Ethical laws and careful monitoring are needed to prevent unnecessary tampering with nature and man’s health by unscrupulous practitioners. The need for balance and safety is very important and Guyana must approach this field with extreme caution.

**Fermentation**

Fermentation is used in biochemistry to describe the breakdown of carbon compounds by cells or organisms to ATP without using molecular oxygen. In chemical engineering, it is used to describe the growth of cells or microorganisms in specialised vessels (fermenters, bioreactors).
Scientists can work on a modified system, which can improve the overall efficiency and yield of products since with this process there are no major hazards i.e., waste is used as feed and CO₂ is used to carbonate beverages. With more research there may be a possibility of producing newer and better raw materials that can speed up production processes thereby resulting in better quality yields. A lot of artificial products or food should not be used and fermentation processes used in industries should be standardised. Proper selection of fermenting organisms is important to ensure good quality. This new approach will require an efficient monitoring system as well as labelling. Product labelling is of vital importance and pollution protocols and safety measures should be in place.

**Bio-transformation**

In this process, a living organism in contrast to abiotic processes modifies a chemical. It involves a series of chemical alterations of a compound (e.g. a drug or nutrient), which occur within the body, as by enzymatic action. Very few respondents knew of bio-transformation and many suggested that we should be open-minded as we evaluate the benefits. In the event of a problem with natural enzyme only then should we be permitted to use bio-transformation as an alternative process. Safety protocols are needed for man and the environment.

**Bio-leaching**

Bio-leaching is a way of using microorganisms to separate valuable metals from surrounding rock. It is especially useful for the recovery of valuable metals from low-grade ores, and also when the gold ore is refractory, meaning that the valuable metal is scattered throughout the rock and difficult to extract using conventional mining techniques. Bio-leaching of sulfide minerals is now an established industrial technology for the recovery of gold from refractory arsenical pyrite ores and for the bio-leaching of copper. Monitoring laws are needed to protect the environment from the introduction of hazardous elements. There should be safety protocols for man and the environment. In the event of threats by hazardous wastes bio-leaching should be implemented to combat the potential damaging effects caused by natural forces or disaster. Consider the risks to people and the environment. We should be open-minded to this, however, if safe and cost effective, and beneficial to humans and the environment bio-leaching should be used.

**Bio-pesticide manufacturing**

This is the natural making of pesticides (organic development) and gene manipulation in certain plants to be resistant to pests. We must be very careful to ensure limited or no pollution. Consider all possible risks and side effects and possible consequences of mis-handling through an efficient monitoring system and properly designed studies. One respondent from Industry opined that chemicals in use presently are sufficient and efficient and introducing bio-pesticides may do more harm than good. Others felt that we can make a positive step forward in this area after we have all the necessary research and are satisfied with the results. Prevention against invasion is important and the safety or organisms being used need to be safeguarded. There is need for a very strict protocol regarding use (safety and pollution management) of organisms. Pollution should be avoided and once bio-pesticides curb one problem their use should be monitored to avoid another problem developing. The science of this needs to be researched, understood and conveyed to the public before a final decision is made.

**Bio-indicators**

These are species, which can be used by observation to determine how various conditions in an environment have changes over time. Very few respondents knew of bio-indicators and called for its importance to the public to be made known to the public and on a consensus basis, so as to ensure ethical rights are maintained. Some were ambivalent in response. On one hand the use of bio-indicators may not be such a good initiative to take since in the event that encouraging results may be given we may want to use higher animals as laboratory rats. On the other hand, the use of bio-indicators may be a good idea but we need to control and limit the organisms involved. In any case environmental health is important. There should be harmony within the environment, and between it and its inhabitants. Safety of usage and avoidance of invasion are important outcomes of an efficient monitoring system.

**Natural products chemistry**

Natural products chemistry is an interdisciplinary area concerned with the discovery of new therapeutic agents and the applications of natural products as therapeutic products. This field combines the disciplines of organic chemistry, biochemistry, and molecular biology to structurally characterize and study the biosynthesis of biologically active
compounds from natural sources; the design and synthesis of small molecules able to affect specific cellular functions; and the chemical features of enzymes and biochemical pathways that are of therapeutic importance.

Some respondents felt that natural products chemistry in particular is critical and we need to support and encourage it as much for beneficial purposes. However there is need for more research and development. Human health and environmental safety is important so as to prevent pollution. Proper knowledge of handling and safe-use regulations for experimenting and transporting of products is required. As it relates to plant studies, this should be encouraged.

**Bio-pharmaceuticals**

These are proteins produced by living organisms that have medical or diagnostic uses. Many medicines developed using recombinant DNA techniques are termed biopharmaceuticals.

This is critical in alleviating some of the exhausting demands for drugs in the health sector. We should first try to improve on what we have then look to create new products. While, new technological advances in the health sector are always welcome we, however, need to carefully monitor the developmental procedures and materials used to limit or avoid pollution. We should aim to produce high quality products with the least negative effects on the environment, human health and the animals. In this regards, proper use of informational products is important in addition to an efficient monitoring system. Once cost effective, cheap, safe, efficient and readily accessible to all consumers we can move in this direction. Disposal of waste products need to be done in a safe manner.

**Bio-extraction**

Bio-extraction is already used in some mineral operations, to concentrate gold or copper, or to purify waste-streams. It now involves the use of microorganisms to extract minerals or energy, more cheaply, cleanly and greenly than any existing process. It is anticipated that bio-extractive microbes will open up vast mineral reserves yet untapped.

With adequate research and a better understanding of the benefits and risks bio-extraction can be useful to Guyana. However, its importance to the public should be known and on a consensus basis, so as to ensure ethical rights are maintained. Proper safety measures are needed to prevent health hazards in their preparation and proper knowledge of organisms/viruses being treated.