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Perspective

Genetically modified food -The dilemma of Africa

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The entire subject of GM organisms and GM technology is saddled with different opinions, considerable frustrations, and a growing sense of ethical and environment concerns, globally. The question then is: should opinions and perceptions about GM crops stand the way of technologies that can potentially improve the survival and quality of life for millions of people in Africa? Scientists must help provide an answer to this question by ensuring that debate on GM crops addresses facts not opinions so as to respond to society's concern. This essay is intended to give an overview of the GM food technology and assesses the benefits and risks to Africans.

Key words: Benefits, concerns, food security, genetically modified plant.

INTRODUCTION

Advances in cell biology and molecular biology have culminated in the genetic engineering or modification of organisms. It is a technology which is used everyday in the laboratory to drive many applications in yeast, bacterial and fungal industrial fermentation. Moving genes between microbial organisms, and designing new, genetically modified (GM) microbes that express genes from eukaryotic species are acceptable whether for the industrial concern or in the eyes of the general public. This technology allows the routine development of GM plants in which DNA from any source can be transferred to specific crops. The use of GM microbes do not necessarily raise alarm but there is considerable concerns, directed at ethics, when higher animals and plants are the organisms that are modified. Other concerns are centred on the effects of GM plants on the environment and at the use of GM plants and their products in food.

The technology offers opportunities to accelerate the efficiency and extent of further crop improvement by the transfer of genes conferring resistance to pests, diseases, herbicides and environmental stress, as well as quality traits such as improved post-harvest storage, flavour, nutritional content and colour. In the year 2000, more that 40 million hectares of cultivated land worldwide were planted with transgenic seeds (James, 2000). Especially in developing countries, the GM crop area is anticipated to increase rapidly in the coming years.

While food production is not a problem for the developed world, the need for increasing yields is an urgent issue for many African countries and in fact, the entire developing world.

Considerable advances have been made by traditional plant breeding method, but there are already some 800 million people who do not have access to sufficient food to meet their needs (Pinstrup-Anderson and Pandya-Lorch, 2000). Malnutrition plays a significant role in half the nearly 12 million deaths each year in developing countries of children aged under 5 (UNICEF, 1998).

THE TRADITIONAL PLANT/CROP BREEDING PRACTICE

Agriculture evolved independently in many places on this earth, but the earliest evidence of farming dates 10,000 years ago in the present day Iraq (Heiser, 1990). Plants have also evolved, or more accurately, they have been changed rapidly by human intervention (Harlan, 1992). Every crop plant grown today is related to a wild species occurring naturally in its center of origin, and progenitors of many of our crops are still found in the wild. A little over 100 crop species are now grown intensively around the world, with only a handful of them supplying us with most of what we now eat. Random genetic variation occurs naturally in all living things and so through a process of gradual selection, our ancestors chose a very tiny section of the wild plant community and domesticated it into cultivated crops. Some profound alterations in the plant phenotype occurred during such selection, and these include determinate growth habit; elimination of grain shattering; synchronous ripening; shorter maturity; reduction of bitterness and harmful toxins; reduced seed dispersal, sprouting and dormancy; greater productivity, including bigger seed or fruit size; and even an elimination of seeds such as in banana. Remarkably, many of our modern crops were developed by people who lacked an understanding of scientific basis of plant breeding. Over the centuries, this selection process has gradually become more scientific, bringing major improvements in yield, quality and diversity of crops grown. Despite the poor understanding of the process, plant breeding was a popular activity. Plant breeding is the science of altering the genetic pattern of plants in order to increase their value. Increased crop yield is the primary aim of most plant-breeding programs; advantages of the hybrids and new varieties developed include adaptation to new agricultural areas, greater resistance to disease and insects, greater yield of useful parts, better nutritional content of edible parts, and greater physiological efficiency. Other goals are adaptation of crops to modern production techniques such as mechanical harvesting and improvement in the market quality of the product.

In the 19th century, Gregol Mendel established the basic principles of plant genetics. He discovered that inherited traits are determined by units of material which are transferred from one generation to the next. The plant breeder's aim is to reassemble these units of inheritance, known as genes, to produce crops with improved characteristics through strategies which capitalize on heredity. Many of the nuts, seeds, fruits, etc that we eat today have been deliberately changed by breeders.

Conventional or traditional plant breeding involved the shuffling of thousands of genes from one plant to another. The breeder chooses the parents to cross, but at the genetic level, the results are unpredictable. It may transfer the desire gene (or trait), but it may also result in the uptake of other unwanted characteristics which the breeder must then select out. Typically, this involves examining thousands of individuals. Traditional plant breeding programs are time-consuming and labour-intensive. A great deal of effort is required to separate undesirable from desirable traits, and this is not always economically practical. For example, plants must be back-crossed again and again over many growing seasons to breed out undesirable characteristics produced by random mixing of genomes. Traits (desirable) occasionally arise spontaneously through a process called mutation, but the natural rate of mutation is too slow and unreliable to produce all the plants the breeders would like to see. Traditional plant breeding takes on the average 12-15 years to produce a new variety. Many potential benefits are lost along the way, as plants that fail to demonstrate the introduced characteristics are discarded. As a result the process is slow.

To some extent therefore, farmers have been altering the genetic makeup of the crops they grow for several thousand years. Traditionally, plant breeders have made genetic changes in crops by using various crossing and selection methods. Attempts have also been made to introduce favourable mutations by the use of ultraviolet or gamma rays and chemicals.

WHAT IS A GM FOOD AND HOW IS IT CREATED?

Transgenic plants were first created in the early 1980s by four groups working independently at Washington University in St. Louis, Missouri, the Rijksuniversiteit in Ghent, Belgium, Monsanto Company in St. Louis, Missouri, and the University of Wisconsin. These discoveries were soon published in scientific journals (Herrera-Estrella et al., 1983; Beyan et al., 1983; Fraley et al., 1983; Murai et al., 1983). In 1994, the first commercially available GM food appeared on the market of USA. The Flavr Savr tomato was genetically engineered to keep it firm for longer.

A transgenic crop plant contains a gene or genes which have been artificially inserted, through Genetic Engineering (GE), instead of the plant acquiring them through pollination resulting in a novel plant that has never been a part of the human diet or the environment. The resulting organism which contains combined genes from different organisms is said to be 'genetically modified', 'genetically engineered', or 'transgenic'. GE is a departure from traditional breeding. In simple terms, the gene technologist uses a "cutting-copying-pasting" approach to transfer genes from one organism to another. For this, bacterial enzymes are used that recognise, cut and join DNA at specific locations acting as molecular "scissors-and-tape". Since DNA does not always readily move from one organism to another, "vehicles" such as plasmids (small rings of bacterial DNA) may be used. Alternatively, some plant cells may be transformed by "shooting" small particles coated with the new DNA into the target cell using a special type of gun, the "Gene Gun". The modified cell can then be used to regenerate a new organism.

Antibiotic resistance has often been used to "tag" genes so that they can be detected easily and rapidly at the cellular level in the laboratory, providing a basis for selection. The use of antibiotic resistance marker genes (ARMG) has, however, been a source of concern. On the contrary, only the same or very closely related species can be combined in traditional breeding.

What is termed GM can be considered as a new approach to achieve old goal because the idea of enhancing desired traits in food crops is not new. Many changes to food materials brought about by gene technology are not different in essence from those which can take place in nature or by selective breeding, except that the gene technologist transfers a carefully targeted and selected few specific genes, thus drastically reducing both their random nature and the time taken to produce an improvement.

Identifying and locating genes for agriculturally important traits is currently the most limiting step in the transgenic process. Usually, identifying a single gene involved with a trait is not sufficient; scientists need to understand how the gene is regulated, what other effects it might have on the plant, and how it interacts with other genes active in the same biochemical pathway. Particularly important to the production of transgenic plants is an extensive evaluation process to verify whether the inserted gene has been stably incorporated without detrimental effects to other plant functions, product quality, or the unintended agroecosystem. If the plant passes these tests, most likely it will not be used directly for crop production, but be crossed with improved varieties of the crop. The next step in the process is multi-location and multi-year evaluation trials in green houses and field environments to test the effects of the transgene and overall performance. This phase also includes evaluation of environmental effects and food safety.

EXAMPLES OF GM FOODS

The Flavr Savr was the first ready-to-eat food product that used recombinant DNA process. Its maker, Calgene, Inc., created the Flavr Savr on the premise that many consumers are not satisfied with most store-bought tomatoes, especially in the off-season.

Bt crops, or crops with the bacteria called *Bacillus thuringiensis* are among the most popular genetically modified food crops in commercial use today. The purpose of introducing the Bt toxin into crops is to make the plant insect resistant. For example, Bt corn is deadly to the major insect predator of corn, the European corn borer. Bt corn has since been followed by Bt cotton.

Canadian scientists have created a tomato that grows in water nearly half as salty as the ocean. The sodium ions in salt are toxic to plants because they interfere with their metabolism. But the modified tomato contains a gene that makes it gather ions inside large cells vacuoles where they cannot harm the plant. The salt-storing takes place only in the leaves, not in the tomato. This ensures that it will look fresh and taste the same as a tomato grown in normal conditions. Genetically engineering tolerance to weed killers in crops allows farmers to spray their fields with herbicides without damaging their crops. Herbicide-tolerant soybean, corn and cotton are the most successful GM crops in the world.

Another production benefit worth mentioning is the development of grape vines that have been modified to protect themselves against a bacterial disease that is decimating wine production in some areas of the United States, and for which there is no effective treatment.

Many other GM foods are being developed with the aim of improving nutritional status, not only in the developing world, but also in Western nations. Just a few examples are: Coffee beans with low caffeine content; Plant oils with improved nutritional characteristics; Fruits and vegetables with enhanced vitamin and mineral content; and foods that contain compounds associated with allergic responses are being modified to remove the allergenic compounds.

Other GM traits in the pipeline include improved flavor and appearance, vaccines engineered into foods vitamin E-enriched soy beans, sweet potatoes and cassava with greater Vitamin A and protein content.

SOME CONCERNS AND RISKS ABOUT GM FOODS

Like all new technologies, GM foods also pose some risks both known and unknown. The introduction of transgenic crops and foods into the existing food production system has therefore generated a number of questions about possible negative consequences which focus on health effects, environmental safety and conservation, intellectual property rights, labelling, consumer choice, and ethical issues. People with concerns about this technology have reacted in many ways, from participating in letter-writing campaigns to demonstrating in the streets to vandalizing institutions where transgenic research is being conducted. Traditionally, animal welfare has been the major source of difficulty between pressure groups, concerned individuals, and scientists. Plants were largely ignored in the ethical debate until the late 1990s, when the public backlash against GM foods began to influence what biotech companies were doing. It is often said that science *per se* is neither good nor bad, and that it is therefore ethically and morally neutral. Whilst this may be true of science as a process, it is the development and applications that arise from the scientific process that pose the ethical questions.

This not withstanding, ethical issues associated with creating GM foods are focussed on tempering or interfering with nature by mixing genes of different species. It does what nature would never do. Other ethical concerns include disruption of the original genetic intelligence of the host since the introduced gene may act differently when working within its new host. The natural organism’s intrinsic values are thus violated. Transferring animal genes into plants raises important ethical issues for vegetarians and religious groups. It may also involve experimenting the GM foods with animals which are unacceptable to many people.

This year marks the 55th anniversary of the discovery of the structure of DNA, but to date, many questions regarding the function of DNA and genes remain unanswered. Modern science has shown that mechanisms and control of gene expression to be far more complex than first thought. The fundamental basis of genetic engineering, which is the central dogma of molecular biology, is now considered over-simplistic. For instance, the central dogma states that DNA (genetic information) generates RNA (an intermediary), RNA then generates proteins (which performs a function). This stipulates that no genetic information is transferred from protein to protein, protein to RNA or protein to DNA. But it is now known that many types of regulatory information are transmitted to DNA by, for example, proteins. As such the effects of GM plants/crops on the environment and human health cannot be predicted.

The methods genetic engineers use to insert these foreign genes are imprecise. Most of the DNA sequences could be inserted in the wrong place, in the wrong order, or they could interrupt important DNA sequences that already exist in the organism. The imprecision of this science leads to unintended consequences in the organisms that are genetically engineered. For example, the genetically engineered papaya, developed and grown in Hawaii, was engineered to be resistant to the ring spot virus, which it is. Over time, however, it also became clear that the GM papaya tree was a weak tree, more susceptible to the black spot fungus. The truth is that no gene works in isolation but as part of an extremely complex genetic network. In fact, the function of each gene is dependent on the context of all the other genes in the genome. The same gene, for example, will have very different effects from individual to individual, because other genes are different.

There is concern that GM foods pose allergy risk because most of the foreign proteins being gene-spliced into foods have not been eaten by humans before or tested for their safety. Almost all known food allergens are proteins, and currently the list of GM food products intersects with the eight most common food allergens: eggs, milk, fish, peanuts shellfish, soy bean, tree nuts, and wheat.

At several stages of the laboratory process, developers of transgenic crops use DNA that codes for resistance to certain antibiotics, and this DNA becomes a permanent feature of the final product although it serves no purpose beyond the laboratory stage. The use of antibiotic resistance markers in the development of transgenic crops has raised concerns about whether transgenic foods will play a part in our loss of ability to treat illnesses with antibiotic drugs. When scientists use transgenic technology to put a new gene into a plant, they put in additional pieces of DNA to direct the activity of that gene. One of these pieces is the "promoter" that turns the gene on. There are concerns that the CaMV promoter might be harmful if it were to invade our cells and turn on our genes. A study has revealed that volunteers who ate one meal containing genetically modified soy had traces of the modified DNA in bacteria in their small intestines (Poulter, 2002). Eating GM food can change the genetic make-up of one’s digestive system and could put someone at risk of infections that are resistant to antibiotics.

Our ecosystem has developed over millions of years, and is delicate, complex, and interconnected. Genetic engineering introduces plants and animals that are brand new to the world into these ecosystems, with unknown consequences. These new species could endanger wildlife and change the complicated relationships between plants and animals that have developed over time, threatening biodiversity. Another environmental concern is an increase in pesticide use. Much research is focused on the development of plants that can withstand heavier applications of pesticides. Some genetically engineered plants therefore introduce new elements into the soil and it is suspected that these may have negative consequences on the soil such as being harmful to beneficial bacteria or change soil structure. There is also the concern of increase in invasive species, so-called “Superweeds“ and “Superpests.” With increased applications of pesticides and with advent of plants that produce pesticides in every cell through genetic engineering, there is concern that weeds and insects will develop resistance to these chemicals, rendering the chemicals unusable and making both the pests and the weeds harder to kill. Even more serious is the danger of what is called "gene flow". This refers to the possibility of transferring a gene from a transgenetic plant to a weedy relative by way of cross-pollination. Novel genes placed in crops will not necessarily stay in the fields in which they are planted. If relatives of the altered crops are growing near the field, the new gene can easily move, via pollen, into those plants. For example, a gene that would change the oil composition of a crop might move into nearby weedy relatives thus enabling the weed to survive harsh winters and become much more of a nuisance to farmers. Similarly, if a herbicide resistant gene jumped to a wild weedy relative then that plant might become resistant to the particular herbicide. These forms of genetic pollution might become major nuisance to farmers. Many plants leak chemical compounds into the soil through their roots. There are concerns that transgenic plants may leak different compounds than conventional plants do, as an unintended consequence of their changed DNA. Speculation that this may happen leads to concern about whether the communities of micro-organisms living near transgenic plants may be affected.

Adoption of GM crops can lead to domination of world food production by a few biotechnology companies. For instance, the “Terminator” seed technology produces crops that have sterile seeds, so that farmers are forced to buy new seeds every year instead of being able to save and store them. The biotechnology companies force farmers to buy new seeds each year, preventing them from saving and replanting seed, which is something that poor farmers in particular rely on. This technology is not being used to help the poor, particularly in developing countries who cannot purchase seed every farming season.

By signing Technology Use Agreements, farmers who choose to grow GMO crops are locked into buying certain kinds of herbicides and pesticides and are forced to buy new seeds each season. They no longer own the crops they grow, they lease them from multinational corporations and there is loss of farmers' independence. There are a number of liabilities concerning the fact that GM crop farmers can be fined or sued if they save and replant GMO seed. On the social level, there is the concern that genetically engineered crops will displace crops grown naturally by farmers in Third World countries, devastate Third World Agriculture and in the process disrupt the lives of millions of poor people. Research is under way to genetically engineer crops including coffee, tobacco, cocoa, coconut, palm oil, sugar and ginseng that are crucial to some Third World economies. The resulting genetically engineered varieties may thrive in temperate zones and thus ravage the Third World economies which are dependent on one or other of these commodities. These poor, debt-burdened countries will have no fall-back industries capable of absorbing their redundant farmers.

THE STATE OF HUNGER, STARVATION AND MALNUTRITION IN AFRICA

Generalized judgments about possible risks of GM crops to developing countries are of limited use. When assessing the risks of introducing a specific GM crop, the socio-economic and agricultural context of beneficiaries and individual countries needs to be considered. It is therefore much more helpful to focus on particular sub-continent or continent such as Africa to assess the impact of GM crops on the livelihood of the people, the environment, agriculture and the economy as a whole.

Like the developed world, people in many African countries are suspicious of GM crops and hostile to their use, especially in food. However, a look at the state of hunger, starvation, and malnutrition may change one's perception.

852 million people do not have enough to eat everyday (FAO & The State of Food Insecurity in the World, 2003). Hunger and poverty claim 25,000 lives every day and the percentage of hungry people is highest in East, Central and Southern Africa (Source: FAO quoted in www.wfp.org) of which children, women and rural communities are on the frontlines. In 2002, six million people faced starvation in Zimbabwe following poor rains in the previous two years, while a reduction of plantings in the large-scale commercial sector, caused by the land reform disturbances, also contributed to the food shortage. Earlier Zimbabwe rejected the GM food for fear of negative reactions in human beings but later made a U-turn and accepted it. Two more southern African countries, Malawi and Mozambique followed Zimbabwe's example and also accepted the GM food as starvation took its toll in the region. In Zambia, hungry villagers in the southern province illegally helped themselves to the GM food (Bote, 2002).

Vitamin A deficiency is practically unknown in the developed countries but it is widely known that every year approximately 2 million people die and hundreds of thousands of infants become blind in the developing countries because of lack of vitamin A in their diet. In total, about 700 million people are vitamin A deficient. At the same time, about 2 billion people (one third of the world's population) suffer from anaemia because they do not get enough iron in their diet. In developing countries, almost half the children under the age of five are iron-deficient, and figures from the United Nations indicate that 20% of all deaths in childbirth are at least contributed to by iron deficiency anaemia (www.abc.net.au/rn/science/ockham/stories/). Of the total number of over 800 million undernourished people, 203.5 million are in Sub-Saharan Africa and 33.1 million are in the Near East and North Africa (Source: FAO quoted in www.wfp.org). For some Africans therefore, the situation to stay with the *status quo* by being skeptic about the use of GM crops cannot be the best option.

WHAT AFRICANS STAND TO GAIN FROM GM CROPS

GM crops such as Golden Rice do hold the potential to expand significantly the nutritional solutions available to the poorest of the poor. In the early 1990s, scientists from Switzerland and Germany began research and development aimed at producing a GM rice that would provide significant quantities of vitamin A and iron as a biotech innovation to address malnutrition in the world's poorest countries. Vitamin A and Iron are required for human growth, but rice, one of the staple food of Africa and the world's most important source of human food, lacks them. For instance, it lacks beta-carotene, or pro-Vitamin A, which allows Vitamin A to be manufactured by the body. Beta-carotene is manufactured in the leaves of the rice plant, but conventional plant breeding has been unable to coax the grain, the part that is eaten, to produce it. The gene from daffodil for beta-carotene production, and genes from bacteria for iron accumulation were incorporated into ordinary rice. Beta-carotene is also the substance that gives many orange/yellow fruits, vegetables and flowers their colour. In rice, as in daffodils, it imparts a golden-yellow colour, so the high-vitamin A/high-iron GM rice is called 'Golden Rice'. The detractors of the Golden Rice project point out that vitamin A deficiency can be prevented simply by eating more green vegetables, many of which are better sources of beta-carotene than Golden Rice. Even better would be eating more animal foods such as milk, butter, and eggs, foods that provide far more vitamin A than Golden Rice, and of course, vitamin A tablets. But these solutions have been available for decades, yet hundreds of thousands of children still go blind every year because of a lack of vitamin A in their diets. If Golden Rice has the theoretical potential to make a significant contribution, then it should at least be given the opportunity to show how much of that potential can be realised.

In large parts of Africa, there are long periods known as “the hungry season” in which few fruits and vegetables are available and people eat stored grain. And even when they are available, it takes many servings of green leafy vegetables to provide enough Vitamin A. Meat and dairy products, a richer source, are not part of many Africa diets, and large-scale Vitamin A supplementation is difficult to administer to children in rural areas. In the developed world, where most people have access to a balanced diet and by law rice is fortified with vitamins, doctors still recommend a daily supplement of Vitamin A. The poor African consumers, too, must have choices that are within their reach and control.

Another aspect of GM that has immense potential for health benefits is the incorporation of vaccines into fruits, greatly facilitating the vaccination of people in developing nations where facilities for storage, distribution and application of vaccines by injection or in oral form often do not exist. Edible vaccines, delivered in locally grown crops, could do more to eliminate disease than the Red Cross, missionaries and United Nations (UN) task forces combined, at a fraction of the cost (Arakawa, et al, 1998; Tacket et al., 1998; Hag et al. 1995). Already, South African scientists have used genetic modification to insert the vaccine for the disease cholera into bananas. Cholera is a particularly serious problem in Africa.

GM technology also offers health benefits for farmers because reducing the use of chemical pesticides reduces harm to human life and health. The benefits to health will be been particularly notable for Bt cotton in Africa, where pesticides have traditionally been applied manually without protective clothing, resulting in high incidences of poisoning.

GM food can save precious lives. In 2000, Africa had 44% of the world’s hungry; if present trends continue, the number may be 73% by the year 2015 (ERS/USDA 2000). GM food channeled through the world Food Program can make the difference between life and death for millions of southern African poorest and war-torn people.

Growing GM crops and adopting innovations in genetic modification can increase the income of African farmers (through improved yields), and create an explosion of new businesses. There is an assertion that when African agriculture does not function, Africa does not function because some 70% of the African labor force is primarily involved in agriculture. The holdings are small and yields are low but GM farmers in Africa can increase their productivity either by reducing input use or by raising crop yields. In South Africa Bt corn yields over conventional varieties was 10% higher (Crop Biotech Update, 2003). Such improved yields will result in a higher profit margin for farmers and would not only raise their incomes and increase food security, but also lower national food prices, stimulate the rest of the economy, and reduce poverty. Half of all Africans earn less than $1 a day; three fourths earn less than $2 a day. A one percent increase in yields would help six million more people raise their incomes above one dollar per day (Thirtle et al.2001). Resource-poor farmers in China who cultivated Bt cotton obtained higher yields, derived benefits estimated at $330 to $400 more per hectare (Pray et al. 2002). Similar benefits can be earned by poor African farmers who spend over 70% of their income on food (Source: World Bank 1992). Money can be channeled through other services and facilities that will raise their standard of living. Already, Kenya researchers have created a GM sweet potato that they predict could increase yields by up to 80% (http://www.bbc.co.uk/ science/genes/gm).

Growing GM crops can contribute to African’s environmental preservation. Besides decreasing the amount of land cleared for farming, GM crops also benefit the environment by reducing the amounts of herbicides and pesticides that are released into it. From another perspective, if yields are increased through GM technologies, by implication, the amount of land needed for agriculture can also be reduced. Less land cleared means greater preservation of biodiversity and less damage to the environment.

Some GM crops, such as soy, are created to be herbicide tolerant and so can be planted by placing them directly into relatively undisturbed soil. This system, termed minimum tillage, conserves moisture and soil fauna and flora, and reduces water and wind erosion.

GM food promises to provide enormous benefits. Genetic modification has enabled scientists to add quailties to crops that no amount of traditional breeding could so many modified crops could boost prosperity in the developing world and provide new choices for consumers. Since there is no early prospect of famine-stricken African countries becoming food-exporters in the foreseeable future, and with millions facing the threat of famine, this may not be the appropriate time to be debating the contamination issue. Many scientists in Africa regard GM crops as the only way to avoid mass starvation on the continent (http://www.bbc.co.uk/science/genes/gm).

THE WAY FORWARD

Although the perceived benefits associated with GM foods and crops are important in determining their acceptability, these alone are not sufficient to determine public reaction. Public acceptance and confidence in GM food will grow provided issues of product safety, environmental concerns, and ethics are satisfactorily addressed as well as effective communication between scientists and the rest of society. Academic and industrial scientists, food, retailers, and consumers must all play an active role in communicating both the benefits of, and concerns about GM foods to the public. If perception of the risks related to any potential hazard or technology are sufficiently high, no amount of benefits are liable to make it acceptable. One issue which GM technology advocates need is to consider in trying to encourage acceptance of GM foods and crops in Africa is the issue of trust. If the source of risks and benefits come from a distrusted source, it matters little how full or persuasive their information is. The exercise of informed choice by consumers requires that they have accurate and unbiased information.

The initial refusal of badly needed food by some African countries made clear that most of them simply do not as yet have the experience and scientific capacity to make informed decisions about GM food. It is not only lack of experience with scientific decision-making that makes Africa hesitant, some of the fears of the new science have their roots in mistakes of the past. Europeans introduced water hyacinth, which now chokes waterways. They introduced the Nile perch, which has eaten everything else in Lake Victoria. So how can Africans be sure that GM food will not lead to bigger mistakes?

There are a number of measures which African governments can take to regulate the acceptance and adoption of GM food and related technologies. For instance, Africans can begin with the basics- building human capacity, a critical mass of people with the abilities to evaluate and manage technology within the individual countries themselves. A strong scientific community will help select the best and most useful biotech applications and to avoid any for which the risks outweigh the benefits. All biotech applications are not the same, all are not equally beneficial, nor equally well understood. It is critical for each country to be able to pick and choose carefully, reflecting its own needs and capabilities. Furthermore, policies that encourage both advanced research in the laboratory and also regulatory systems on the ground, to ensure the safety of new technologies for both human health and the environment should be formulated and implemented. African nations should also submit themselves to international agree-ments such as the International Biosafety Protocol, in order to regulate international trade of GM organisms. In this regard, oversight institutions and agencies in charge of Biosafety, Plant health inspection, Food administration, and Environmental Protection should be set up or if already in existence, should be empowered and strengthened through legislation. Their ultimate goal should be to ensure the safety of products so they should have the jurisdiction to monitor transgenic crops at every stage of their development, from research planning through field testing, food and environmental safety evaluations and internal as well as international marketing. Among other duties, they should be mandated to monitor potentially hazardous biological research and ensure compliance with biological safety guidelines. They should also determine the safety of foods or food ingredients by consulting crop/plant developer, review safety and nutritional data and assess for allergenicity, for example, toxicants, nutrient levels, antibiotic resistance markers, new substances and accordingly advice their respective governments whether or not to apply the ‘precautionary principle’. Additionally, they must determine whether a transgenic plant variety is likely to have negative agricultural or environmental effects such as potential problem of contamination of non-GM crops. They may also advice labelling of GM foods and food products to allow consumers choose what they eat and also help trace the source of health problems arising from these foods.

Higher yields, higher income, better nutrition prevention of starvation, less pesticides, these are just a few of the promises which GM food offer Africa today. These are why others believe that GM foods are the wave of Africa’s future for food security, but are these enough? If they can do all that the scientists say that they can, why doesn’t Africa embrace them? Africans should not be blind-folded by what they stand to gain from GM food/crops. Like all new technology, genetic modification is risky. African governments should have enough political will to take best decisions for their nations.

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