

Advances in Agriculture Biotechnology

Drugs from plants and animal genes

Bacteria, yeast, and mammalian cell cultures are routinely used for large-scale commercial production of biopharmaceuticals, but these systems are costly and lack flexibility for scaling up production. Typical unit production costs range from US\$100–1,000 per gram of purified protein product, depending on the product, volume, and production system. Capital investment is in the order of several hundred million dollars for a large capacity facility.

The construction and validation of GMP compliant facilities requires long lead times, typically three to five years, which creates challenges in matching capacity to demand. As a result, companies must make manufacturing choices and a substantial upfront investment in capacity while their products are still in the test phases. The uncertainty of regulatory approval, and the difficulties in predicting market demand impose a significant business and financial risk. For drug developers, investing large amounts of capital on a drug that is awaiting approval, is an expensive and very risky prospect; however, having a drug that is approved without a reliable supply of product can have equally dire consequences.

Transgenic production holds tremendous promise for dealing with the cost, capacity and scale-up limitations faced by traditional systems. Trans-genics can substantially reduce capital investment and lower production costs through economies of scale and more-flexible scale-up. Such advantages could enable the commercialization of proteins that would otherwise be impractical due to cost or capacity constraints, and provide scope for pricing flexibility that could be passed on to patients and health care systems. These benefits could allow companies to expand into new markets, such as follow-on biologics, where price is a barrier to entry.

The world's first medicine derived from a genetically engineered animal has been recommended for approval by a panel of European experts, following a re-examination of the evidence. The European Medicines Agency had initially rejected ATryn, an anti-clotting agent for use by people with a rare inherited disease, which is made from the milk of transgenic goats. But the agency's Committee for Medicinal Products for Human Use (CHMP) said that it had now changed its mind and supported the drug's use in patients with congenital antithrombin deficiency undergoing surgery, to prevent deep-vein thrombosis.

Focus on rice for higher yields

Scientists have announced plans to radically boost rice yields, warning that unless production increases millions of people could fall back into poverty. Traditional methods of increasing rice production such as crossing different varieties have been pushed to the limits of what is scientifically possible. But now that researchers have sequenced entire genetic code for rice more advanced approaches could become available. Key to the strategy discussed at the workshop is a difference in the way that rice and other plants convert sunlight and carbon dioxide into sugar for growth, a process called photosynthesis. Rice photosynthesis is less efficient than that of some other plants such as maize that use an extra chemical process for capturing carbon dioxide. The researchers at IRRI say it should be possible to transfer this process to rice by inserting genes from maize or from wild relatives of rice that also use it. The project is ambitious. The specialists say it would take about four years to determine whether the technique is feasible and another 10-15 years until the first improved varieties are available.

Similar efforts are also on at the Department of Molecular Biology and Genetics at Cornell University for improving the rice yields by adding a molecule responsible for photosynthesis. A highly specialized molecule that responds to light, called a photoreceptor, provides a new plant architecture and increases grain yield. Translucent white grains with a great aroma are the well-known characteristics of Basmati rice that renders this rice so attractive for global agricultural markets. However, yields are reduced by other traits of Basmati rice. For example, a tall stature and a weak stem are among the traits that trigger low yields. Yet, genetic engineering could solve this issue. This is exactly what a research group at Cornell did.

Apart from efforts at IRRI, recently, researchers of the Department of Molecular Biology and Genetics at Cornell University published their work in the journal *Planta*. They reported on how they were able to increase the production of *Arabidopsis thaliana* PHYTOCHROME A (PHYA), which led to an increase in grain yield in a rice variety called Pusa Basmati-1 rice. The PHYA gene that they studied encodes a photoreceptor belonging to the phytochromes, a family of molecules absorbing light in the range of red to far-red. When light hits the PHYA photoreceptor, it induces a structural change in PHYA, which triggers an intercellular signal called a signal-transduction.

The team generated transgenic Pusa Basmati-1 rice seedlings containing the Phytochrome A gene - the photoreceptor - of *Arabidopsis thaliana*, a plant common in research. The main effect of the increase in the production PHYA has been observed by the research group in several experiments. For example, in experiments with tomatoes, a phenomenon called dwarfing occurred, where the overall stature of the tomato plant was reduced. In addition, by increasing the production of PHYA, the adult tomato plants grew bushier and increased their branching.

Although the complete mode of action of PHYA is not understood, what is known is that this type of photoreceptor belongs to the phytochromes, a family of molecules absorbing light in the range of red to far-red. When light hits the PHYA photoreceptor, it induces a structural change in PHYA, which triggers an intercellular signal called a signal-transduction. The research group believe that if they are able to extend their observations to other rice varieties this could provide high yielding, semi-dwarf plants that can be used as donors in breeding programmes.

Next generations' transgenic technology for GM crops

Researchers at the National Research Centre on Plant Biotechnology (NRCPB) of Indian Agricultural Research Institute (IARI) have developed next generation transgenic technology for GM plants. In their approach, plants can be genetically modified through chloroplast transformation instead of the traditional nuclear method – as in the case of present day biotech crops such as soybean, cotton, canola and maize — for not just high yield but also with high level of protection against insect pests and significant saving on resources. Potato, tomato and agriculturally important crop plants such as carrot, cotton, soybean

and oil seed mustard have been successfully modified this way to keep common infectious affiliations at bay. Researchers term their innovation as transplastomic plants.

Most importantly, this technique, called chloroplast genetic engineering, opens new opportunities for developing low-cost drugs and vaccines from transplastomic plants such as tobacco and tomato. Monsanto and ICGEB scientists have already demonstrated in tobacco plants how genetic engineering could potentially be used to produce vaccines and antibodies for fighting diseases such as cholera.

Genetic engineering of plants has tremendous potential to create crops with new metabolic capabilities, like the ability to accumulate pharmaceuticals or other high-value specialty materials, says KC Bansal, leading the research foray at NRCPB. The new technology could be used to develop fruit and vegetables that could help immunise against certain diseases. While several biotech crops with many desirable traits have already reached the market, and many more are in the pipeline, these are the outcome of nuclear transgenic technology. This is associated with certain drawbacks such as gene silencing, low level of gene expression, and most importantly, uncontrolled spread of the transgene via pollen to the neighbouring wild relatives.

Transplastomic plants would have a future only if they are demonstrated to be economically beneficial and have agronomically useful traits. With eight Indian states recently joining hands to collaborate with agricultural universities to come up with indigenous GM alternatives in the wake of Mahyco-Monsanto's exorbitant prices for GM crop seeds, the research efforts of biotechnologists need to be given an impetus to bring the technology from the confines of the laboratory into the agricultural landscape.

Uproar over diarrhea treatment grown in transgenic

In Peru a research experiment is under investigation for having tested two anti-diarrheal proteins from genetically modified (GM) rice on babies hospitalized in Peru with serious diarrhea attacks. Out of 140 babies, those given the proteins added to a standard rehydration solution recovered faster; the average recovery time was 3.67 days versus 5.21 days. Diarrhea is the second leading cause of death among children under five in Peru. The experimental proteins administered were made by a U.S. biotechnology company, Ventria Biosciences, which is also

testing them on elderly patients in the U.S. International Academy of Life Sciences at Germany hailed the research a nonprofit Peruvian Medical Association has complained to authorities that the hospital tests endangered the babies involved, and were illegal.

Biotech to address metallic contamination

Heavy metal pollution is a big problem worldwide. Even essential metals such as zinc are toxic for all organisms when present in excess. However, some plants are able to grow in metal contaminated soils. These metal tolerant plants are important to scientists, as they can be used in bioremediation, the cleaning up of heavy metal pollution. How these plants can tolerate in heavy metal access, however, is still not understood. Research teams from institutes in France and Belgium have discovered one more clue to the hardiness of metal-tolerant plants.

Researchers screened an *A. halleri* cDNA library expressed in yeast that was grown in medium containing zinc. The screening revealed four cDNAs that encode plant defensins (PDF), a group of small proteins widely distributed in all living organisms. Defensins are known for their involvement in the plant immune system, inhibiting the growth of fungal pathogens. However, these proteins were previously unknown to play any role in metal physiology.

Researchers found that the gene induced zinc tolerance in yeast, but not cadmium tolerance. When they transferred the defensin genes to *Arabidopsis thaliana*, they found that transgenic plants were more tolerant to zinc than wild-type plants, but had not increased tolerance to cadmium, copper, cobalt, iron, or sodium. These results open up new horizons for the investigation of defensin mechanisms of action, both with respect to fungal growth inhibition and metal physiology in plants.

Chinese scientists develop salt tolerant grass

Scientists in China have developed a salt-tolerant form of grass that they say could be used to help bring millions of hectares of degraded land back into production. The team at the Beijing Research Center of Agro-Biotechnology published their findings in the *African Journal of Biotechnology*. The researchers genetically modified tall fescue grass (*Festuca arundinacea*) by inserting a gene from a relative of mustard called *Arabidopsis thaliana*. The modified plants had “remarkable salt tolerance”, all growing better than non-modified plants under

conditions of high salt stress, say the researchers. Tall fescue is grown widely in Africa, China and South America as turf and as a forage crop for grazing animals, but soil salinity is becoming increasingly problematic in many areas. This improved grass has the potential to benefit livestock operations that depend on sustainable forage production.

Israel to develop salinity resistance

Imagine what it would mean for the world hunger problem if farmers could grow wheat and other crops on land considered unsuitable for agriculture. That day may be coming soon, after Israeli researchers from the Institute of Evolution, University of Haifa, have succeeded in isolating a gene that withstands salinity. The research will contribute to a significant increase in the amount of arable land available for agriculture.

Of the earth's 57 million square miles of land, approximately 12 million square miles are arable - meaning land that can be used for growing crops. However, arable land is being lost at the rate of over ten million hectares per year. This research will make it possible to grow plants, including crops, in saline earth, a development that will contribute in the future to a true revolution in saline agriculture throughout the world.

Saline agriculture is the production of crops on land that is affected by salt. Too much salt in soil or in irrigation water will inhibit the growth of most crops, or may even kill them. Saline soils are found in arid lands, in coastal deserts, and where arable land has been ruined by poor farming practices. Modern methods of irrigation and fertilization of crops has caused much of the arable lands around the world to become saline. This is especially true in drylands because of the high rate of evaporation, which leaves the salt behind. More and more farmers are forced to plant crops on marginal lands and to use soil that was once arable but now has a high saline content.

In the current study, *Eurotium herbariorum*, a common fungal species, was isolated from the lake. The researchers isolated and sequenced the HOG gene that is responsible, in concert with other genes, for the fungus' ability to defend itself from the salinity of the Dead Sea. The gene was introduced into '*saccharomyces cerevisiae*' - better known as baker's yeast - and the team observed that resultant transgenic yeast was able to tolerate more salt than normal, especially in resisting large temperature changes. The researchers found that in

comparison to yeast that was not genetically engineered, the yeast that had been genetically transformed by the insertion of the HOG gene was more durable in saline or highly oxidative environments and also able to better withstand extreme heat and cold.

The genetic salt resistant resources of the Dead Sea could be very important for revolutionizing saline agriculture around the world. If transformation of this gene and other genes is cloned, it will be possible to improve crop production by making them salt tolerant and enable the growth of crops like wheat in a tepid desert area. The idea is to develop a battery of salt resistant genes to be used for crop improvement.

CIMMYT to engineer drought tolerance

The publicly-funded International Maize and Wheat Improvement Center (CIMMYT) has been involved with crop improvements since the green revolution. Both transgenic and traditional breeding approaches to crop improvements are used. A drought tolerant transgenic wheat variety is being evaluated and may be ready for commercialization within five years. However, an interesting twist has been discovered with this research project. It seems that under drought conditions the transgenic wheat does better than non-transgenic varieties, but under adequate water conditions the transgenic wheat performs less well. Therefore, researchers are looking for ways to control when the transgene (gene engineered into a crop) is turned on.

There has been some excellent research looking at controlling pieces of DNA, called promoters, which will only turn genes on under specific environmental conditions. Using this controlling DNA is a type of genetic use restriction technology (or GURT). Although critics of GE crops have been very active fighting the advancement of GURT research, Canada is one of a select number of countries that has called for more research into using these technologies to improve crops. Further, the use of another type of GURT would stop the unwanted movement of the drought tolerance trait itself. Using this type of GURT the pollen or seed of the drought tolerant crop would be sterile so there would be no transfer of the drought resistance into other crops or natural weed populations.

The most popular type of genetically engineered crop grown around the world is engineered to be herbicide tolerant. Growing these crops results in excellent weed control and at the same time allows the farmers

to practice reduced or zero tillage agriculture. The benefits have been well documented. By reducing the amount of ploughing, soil erosion and the loss of soil moisture to evaporation are greatly reduced. Therefore, growing this type of GE crop also helps with water conservation.

The other big players in agriculture biotechnology are also heavily investing in drought tolerance research. Bayer, Syngenta, Dow, BASF and Dupont all have extensive research programmes in this area. At this point no one knows how many drought tolerant transgenic crops China has in development. But we can be confident it is quite a few as China has three times as many transgenic crops in development as the United States. The adoption rate of agricultural biotechnology is fastest in developing world. If the current trend of climate change continues there will undoubtedly be shifts in precipitation patterns around the world. Those areas that rely on rain water for agriculture may be at risk. Along with newer drip irrigation systems, agri-forestry, and traditional plant breeding, genetic engineering of drought tolerance will play an important role in maintaining food production with less water.

Local plants for pest control

Kenyan scientists have turned to traditional methods of pest control in a bid to produce a new variety of genetically modified cotton. The scientists conducting trials at the Kenya Agricultural Research Institute (Kari) at Kimbimbi in Mwea, Kirinyaga District, are testing the efficacy of tobacco and neem leaf powder in eradicating the destructive bollworm. Researchers at the station said that they have been spraying the genetically modified cotton, codenamed HART 89 M, with the powder for one year. The chief researcher of the project said that some consumers of cotton products in Europe were ready for higher prices of genetically modified cotton. But the scientists decried lack of a legal framework regulating biotechnology, saying it had hampered research.

Funding for alternative research approach

There are some recent initiatives which are important in the sense that they intend to emphasize the relevance of alternative approaches. We present such initiatives from Divergence Inc. from US, DEFRA from UK and by the European commission. Divergence Inc. has received three federal grants, totaling \$280,000, to develop a new

method of creating genetically modified plants. The company, based at the Nidus Center for Scientific Enterprise incubator in Creve Coeur, announced that its first target is biotech crops that can resist harmful nematodes, also known as roundworms. But the technology platform, if it works, could be used to transfer a variety of beneficial genetic traits to plants. Divergence received two small-business innovation research grants from the National Science Foundation and one from the U.S. Department of Agriculture. Since 2001, the company has been awarded 12 innovation research grants totaling more than \$2.5 million.

In case of Defra, the British Department for Environment, Food and Rural Affairs, a methods for containing the spread of novel genes in GM crop plants is developed. This issue is of potential relevance to the risk assessment of new types of GM crop. The review was considered in near-final form by the independent Advisory Committee on Releases to the Environment.

The European Commission is devoting \$12 million to AGRON-OMICS, a plant research consortium of the Flanders Interuniversity Institute for Biotechnology (VIB) and Ghent University. The goal of this 5-year initiative led in collaboration with other top European research institutes is to understand the network of biological processes involved in leaf growth. With the exception of the Arabidopsis genome initiative, this is arguably the largest grant ever awarded in this area of research, and a clear indication of the social importance of a deep understanding of life processes in plants.

The Department of Plant Systems Biology, in collaboration with nine other top European research institutes, has set out to perform an in-depth study of leaf growth in the model plant species *Arabidopsis thaliana*. To support their efforts, these scientists launched an initiative called AGRON-OMICS (Arabidopsis GROWth Network integrating OMICS technologies). In the coming five years, this network of major European players in plant biology will perform experiments to identify the molecular components controlling growth and build mathematical models to explain how these components interact.

USDA to approve second genetically-modified fruit

The U.S. Department of Agriculture (USDA), Institut National de la Recherche Agronomique of France and Cornell University are

planning to introduce genetically-modified plums for commercial use. This would make plums the second genetically engineered fruit along with papaya to be approved for commercial use. As a result, many consumer, health, and environmental advocacy groups are now on alert for their potential arrival on the market. The genetically modified variety of plum, called c5, will enable it to resist the mutation of the Plum Pox Virus among stone fruit trees. The virus has had commercial growers and government officials otherwise at a loss about how to contain it.

First found in Adams County, Pennsylvania and in the Canadian provinces of Ontario and Nova Scotia, Plum Pox Virus is considered to be the most serious virus disease of stone fruit, with the potential to devastate stone fruit production. One organization, the Organic Consumers Association, indicated in a nationwide action alert that since the new plum tree will be the first GE temperate tree proposed for commercial planting, it could open the door to the commercialization for other GE varieties of temperate trees-such as poplars, pines, or walnuts. Flowers and fruit in organic and conventional plum orchards can be contaminated if pollen from GE trees were transported by bees and other insects that often travel long distances. Should contamination occur, the result is that organic, or even conventional plum growers will lose their markets.

Recent trials with other GE fruits have confirmed this to happen. Jeffrey Smith, author of the book *Seeds of Deception* recently wrote in a July e-newsletter that introducing GE papaya in the state of Hawaii did not show the results scientists wanted, and in fact, made the situation worse than before. The USDA does admit that the GE plum will contaminate both organic and conventional non-genetically engineered plum orchards, if approved. Since all commercial plum trees are cultivars (a plant variety created intentionally and maintained through cultivation) that are cross compatible within the same species, contamination will infiltrate the plum orchards of organic and conventional growers.

Private Sector and Biotechnology

Commercialization of new Bt cotton variety

Andian firm JK Agri Genetics Ltd has signed an agreement with the National Botanical Research Institute, Lucknow (a CSIR Institute) to

commercialise their new Bt cotton technology by using Cry IEC gene in India. The firm has recently launched the first indigenously developed Bt Cotton in Indian market after getting clearance from GEAC, the product was first developed under collaborative research with BREF-IIT Kharagpur. The new gene (Cry IEC) developed by NBRI would be pyramided with the recently released material carrying Cry 1Ac gene. This elite Bt Cotton will give broader insect resistance coverage, particularly against Spodoptera (tobacco caterpillar) and is expected to provide season long uniform protection against the target pests throughout the entire field. Besides this, the new product would also help in delaying the resistance development in Cotton Bollworm complex. Currently cotton varieties containing Bt do not offer acceptable control of Spodoptera.

US debate over biotech and taxes

Some of the state of Arizona's most prominent business leaders are being criticized by a few of their private-sector brethren and conservatives for coming out against sweeping income tax cuts and backing an incentive fund aimed at attracting biotechnology to the state. Greater Phoenix Leadership (GPL) is feeling the blowback after a recent meeting with Republican legislators in which the group voiced skepticism toward a proposed 10 per cent income tax cut and strong support for the Arizona 21st Century Competitive Initiative Fund. That fund would be used to help fund research, startup companies and other life-science endeavours. In addition, it would subsidize the new Science Foundation Arizona, which is slated to get a \$100 million donation from Scottsdale real estate developer and philanthropist Jerry Bisgrove.

Current Republican budget plans call for \$15 million from existing job-training funds to be allocated to the newly established 21st Century Fund. The governor, GPL and other backers of the biotech programme want more money put toward the fund but don't want it to come from job-training pools. They say the fund is key to attracting and growing the biotech sector in the state. GPL opposition to income tax reductions and its support for the governor's spending plans is drawing criticism from business groups backing major tax cuts and Republican rivals of the governor.

GPL is very supportive of the proposed 21st Century Fund and has concerns about the financial impact of income tax cuts. They see taxes and biotech as two separate issues, and the state needs to invest in education, economic development and transportation. GPL feels a new

round of proposed business-backed property tax cuts as “reasonable,” but added his concern over income tax reductions and its result in future deficits.

A number of major business and real estate groups favour property tax reductions. They feel that large tax cuts may result in future budget deficits. Other critics of the income tax and property tax cuts argue that it will disproportionately help the wealthy and large commercial property owners. Some major business groups are supporting tax cuts and stress the business community has a diversity of views on taxes, spending and how to attract jobs.

Public-private partnership to develop GM wheat

BASF Plant Science and Australian research centre Molecular Plant Breeding CRC strengthen cooperation to develop genetically optimized wheat. BASF Plant Science and the Molecular Plant Breeding Cooperative Research Centre (MPBCRC) announced the expansion of their joint research and development programme. The aim of BASF's seven year, 17 million programme, is to develop high yielding wheat varieties that are also more resistant to fungal diseases and adverse environmental conditions such as drought. As part of the programme, BASF Plant Science is making available its collection of gene candidates for yield increase, drought tolerance and fungal disease resistance.

Global seed market and Monsanto's profit and market share

Shift in global crop production base, transgenic and hybrid seed technologies and changes in targeted plant populations helped in increase in the value of the global proprietary seed market to more than \$17 billion in 2005. The increase is more than 30 per cent over the past five years. According to the latest edition of an extensive global seed market survey completed by The Context Network, the “expanded plantings of oilseed crops and maize (corn) and the continued adoption of biotech seed are two mega trends that are pushing up the value of and importance of proprietary commercial seed globally.”

Monsanto earned \$334 million, or \$1.21 per share in the third quarter, compared with \$47 million, or 17 cents a share, a year earlier. Net sales rose to \$2.35 billion from \$2.04 billion a year earlier. The company cited greater adoption of its genetically modified corn seeds

as a key driver of growth, as well as a research-and-development write-off that weighed down profits a year ago.

Monsanto's American Seeds Inc. subsidiary has bought five regional Corn Belt companies for a total of \$77 million, bringing ASI's share of the U.S. corn seed market to nearly 6 per cent. Dekalb and Asgrow, Monsanto's in-house seed brands, captured an additional 16 per cent of that market last year — following a trend of year-over-year growth that began in 2002 and is expecting to continue this trend in near future also. Adding more than 250 independent regional seed companies that license Monsanto's seed technology, its products encompass more than half of the corn seed purchases made by American farmers. It is developing second-generation biotech corn seeds — hoping to add drought tolerance and improved nitrogen absorption to its stable of seeds genetically modified to withstand destructive pests, or applications of glyphosate herbicide, which Monsanto sells as Roundup. The company also is expanding its hybrid offerings by using molecular analysis to identify and cross-breed high-yielding and better-performing strains.

Bayer signs collaborations in CropSciences

Bayer Innovation GmbH and greenovation Biotech GmbH has signed a licensing and service agreement in the field of protein Glycosylation in plants. Glycosylation is a process by which certain sugar molecules are added to proteins in plants. Understanding and controlling this process in plants can enable researchers to enhance considerably the activity or bioavailability of new proteins produced by plants which can be used for therapeutic purposes

Collectis SA, the national genome engineering company, and Bayer BioScience NV, a Belgian subsidiary of Bayer CropScience have signed an agreement under which Bayer CropScience will have access to Collectis' proprietary custom-made Meganuclease technology for use in plant research and to develop products for use in agriculture. Meganucleases are a proprietary genome engineering technology developed by Collectis allows for highly precise 'editing' to genetic sequences. They consist of sequence-specific endonucleases with large (>18-24 bp) recognition sites. This high specificity ensures Meganucleases can bind and cut at a single point in a chosen genome without the imprecision associated with most other forms of gene modification. Custom-made Meganucleases can be designed for very specific gene

targeting applications. Bayer CropScience will use custom-made Meganucleases in plant research and the development of new products.

Delta and Pine Land Company acquires technology licenses from DuPont

Delta and Pine Land Company has acquired several licenses from DuPont including its Optimum(TM) GAT(TM) herbicide tolerance technology for cotton and soybeans, enabling the Company to enhance its leading product portfolio. In addition to this, the Company has acquired licenses for other products developed by the DuPont biotechnology research programme and certain enabling technologies for use in cotton, soybeans and other crops. Optimum(TM) GAT(TM) trait developed by DuPont will provide farmers with expanded weed control options and will help in optimizing yield. This herbicide tolerance technology makes plants tolerant to both glyphosate and ALS herbicides, including sulfonylureas.

GM debate in Africa

Researchers from Africa found that GM crops are coming in by way of food imports and seed smuggling, even for countries that have taken measures to prevent imports of GM foods, such as Zambia, Angola, Sudan and Benin. In short, the researchers argue that Africa is in danger of becoming the dumping ground for the struggling GM industry and the laboratory for frustrated GM scientists.

South African farmers grew more than 1.2 million acres (480,000 hectares) of biotech corn, soybeans and cotton in 2005. Plantings have significantly increased each year since commercial-scale introduction in 1997, enabling these farmers to increase their incomes by US\$56 million and reduce pesticide applications by 330,000 pounds (150,000 kg)

Mr. Zachary Makanya, in his well-researched paper entitled "12 reasons for Africa to reject GM crops," says that the proponents of GM technology sell a sweet message of GM crops as the second green revolution and the answer to African hunger, but the reality is quite different. A close look at GM crops and the context under which they are developed makes it clear that GM crops have no place in African agriculture.

GMOs are the on the frontline of one of the biggest conflicts of recent years between the science-business community and activist

groups. Many of these feel that, in addition to environmental concerns, with four big multinational companies dominating the global biotech market, the proliferation of patented GMOs will give corporations an unhealthy control over food production. Apart from other problems related to GMOs, researchers say that GM crops will foster dependence on a corporate seed supply. Most GM seed manufacturing companies prohibit farmers from saving their on-farm produced seeds for the next season and from sharing them with their neighbours, relatives and friends. This is imposed through elaborate contracts, agreements, and conditions, which are imposed by the multinational GM seed companies.

There is a study that says that more than 80 per cent of the small-scale farmers in Africa today save their on-farm produced seeds for the next season. Farmers sometimes do this because they do not have enough money to buy new seeds and sometimes because they value their own seeds. Also, seed sharing is a crucial norm in many African communities. The fear is that the introduction of GM seeds will jeopardize these traditional and vital practices. The environmentalists say that seed saving gives farmers life, and seed monopolies rob farmers' life and makes free resources available on farm, a commodity to which farmers are forced to buy every year. This is a shift from biodiversity to monoculture in agriculture, and monoculture increases the risk of crop failure.

A high-level panel of experts warned that Africa might be forced to consume genetically modified food products made from other continents in future if it fails to nature its own research capacity on genetic modification (GM). The Nairobi-based African Agricultural Technology Foundation said that Africa was already too dependent on everything and that taking an early lead in scientific research was one way to ensure it not to become over dependent in the future. This panel needs to recommend what Africa needs to do. We must keep building on what we have already done.

In a conference on food security and the challenges of genetically modified organisms (GMOs) at Harare participants raised pertinent questions on the need for African governments to set clear guidelines on GMOs when it comes to food aid as well as the general consumption of other GMO products. It was suggested that Africa must resist pressure from multinational corporations that continue flooding the agro-business sector with genetically modified organisms (GMOs) until

Africans understand the implications of genetic engineering on biodiversity, the environment, farmers as well as consumers. It is worrying that the majority of people in Africa have become consumers of foods that they have no knowledge of how they were produced and manufactured.

Delegates agreed that the adoption of GMO technology and food aid was not the panacea to hunger in Africa. There are huge risks to the smallholder rural African farmers if they adopt GM-crops. Experience highlights the danger of dependency and monopoly control over GM seed by multinationals. Large multinationals have monopoly through their country agents, subsidiaries and joint-venture exercises on the price of the GM seed eroding the rights of the poor farmers to other alternatives.

New genetically engineered seed, known as “suicide” or “terminator” seeds which were engineered to be sterile, forced poor farmers to repurchase seed each year from the multinationals who have patented these ‘genetic use restriction technologies’. These GM seeds, included “junkie plants” that were dependent on chemicals sold by multinationals to flower, seed or sprout. Farmers using GM crops in South Africa had to sign contracts with Monsanto, a giant GMO corporation, where they agree not to share their seed, only use Monsanto chemicals, buy new seed the following year and agree to set aside 25 per cent of their land as a “refuge” area to control diseases.

Participants felt that GM seed would increase the dependency and indebtedness of smallholder farmers to multinationals eroding the communal rights, which entitled them to traditional crop varieties, which they would share freely without added costs. Critics say that most South Africans are not aware that they are consuming GM foodstuffs due to lack of information, labelling and the monopolistic influences of the multinationals when it comes to media advertising, lobbying government and the funding of stooge NGOs which support the proliferation of GMOs for profit.

Experts fear that genetic engineering in agriculture is likely to have adverse environmental impacts that may affect the ecological basis of food production. They say GM crops will stimulate the growth of “superweeds” and “superbugs” leading to the use of higher doses of chemicals making food supplies more vulnerable to pest damage. Adoption of GM crops may lead to reduced genetic diversity resulting in fewer and fewer types of food crops. This, in turn, may increase the

likelihood of pest and disease epidemics. This calls for the region to develop collective regional policies on food aid that address the array of potential risks in all facets of the technology.

In light of the controversy and public concern over GMOs, it was concluded in the conference that: "It is imperative that an immediate freeze on genetic engineering on food and farming is declared throughout Africa until we have assessed and understood all the implications for consumers, farmers and the environment."

GM products in South Africa

A multi-billion shilling research project by a Kenyan scientist to develop a genetically modified sorghum type has been suspended. The project was expected to come up with a new variety of sorghum to help alleviate hunger in the sub-Saharan Africa. South Africa had expressed concern over the possible contamination of the sorghum varieties native to Africa by the introduction of a genetically modified type.

The government said they could not grant the permits on the basis of information provided and asked for additional information which is going to be provided. Prof Wambugu is optimistic that the project would eventually take off after she addressed the concerns raised by Department of Agriculture's Council for Scientific and Industrial Research, which regulates research in bio-technology in South Africa.

Ghana to have biosafety legislative framework

In a three-day workshop for the media in Accra on the relevance of biotechnology by the United States Agency International for Development (USAID) and Africa Bio (an NGO based in South Africa) it was conveyed that while the bill is awaiting cabinet approval, there is the need to develop and apply a biosafety legislative framework in order to govern the introduction of Genetically Modified Organisms (GMOs) adding that they are becoming increasingly common as the country applies more modern technologies. USAID aims at developing a strategic plan and to create awareness on issues of biotechnology among various stakeholders nationwide. The proven and potential benefits of modern biotechnology are accepted as means of increasing food production efficiency, of ensuring sustainable agriculture and of developing new products from and uses for different plant varieties. Public awareness based on factual information is required to enable consumers to make informed decisions.

ITPGRFA to work on MTAs

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) under the aegis of FAO concluded in November 2001. This legally-binding Treaty covers all plant genetic resources relevant for food and agriculture. It is in harmony with the Convention on Biological Diversity.

The Governing Body of the Treaty, which will be composed of the countries that have ratified it, will set out the conditions for access and benefit-sharing in a "Material Transfer Agreement". Resources may be obtained from the Multilateral System for utilization and conservation in research, breeding and training. When a commercial product is developed using these resources, the Treaty provides for payment of an equitable share of the resulting monetary benefits, if this product may not be used without restriction by others for further research and breeding. If others may use it, payment is voluntary. But it lacked the detailed provisions needed to implement the system.

The tough nuts-and-bolts decisions were bequeathed to the first meeting of the Treaty's Governing Body, the 104 countries that had formally ratified the Treaty when the Governing Body convened in June 2006 in Madrid.

Confounding most observers who thought the issues too technically and politically intractable to resolve, the Governing Body:

- (1) Agreed on the terms of a standard Material Transfer Agreement (sMTA) through which all crop diversity covered by the Treaty's Multilateral System (covering more than 35 of the world's most important crops, plus a number of forages) will be accessed and used. The sMTA calls for a royalty of 1.1 per cent of sales to be paid into a fund when (a) genetic material is accessed from the Treaty's multilateral system, (b) it is incorporated into a product that is a plant genetic resource, such as a new crop variety, (c) the product is commercialized, and (d) there are restrictions, such as patent protection, that limit use of the product for further plant breeding and research. Users can opt for a lower royalty rate (0.5 per cent) if they apply it to all products of a particular crop regardless of whether there are restrictions to further use and regardless of whether multilateral system materials were used in making them. The Treaty's Governing Body will control and dispense funds raised, using them to support crop diversity related programmes.
- (2) Agreed on a financial strategy for implementation of the Treaty and Rules of Procedure for the Governing Body.
- (3) Approved the text

of agreements bringing collections held by the CGIAR under the terms of the Treaty. These collections contain much of the diversity of the world's major crops and are the most widely used collections in the world. (4) Expressed in the final report of the meeting its "unanimous support" for the Global Crop Diversity Trust and approved and signed a Relationship Agreement with the Trust recognizing, uniquely, the Trust's role as an "essential element" of the Treaty's funding strategy in regards to *ex situ* conservation and availability of plant genetic resources.

The Treaty removes the uncertainty of access and the fear of exploitation that prevailed in the 1990s – uncertainty and fear that choked off exchanges of crop diversity and undercut conservation and plant breeding efforts. The first meeting of the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture (Madrid, 12-16 June 2006) highlights the importance of conserving the genetic material. It was said that "crop, forest, animal and fish genetic resources represent an insurance against future changes in production and climatic conditions or in market needs. They are also a source of material for scientific research as well as a cultural and historical part of mankind's heritage." Numerous new and old biotechnologies provide a broad collection of tools that can be applied for a range of different purposes (genetic improvement; disease diagnosis; vaccine development; etc.). They include molecular markers, cryopreservation and reproductive technologies that can be used directly for the characterization and/or conservation of genetic resources for food and agriculture. Characterization of genetic resources goes hand in hand with their conservation since it is fundamental both for understanding what is being conserved and for choosing the genetic resources that should be conserved.

The ability to apply these biotechnologies in developing countries is currently limited by the lack of sufficient funds, human capacity and adequate infrastructure. It can be strengthened through greater collaboration among research institutions in different developing countries and also between industrialized and developing countries.