Ten Years of Biotech Crop Production

Economic, environmental and social benefits

INTRODUCTION

Since the dawn of agriculture 10,000 years ago, almost all of the plants that we now use for food, feed and other purposes have been very extensively modified using various hybridization and mutation techniques. Sophisticated plant breeding programmes resulted in the "Green Revolution", that in the 1970's and 80's intensified agricultural production to such an extent that it contributed significantly to preventing starvation in many parts of the world, while, at the same time permitting large areas of "wilderness" to escape conversion into cropland[1,2]. Genetic modification, a tool for plant breeders developed over the past 30 years, is an important step in the continued evolution of breeding techniques. It enables new crop varieties to be produced with desirable traits not achievable using longer-established methods. However, we should not consider it in isolation, as just being valuable for agriculture: modern biotechnology is also widely used for health-care and industrial applications, and the boundaries between these uses are becoming increasingly blurred.

Economic, environmental and social benefits

ACCELERATING GLOBAL ADOPTION BY FARMERS

GM crop varieties were grown on over 80 million hectares of land in 2004, only nine years after they were first commercialised[3]. Eight and a half million of the world's farmers in 17 countries are choosing them because of the benefits they deliver: easier management, better pest control, reduced spraying, safety for non-target species and more consistent yields that provide a more secure food supply. Many citizens of Europe are unaware of this, because at this time the immediate and direct benefits lie predominantly with the growers.

BENEFITING DEVELOPING WORLD FARMERS

Small-scale farmers in the developing world have at least as much to gain as larger-scale commercial growers. There are still over 800 million people who are chronically undernourished, and many others whose diet is poor. Genetic modification can, and is already making a significant contribution towards alleviating this problem by improving the food security of subsistence farmers and allowing some of them to grow a surplus to trade and make a return. Today, 90% of farmers planting GM crops are resource-poor farmers from developing countries, whose increased incomes from GM crops is helping in the alleviation of poverty[3].

In the developing world, some GM crops are already contributing to improving the quality of life through yield enhancements and a healthier farming environment[3,4]. White maize for food resistant to insect pests, grown by commercial and subsistence farmers in South Africa, provides greater food security through improved yields while allowing a reduction in pest control spraying[5]. Insect resistant cotton in the same region provides a direct cost benefit for its growers through more consistent and higher yields, savings in the form of lower requirements for pesticide but also reduced requirements for water and labour[6], a benefit experienced particularly by women and children in rural farming areas. In China, similar benefits are experienced by 7 million farmers growing insect-resistant cotton on plots of one hectare or less . Sorghum and cassava, the staple foods of more than half a billion Africans, are being nutritionally improved to give increased levels of protein, vitamins and minerals. This work is supported by the Gates Foundation as part of their Grand Challenges in Global Health initiative[7]. Disease- and pest-resistant plants are also being developed, with drought tolerance being a longer-term goal.

SOCIETAL AND ENVIRONMENTAL GAINS

Meanwhile, the benefits experienced by larger-scale farmers in both industrialised nations and lesser developed countries are already considerable. Recent research[4] shows that in the first nine years of GM crop cultivation:

- Global net farm income increased by $27 billion (€ 23 billion);
- The environmental footprint of farming was reduced by 14%;
- This includes a reduction in carbon dioxide emissions in 2004 equivalent to taking nearly five million cars off the road for a year. Reduced-till agriculture – made much easier by the use of GM herbicide-tolerant crops – means healthier soil, with reduced erosion and far less carbon dioxide release; and,
- Pesticide use fell by over 170,000 tonnes. In 2004 alone this was over 40,000 tonnes, equivalent to more than 30% of total active ingredients used on European arable crops. Because less spraying means fewer tractor passes, this also contributes to lower CO_2 emissions.

Insect resistant maize also has an additional health benefit; because fewer insect damaged leaves and cobs result in much less infection by fungal moulds, there is also a marked reduction in the presence naturally occurring toxins (called fumonisins) produced by these fungi, toxins that are know health risks to animals and that are associated with human health problems[8].

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GAINS FOR EUROPEAN FARMERS

Even though farm experience in Europe is limited, there is also clear evidence here of benefits from insect resistant and herbicide tolerant crops. Spain has been growing insect resistant maize since 1998 and a total welfare gain of € 15.5 million was estimated during this six year period[9]. In the Rhine Valley, the use of insect resistant maize between 1998 and 2002 resulted in an average increase in profit for the farmer of 84 – 93 €/ha compared to insecticide application or biological control (Trichogramma)[10].

In 2005 there were plantings of GM insect resistant maize in five EU countries: Spain (the largest producer with an estimated 55,000 hectares); Czech Republic; France; Germany and Portugal. Even so, the overall area of GM crops grown in the European Union remains small and few EU farmers are experiencing the benefits of this technology. Yet the EU imports considerable quantities of approved GM animal feed ingredients from the Americas. Twenty nine million tonnes of soy meal were consumed in 2004/05, mostly un-segregated EU approved GM and non-GM material from the Americas[11] and some 6 million tonnes of maize and maize gluten feed, some from EU approved GM varieties, are imported into the EU on an annual basis.

POSITIVE HEALTH BENEFITS

While the benefits of today's biotechnology crops are most apparent to growers, increasingly, we will see crops with direct consumer health benefits. Oilseeds with high levels of omega-3 fatty acids for example, for improved cardio-vascular health and brain development[12] that are already being tested in research trials, or tomatoes with enhanced levels of antioxidants that help to protect against certain cancers[13]. There is also advanced work underway to improve oilseed crops that will produce healthier oils, for example, increasing levels of oleic acid (a mono-unsaturated fatty acid), to increase levels of beta-carotene to improve diets deficient in vitamin A, to increase vitamin E and enhanced levels of minerals[14,15,16].

BIO-BASED ECONOMIES CONTRIBUTING TO THE LISBON AGENDA

Moving beyond food, the benefits of agricultural biotechnology to European society can be even more significant. Growing modified crops as sources of renewable raw materials (converted to valuable end products by further bio-processing) makes the sustainable bio-based economy a reality[17]. Instead of relying on fossil fuels for energy and as a source of chemicals, we will harvest plants and process them with enzymes. Bio-fuels and bio-plastics are already a commercial reality. Using plant genomics and biotechnology to optimize plants to produce these renewable feeder stocks for the industrial biotechnology sector will play an increasingly important role. An example is using oilseed crops to produce biodiesels that contribute to European environmental sustainability.

Summary

As crops for non-food uses become more widely grown, so will the demand for agricultural land increase. Instead of having a surplus of cropland as at present, agricultural land will be at a premium, and it will be essential to maximise crop yields to avoid encroaching on unspoilt countryside. This takes us full circle back to those traits so important to the growers, traits that are already providing efficient production with reduced environmental footprints. Here too there are exciting developments that can help to achieve sustainable production in an environmentally responsible way. Good progress is being made in modifying crop plants that will utilise water more efficiently and are tolerant to drought conditions[18], this will benefit farmers growing crops in arid areas and will lessen irrigation needs. Research into developing plants that are more efficient nitrogen users[19] is also well advanced, this will enable the use of less nitrogen fertilizers thus helping to lower the leaching of nitrogen into groundwater supplies. These two "input" traits, primarily benefiting growers, would provide very substantial environmental and social benefits.

FOR MORE INFORMATION:

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