Chapter 3

GM Crops and Africa

3.1 Plant Biotechnology and GM crops in Africa

Africa missed the green revolution, which helped Asia and Latin America achieve self-sufficiency in food production. The problems of food shortage, a burdened economy, political instability and poor environmental sustainability have contributed to Africa lagging behind in reaping the benefits of the "Green revolution" and it might possibly also miss the "Gene Revolution" (Wambugu, 1999; Woodward *et al.*, 1999)

Biotechnology can make enormous impacts on making intensive agriculture sustainable. Currently, there is misused application of pesticides and poor management of fertilizer over very large areas of intensive agriculture in Africa. With dwindling arable land, the challenge is also to increase yield on current fields and to control pests and diseases that account for about 30% yield losses and to use fertilization more efficiently. Creating plants that carry internal resistance, either through conventional breeding or through application of transgenic approaches to intransigent problems are clearly the most environmentally safe and economically attractive approach. In general, the potential benefits of genetically modified transgenic plants are more crucial to developing nations, whose populations are growing faster than those of developed countries (Keshun, 1999).

There is increasing evidence that genetic modification of plants will contribute to improved agriculture and the quality of life in Africa by producing crops more efficiently and producing healthier food, which is more nutritious, will keep much longer in storage and allows better transport (Flavell, 1999; Bundell, 2000). Africa's crop production per unit area of land is for example the lowest in the world. The average maize yield in Africa is about 1.7 tons per hectare compared to the global average of 4 tons per hectare.

There is a clear potential to already double African crop production by controlling viral diseases, such as maize streak virus, using genetically modified plants (Wambugu, 1999) and improving photosynthesis to increase crop yield (Miflin, 1999). In particular, the use of genetically modified plants might help farmers in Africa to produce more and better food due to new crop varieties that might be drought-tolerant, resistant to insects and weeds and able to use fertilizers more efficiently in Africa with its generally poor soil quality.

One of the most compelling motivations for genetic engineering of plants in Africa is to improve resistance to pest and diseases. The access to novel sources of genetic resistance will provide the opportunity to reduce our dependence on chemical sprays for their control. The use of Bt (*Bacillus thuringiensis*) crop varieties has dramatically reduced the amount of chemical pesticides applied to cotton. In the US, farmers used 450,000 kg less pesticide on Bt cotton than would have been used on conventional varieties in 1998 alone. Further benefits also applicable to Africa include modification of oil, starch and protein to provide sustainable supplies of raw materials for food (Dale, 2000). Recently, sweet potato, a developing country crop, was engineered for improved protein quality (Moffat, 1998). The benefits of genetically engineered plants are shown in Figure 3.1.

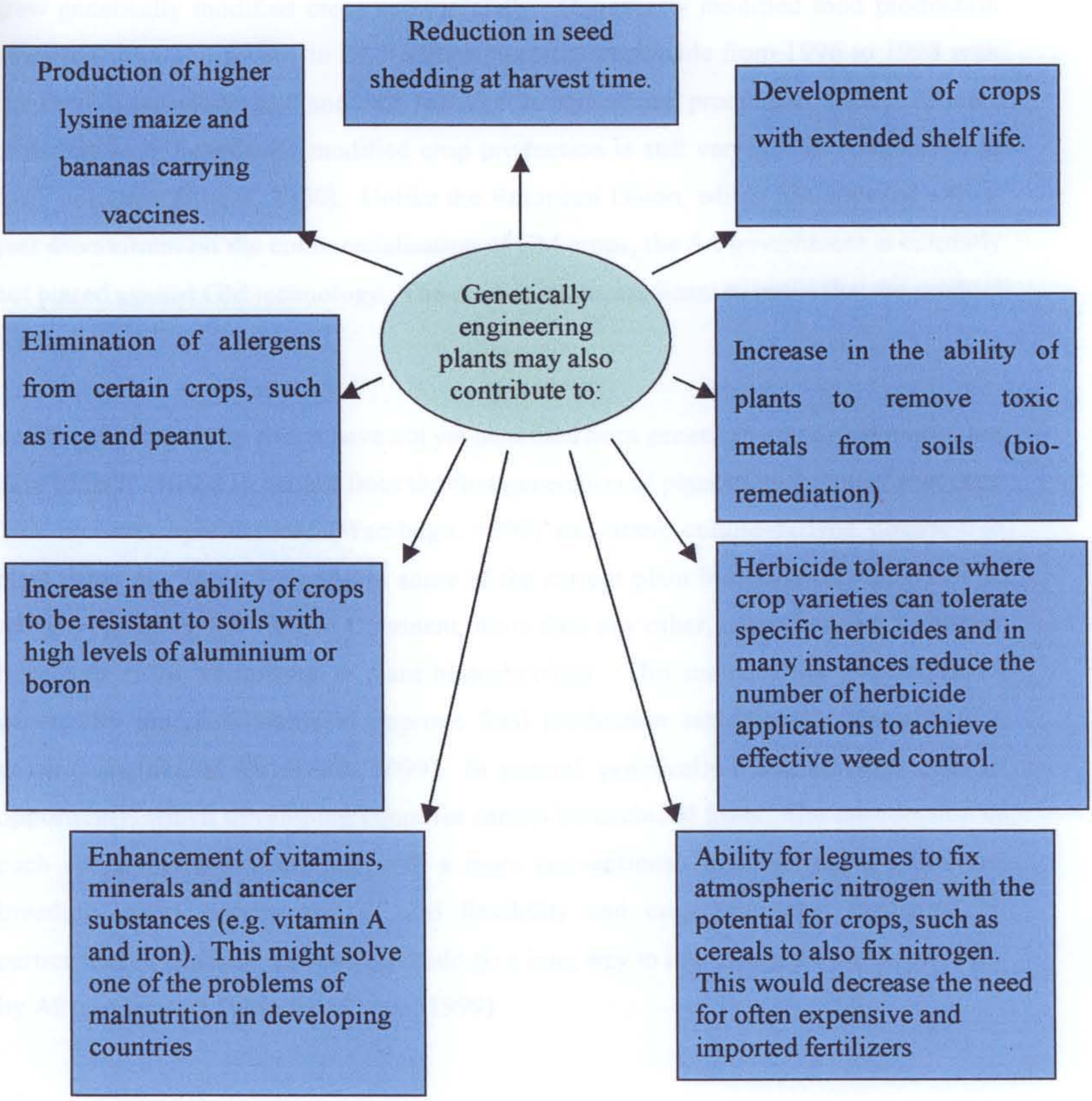

Figure 3.1 Benefits of genetically engineered plant (Skerritt, 2000; Dale, 2000; Feed Magazine, 2000).

In 2000, eight industrialized countries and 5 developing countries including South Africa grew genetically modified crops commercially. Genetically modified food production increased from 1.6 million to 28.3 million hectares worldwide from 1996 to 1998 with measurable economic gain and with sustainable agricultural production. South Africa's contribution in genetically modified crop production is still very low in comparison to other countries (James, 2000). Unlike the European Union, which has imposed a five-year moratorium on the commercialisation of GM crops, the SA government is currently not biased against GM technology. The onus is on the applicant to prove that the product is safe.

Small-scale farmers in Africa have not yet benefited from genetically modified plants, but have already started to benefit from the first generation of plant biotechnology products. This includes hybrid seeds (Wambugu, 1999) and tissue culture-derived disease-free plant material. Table 3.1 outlines some of the current plant biotechnology activities in Africa. However, the African Continent, more than any other, urgently needs to further benefit from the advantages in plant biotechnology. This includes the optimal use of genetically modified plants to improve food production satisfying the demand of a growing population (Anderson, 1999). In general, genetically modified crops offer an opportunity, which developing countries cannot be excluded from. The introduction of such crops, perhaps combined with a more conventional approach using traditional breeding, good management of soil flexibility and crop protection facilitated by participatory extension approaches could go a long way to improving the yields obtained by African farmers (Woodward *et al.*, 1999).

Table 3.1 Current research in plant biotechnology and GM crops in Africa (Brink *et al*., 1998).

Region	**Country**	**Area of research**
North Africa	Egypt	○ Genetic engineering of potatoes, maize and tomatoes
	Morocco	○ Micro propagation of forest trees, date palms ○ Development of disease-free and stress-tolerant plants
	Tunisia	○ Stress-tolerant and disease-resistant plants ○ Micro propagation of date palm, prunes rootstocks and citrus
West Africa	Burkina Faso	○ Biological nitrogen fixation, production of legumes inoculants, medicinal plants
	Cameroon	○ Plant tissue culture ○ Micro propagation of banana
	Gabon	○ Large production of virus-free banana, plantain and cassava plantlets
	Nigeria	○ Micro propagation of cassava, yam and banana ○ DNA fingerprinting of cassava and banana
East Africa	Burundi	○ Micro propagation of ornamental plants-orchids, tissue culture of medicinal plants
	Congo	○ *In vitro* culture of spinach
	Kenya	○ Production of disease-free plants and micro propagation of bananas, potatoes, sweet potato, sugar cane, citrus, papaya
Southern Africa	Malawi	○ Micro propagation of bananas, trees, tropical woody species, tea
	South Africa	○ Genetic engineering of cereals, vegetables and ornamentals, fruits ○ Molecular marker applications
	Zimbabwe	○ Genetic engineering of maize, sorghum and tobacco ○ Micro propagation of cassava, potato and sweet potato ○ Marker-assisted selection
	Zambia	○ Micro propagation of cassava, potato and banana

3.2 GM crops and South Africa

3.2.1 Maize

The South African government gave permission to produce GM crops for human consumption and the first crops were harvested in June/July 2002 (Bissekerm, 2001; Ferreira, 2002). According to GM registrar Shadrack Moephuli, the Bt white maize constitute only 1% of the local market which come from 100 000 ha of farm land scattered around the country. Seed breeder Arthur Schroeder from Pannar believes that GM maize will reach both livestock and people especially the disadvantaged black populations, as maize is their staple food. Genetically engineered yellow Bt maize (Yieldgard) already entered the human food chain in the form of corn flakes and it is often fed to animals (Ferreira, 2002)

3.2.2 Cotton

Cotton cultivation is the main source of income in the Makhathini area in South Africa. The majority of the cotton farmers are smallholders with an average farm size of 1 to 3 ha. Cotton plants account for 90% of the cultivated land. The remaining area is used for cultivating other crops like maize and beans. Insect pests are the main obstacles to increase production. The bollworm complex, namely American bollworm (*Helicoverpa armigera*), Red bollworm (*Diaparopsis castanaea*) and Spiny bollworm (*Erias* spp) are the most damaging insect pests (Ismael *et al.*, 2002).

Genetically modified Bt cotton (Bollgard^{TM}) has been planted as a commercial product since 1997/1998 (Kirsten and Gouse, 2002) and 75 farmers started using the Bt technology with only 80 ha. farms. In 2001/2002, 2976 farmers have decided to use the Bt technology and 5670 ha of land is currently being used for Bt crops (Figure 3.2). This corresponds to about 5% of South Africa's cotton crop (Kirsten and Gouse, 2002). The rate of adoption of Bt crop by small-scale farmers is an indication of the socio-economic benefit of Bt crops in South Africa.

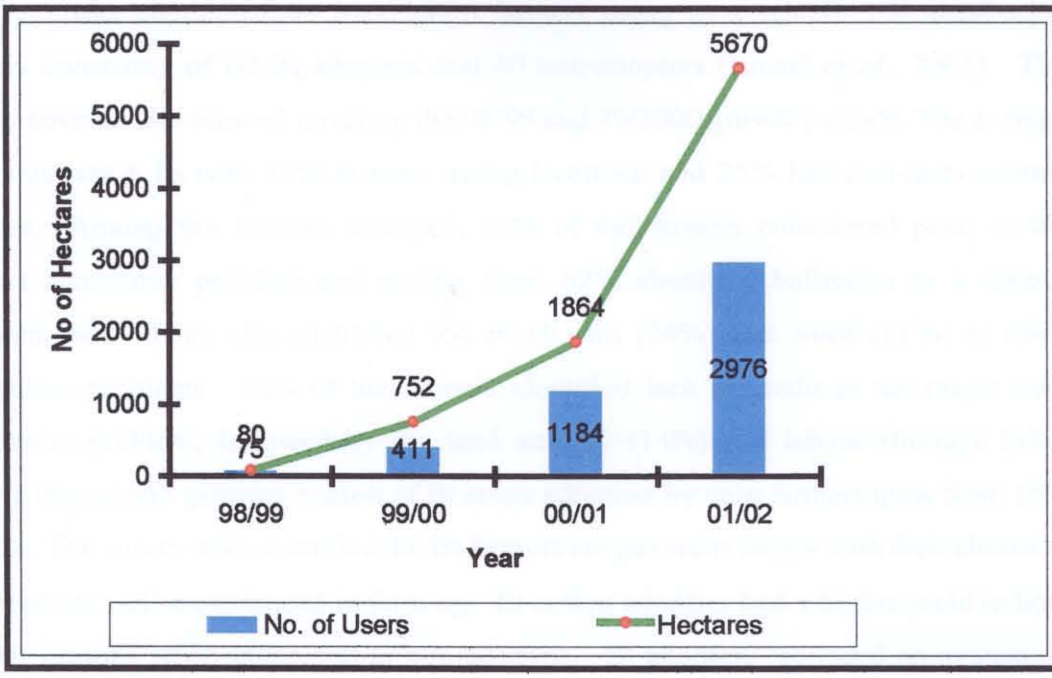

Figure 3.2 Adoption of the Bt technology by small-scale farmers (ISAAA news, 2002).

Makhathini farmers were among the pioneers who tried GM crops in South Africa. They were sceptical when asked not to use chemicals anymore for insect control. Due to the economic hardships, they were willing to try any new technology to make the crop profitable. "Mr. Buthelezi, spokesperson of the Makhathini farmers, testify that the new GM cotton helps them to increase their farm yields substantially and managed to increase the farm to about twice its original size. The GMO Act of 1997 facilitated the commercialisation of GM crops, mainly the insect resistant Bt crops in South Africa. Bt. Cotton is planted in Northern Province, Kwazulu Natal and in the Free State. 1530 commercial farmers and 3000 small-scale farmers planted approximately 100,000 ha in dry land conditions. It is estimated that 95% of the Makhathini farmers will ultimately adopt GM cotton. The main reason for the adoption of cotton is that it is a cash crop and requires less intensive management when compared to other crops in the area, such as beans and maize, and can also survive fluctuating weather (Associated Press Philadelphia, 2001).

A survey was conducted on Makhathini farmers using as a sample 100 small-scale farmers consisting of 60 Bt adopters and 40 non-adopters (Ismael *et al.*, 2001). The survey covered two seasons covering the 98/99 and 99/2000 growth periods. The average farm size was 6 ha with 73% farmers owing livestock and 25% had non-farm income sources. Among the farmers surveyed, 57% of the farmers considered pests as the biggest agronomic problem and among them 62% identified bollworm as a serious problem pest. They also identified too much rain (24%) and weed (11%) as other agronomic problems. 82% of the farmers identified lack of credit as the major non-agronomic problem, followed by the land scarcity (14%) and labour shortage (4%). During the second growing season of Bt crops adoption by crop farmers grew from 19% to 65%. The survey also identified the Bt farmers are generally happy with their choice of crop and are well experienced in farming. Bt cotton adopters had a higher yield in both growth seasons when compared to non-adopters. Bt adopters produced an average of 47kg of cotton per kg of seed while non-adopters produced an average of 30 kg. The average cost of seed for Bt crops was R 206/ha while non-Bt crop farmers spent an average of 123/ha on seeds. At the same period Bt adopters spent an average of R 88/ha on chemical spray compared to the R131/ha by non-Bt farmers. Average gross margin of Bt crop farmers was R 729 compared to R 609 for non-adopters. The survey provided a considerable cause for cautious optimism regarding a higher yield, lower spraying cost, labour and saving time, thus giving hope for optimism regarding the impact of Bt cotton (Associated Press Philadelphia, 2001).