CHAPTER 6

CONCLUSION

6.1 INTRODUCTION

This chapter briefly summarises the findings of this dissertation and how it has attempted to meet the objectives specified in Chapter 1. The conclusion includes a discussion of some of the shortcomings of the study, indicates some further research opportunities, and discusses some issues that might determine the future of agricultural biotechnology in South Africa and other neighbouring African countries.

6.2 SUMMARY

Agricultural biotechnology is not a new phenomenon. Man has been manipulating living organisms to solve problems and improve his way of life for millennia. Genetic engineering in agricultural biotechnology however has brought a whole new dimension to the development of products and operations. These transgenic techniques and the crops they make possible have caused proponents of and scientists in the field of agricultural biotechnology to envisage a world without hunger and malnutrition. Product possibilities cause profit driven multinational biotech companies to invest billions of dollars in research and development and it is partly also these possibilities (seen as threats to the environment and mankind), as well as the profit driven endeavours of these multinational companies that cause an international outcry amongst certain consumers and anti-biotech advocacy groups. Different groups support and oppose genetically modified crops for different reasons, motivated by their different perceptions, ideologies and constituency.

South Africa has been involved with biotechnology research and development for approximately 25 years through governmental, parastatal and academic institutions. Due to this strong scientific background, role-players were able to competently and efficiently develop and implement regulatory guidelines when the biosafety process was kick-started in 1989. South Africa currently has a well-established and accredited regulatory system and is in a position to make informed decisions regarding genetically modified crops and their uses. Communication of risks and benefits to consumers on the other hand has been slow, leaving them vulnerable to exploitation by advocacy groups.

The only genetically modified crops that have been approved for commercial production in South Africa are herbicide-tolerant soya-beans, cotton and maize and insect-resistant cotton and maize. Bt cotton has been produced since the 1997/1998 season and Bt yellow maize since the 1998/1999 season. Herbicide tolerant cotton has been made available for commercial production in the 2001/2002 season while only a limited quantity of herbicide tolerant soya-bean seed has been released. Bt white maize was introduced in the 2001/2002 season and a limited quantity of herbicide tolerant maize seed will be commercially released for the 2003/2004 season. Cotton seed containing the Roundup Ready – Bt combination has not yet been released commercially.

Agricultural biotechnology is the most rapidly adopted agricultural technology in history and it is said that the impressive adoption rates of these crops are evidence of their perceived value to farmers. South African large-scale cotton farmers, for whom cotton production is usually not the dominant farming activity, indicated better crop and risk management, pesticide saving and peace of mind as the main benefits. Small-scale resource poor cotton farmers in comparison indicated higher yield and saving on insecticides as the major benefits. Large-scale commercial yellow maize farmers indicated higher yields, better pest control, easier crop management and peace of mind as the main benefits, while small-scale farmers who depend on their harvest for food security, indicated higher yield and better quality as the major benefits. It is thus clear that different benefits appeal to different farmer groups and these benefits have been the reasons that farmers have adopted the new technology. Farmers indicated the cost of the seed and the additional technology fee as the major disadvantage of Bt cotton and maize. A high percentage of large-scale cotton farmers who planted Bt cotton noticed environmental benefits through increased populations of beneficial insects in their Bt cotton fields.

The direct costs and benefits associated with Bt crop adoption, as indicated by small- and large-scale maize and cotton farmers, were quantified and expressed in monetary terms. For both large-and small-scale cotton farmers as well as large-scale maize farmers, the increased seed cost (higher seed cost and / or an additional technology fee) were partly offset by a decrease in the need for chemical pesticide application, but mainly by a significant increase in yield due to better pest control. Large- and small-scale Bt cotton farmers as well as large-scale Bt yellow maize farmers enjoyed a higher income per hectare with insect resistant varieties than with conventional varieties. Early indications suggest that small-scale maize farmers are also able to benefit from Bt technology – predominantly through increased yield.

The additional economic rent, income or increase in welfare created by the introduction of Bt cotton in South Africa is distributed between four major role-players: The innovator or biotech company, the germplasm or seed supplier, the farmer as cotton producer and the cotton gins as primary consumer of seed cotton. Despite facing two monopolists (Monsanto and Delta & Pineland) and a dormant monopsonist (Clark Cotton), cotton farmers receive the lion's share of the additional income created through the introduction of the new technology. It seems in fact that it is currently only this additional welfare that enables South African farmers to survive under the depressed cotton market conditions - in all probability caused by subsidised overproduction of large cotton producing countries.

6.3 SHORT-COMINGS OF THIS DISSERTATION

This study focussed mainly on economic farm-level impacts of insect resistant cotton and maize in South Africa. Even though the yield advantage and saving on chemical insecticides were quantified, this dissertation was not able to quantify the possible economic benefits of savings on insecticide application labour, and fuel cost and mechanical hours on large-scale farms. Another important issue that warrants in-depth research concerns the environmental effects of Bt cotton and maize adoption. Reduced insecticide spraying may increase populations of beneficial insects and improve the environment as a whole, but the possibility of gene flow, resistance development and the appearance of new problem insects particularly under small-scale conditions needs to be considered.

This study focussed on only one or two production seasons and due to the novelty of the technology, only a limited number of farmers were surveyed. In order to increase the significance of research findings a larger group of farmers' Bt production experiences should be followed for a number of seasons. By doing this, the economic consequences, socio-economic effects and performance of the new technology can be measured under different climatic conditions and insect pressures.

6.4 FUTURE RESEARCH OPPORTUNITIES

Future research on the performance of insect resistant cotton and herbicide tolerant cotton produced by small-scale farmers is currently being hampered by the situation on the Makhathini Flats where many small cotton farmers are located: Without production finance few farmers are able to sustainably produce cotton and the Flats has been plagued by some severe weather conditions the last couple of seasons that also decreases the number of researchable farmers. With Bt adoption on the Flats nearing 100% it would be interesting to see how many farmers adopt RR cotton. It is hypothesised that insect control is more problematic for small-scale farmers as weeds can be relatively inexpensively controlled by hired and family labour. It is possible that the stacked gene technology, when released, could be adopted quite readily.

Up to now no comprehensive, independent study has looked at economic, environmental or socio-economic (focused on labour) effects of herbicide tolerant soya-beans in South Africa. South Africa's domestic demand for soya-beans has increased the last number of years due to impressive growth in the poultry industry but approximately 70% of the domestic soya-bean demand still had to be imported. In dry hot seasons soya-beans struggle in South Africa and profit margins are small. It can be expected that a technology that decreases input costs will be welcomed.

The approval and release of insect resistant maize also introduced a number of other researchable topics. South Africa is the first country in the world where an agricultural biotechnology application has been introduced as staple food i.e. white maize. Some of the related topics include:

- The pertinence of Bt maize for small-scale farmers
- Consumer acceptance of Bt maize – subsistence farmers vs. other consumers
- Impact of Bt maize on export markets
- GM and Non-GM separation, costs, effectiveness and profitability

Impacts of Bt white maize as produced under small-scale subsistent conditions will be studied in a Rockefeller Foundation funded research project by the Department of Agricultural Economics, Extension and Rural Development at the University of Pretoria, in collaboration with the Promec unit at the Medical Research Council of South Africa and other overseas based research partners. The main objective of this study, that kicks off during the 2004/2005 season, is to investigate the link between esophageal cancer (EC), the mycotoxin fumonisin and maize produced by subsistence farmers in certain areas in South Africa. Stalk borers are periodically a major problem in some regions of South Africa and are considered to be a vector for both fumonisin and aflatoxin producing fungi. High levels of fumonisin have been shown to occur in homegrown maize consumed as the staple diet by people at high risk for EC in the former Transkei region in the Eastern Cape province of South Africa (Rheeder et al 1992). We hypothesise that if Bt technology can reduce the damage caused by stalk borers, then the hazardous fumonisin levels will also be reduced.

6.5 THE FUTURE OF AGRICULTURAL BIOTECHNOLOGY IN AFRICA

It is clear that both small and large-scale maize and cotton farmers in South Africa are benefiting from the use of genetically modified, in this case insect resistant, crops. It is worth restating that GM technology is no panacea, cure all, universal remedy or silver bullet. As was stated in Chapter 1, it is merely an agricultural tool like applying fertiliser and making use of irrigation. It is a tool to increase efficiency, decrease production risk and to enhance the ability of the farmer to manage his / her crop in the most profitable or food secure way.

Africa is awakening to the possibilities of agricultural biotechnology. Agricultural biotechnology research and development was, in some cases, initiated in a number of African countries by the agricultural research centres known as the "Future Harvest Centres". These centres include (amongst others) the International Maize and Wheat Improvement Centre (CIMMYT) in Malawi, Kenya, Ethiopia and Zimbabwe, the International Institute for Tropical Agriculture (IITA) in Nigeria and the International Livestock Research Institute in Kenya and Ethiopia. These are centres of the Consultative Group in International Agricultural Research (GGIAR) with the mandate to serve as a bridge between the advanced science and technology developed and available in developed countries and the specific needs of developing countries. A number of African countries are currently collectively developing biotech and biosafety legislation, policies and strategies. This process is driven partly through capacity built in the Consultative Group (CG) centres and through regional cooperation lead by (amongst others) the International Food Policy Research Institute (IFPRI), the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), the Forum for Agricultural research in Africa (FARA), Agricultural Biotechnology Support Projects (ABSP I +II) and the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). Through these "Future Harvest Centres" a number of developing country and region specific agricultural biotechnology applications are being developed in local food crops like cassava, cowpeas and bananas. Some of these research and development projects are marked by private and public cooperation.

It is unlikely that the introduction and adoption of privately developed transgenic crops in other African countries will happen as quickly and as smoothly as in South Africa. Unlike most African countries, South Africa began with both public and private biotechnology research capacity and regulatory structures in place that could be adjusted to GM crop evaluation and regulation. If there is one thing the South African Makhathini experience can teach us it is that despite the presence of a new, on-farm profit boosting technology, the institutional structures on both input and output sides play an important role in the success and sustainability of small-scale agriculture. Without access to credit, fertiliser, insecticides or other inputs or necessary extension services and information, agriculture will struggle despite the presence of a "new type of seed". Likewise on the output side; if the crop is meant to be sold and not consumed on-farm there has to be transportation, marketing and the rest of the supply chain. There are many African countries where these basic input and output institutions and markets are not in place or not functioning to the benefit of farmers. Ineffective input and output markets and institutions will hamper the introduction, adoption and sustainable use of transgenic crops in Africa.