Fourteen years of GM crops in South Africa: Lessons for the rest of southern Africa

By Marnus Gouse
Department of Agricultural Economics, Extension and Rural Development – University of Pretoria

SACAU Policy Conference
16-18 May 2011
"GMOs in agricultural development – Perspectives of farmers in southern Africa"

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Outline

- Background and GM crops in SA
- Adoption of GM crops by SA farmers
- Large-scale commercial farmers
- Smallholder farmers
  - Bt cotton
  - Bt and HT maize
- Lessons

History

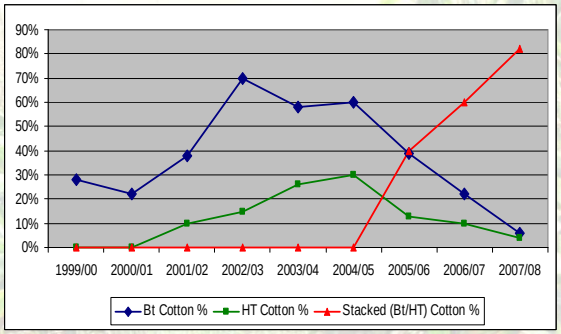
- Application to do field trails by D&PL kick-started SA biosafety process – 1989
- South African Committee for Genetic Experimentation (SAGENE) formed in 1979 monitored and advised NDA on responsible development and use of modern biotechnology.
- 1995 Bt cotton seed multiplication for US market
- Approval of Bt cotton and maize under SAGENE's guidelines and procedures in 1997/98 and 1998/99.
- South Africa's GMO Act 15 of 1997 came into effect Dec 1999 - Amended a number of times

GM crops in SA

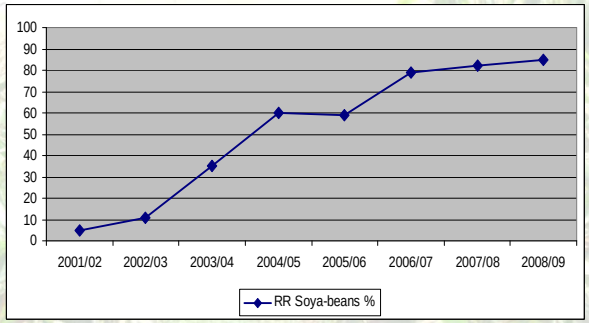
Crops and events approved for commercial release in SA:

1997/98 insect resistant (Bt) cotton
1998/99 Bt maize - - - Bt white maize first planted in 2001/02
2001/02 herbicide tolerant (HT) cotton
2003/04 HT maize
2005/06 Stacked cotton (Bt + HT)
2007/08 Stacked maize (Bt + HT)
2010 Bollgard II cotton (2 Bt genes)

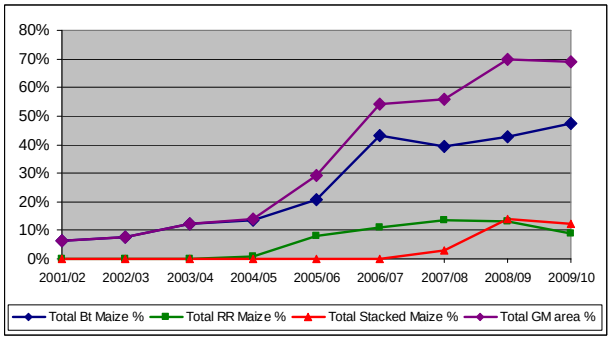
Adoption of GM cotton in SA: % area



Adoption of GM (HT) soy beans in SA: % area



Adoption of GM maize in SA: % area



Currently:

GM cotton >90% of total cotton area
GM soy beans > 80% of total soy bean area
GM maize > 69% of total maize area
74% of white maize area
61% of yellow maize area

Study by Brookes and Barfoot (2010)

Increase in farm income for South African adopters:

- **HT soy beans 2001-2008 = 4.13 million US$ through saving on weed control inputs**
- **Bt cotton 1998-2008 = 21 million US$ through saving on insecticides and more effective bollworm control (yield increase)**
- **Bt maize 2000-2008 = 476 million US$ through yield increase due to more effective stem borer control**

But what about South African smallholder farmers????

Two case studies:

- Bt cotton on Makhathini Flats
- Bt and HT maize in Hlabisa

Research areas

Selected household and livelihood info (Hlabisa)

Gender of household head	Male 48% Female 52%
Age of household head	46% between 46 - 59 26% between 60 - 65 16% older than 65
Education of household head	15% no education 43% up to 3 years 34% more than 3 but less than 6 years
Average household size Average number of children <15 Average number of people 16-59 Average number of people >60	8.87 people 3.5 children 4.7 people 0.6 people
Main household income source	15% permanent employment 64% government pension 9% other government grants
Average maize plot size Min Max	0.47 hectare 0.12 hectare 1.6 hectare

Cotton plots are larger 1-2 ha

Bt cotton on Makhatini Flats

Bt cotton adoption

1997 – 4 farmers
1998 – 75 farmers
1999 – 411 farmers
2000 – 1184 farmers
2001 – about 3200 farmers (90%)

Why? / How?

- Success of first planters
- Credit from VUNISA and Land Bank similar to before Bt

Vunisa recommended Bt cotton to farmers in order to:

- Increase return on investment
- Decrease need for insecticides (credit)
- Decrease risk on investment

Farm-level impacts of adoption:

Yield:

All peer reviewed studies found yield increases (more effective bollworm control) with Bt cotton:

UP and Reading - 16% and 40% (1998/9-1999/0);
Bennett et al, (2006) - 63% and 56% for 1998-2000;
CIRAD + UP (Fok et al, 2007) - 23% for 2002/03

Yield increases high because farmers were unable to control bollworms effectively:

Shankar and Thirtle (2005) showed average insecticide application on Flats is less that 50% of the optimal.

Insecticide application:

Farmers saved on 3 / 4 / 5 pyrethroid sprays

Saving on insecticide chemicals not large enough to offset additional techno fee.

Labour aspect of insecticide application – spraying , water fetching

Seed cost:

- **Bt seed is more expensive due to additional technology fee:**

In 2008/09 seed cost = R430.50 / 25kg

Additional technology fee for Bt = R785

Studies showed that:

Higher yields + saving on insecticides + pest control labour saving – techno fee – more harvesting labour

= Increased gross margin

Did increased gross margins lead to increased welfare, development of rural area, development of local industry?

Yes farm income did increase and farmers where better off.

But no, Bt adoption did not lead to sustained development.

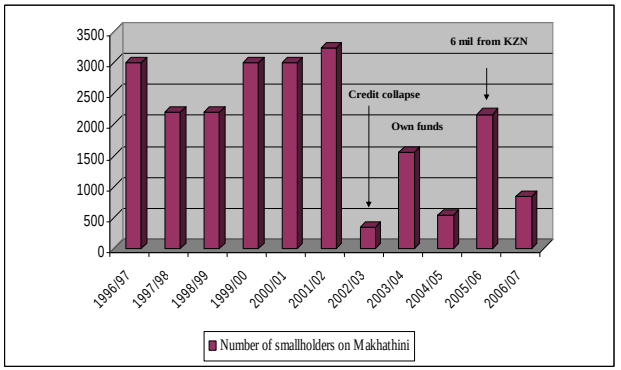
Why? Institutional failure

For >10 years Vunisa was sole input supplier and cotton buyer on the Flats.
Supplied credit in collaboration with Land Bank
Cotton crop is collateral for production loan – farmers do not own land
Loan recovery rate of close to 90% for number of years

BUT: In 2001/02 MCC open gin on Flats
Farmers default on loans due to adverse weather conditions and adverse selection (better prices)

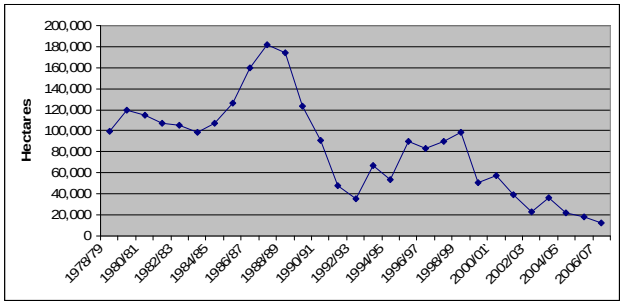
2002/03 No input credit available – only farmers who could fund input continued

Makhathini cotton producer numbers



MCC closed down - unable to source enough cotton for gin at prevailing prices

SA cotton production (ha)



Current situation:

- Low world cotton price – higher relative prices for competing crops
- Low cotton production levels in SA, but farmers still plant GM

Bt and HT maize research

Maize production season	Number of research sites	Research focus
2001/02	6	Does it work? Farm-level effects
2002/03	2	Does it work? Farm-level effects
2003/04	2	Farm-level and health effects
2004/05	2	Farm-level and health effects + focus on labour
2005/06	2	Farm-level and health effects + focus on labour
2006/07	3	Farm-level and health effects + focus on labour
2007/08	3	Farm-level and health effects + focus on labour
2009/10	3	Farm-level and health effects + focus on labour + risk perceptions

Bt maize

Adoption of an insect resistant (Bt) crop has mainly three direct farm-level impacts:

- Possible decrease in input cost through savings on insecticide chemicals and application costs
- Possible increase in yield due to better pest management (stalk / stem borer control)
- Increase in input cost through a higher seed price - an additional technology fee. (Bt is 23-30% more expensive due to technology fee)

Stem borer pressure and insecticide use

- ***Busseola fusca*** **and** ***Chilo partellus*** **(borers) are the main maize pests in SA.**
- **Generally excepted that African stem borer (*Busseola*) reduces SA maize crops by 10% (Annecke & Moran, 1982).**

Hlabisa farmers indicated that stem borer is main pest

But insecticide application to control stem borers are limited:

2003/04 9%, 2006/07 8% applied insecticide. Other seasons almost no one

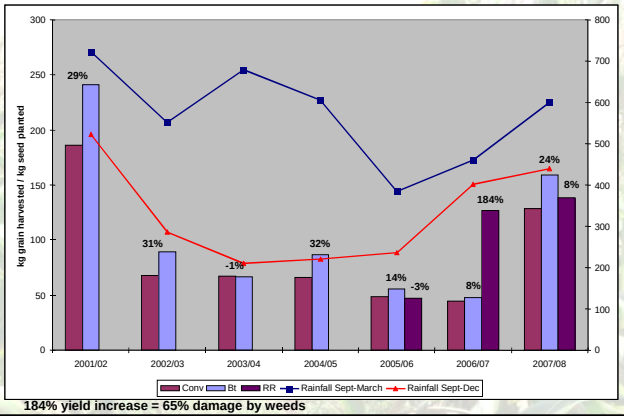
Insecticide saving benefit?

Small, due to low insecticide application level
Linked to perception of limited damage

Labour saving benefit = minimal

Yield comparison for Hlabisa farmers planting conventional, Bt and HT maize

for the seven seasons 2001/02 to 2007/08



184% yield increase = 65% damage by weeds

<u>Food security impact:</u>

Based on 2002/03 findings for pooled data for Simdlangetsha and Hlabisa in northern KZN, a farmer who planted 10kg of Bt seed on average harvested 16% or 110kg of grain more than a conventional maize planting farmer.

If we use the rule-of-thumb of:

A household of 7 people needs 14 x 80kg bags of maize meal per year:

Then a 110 kg yield increase means 35 more days of food security.

<u>However:</u>
In 2003/2004 a farmer planting Bt maize were financially <u>slightly worse</u> off than a conventional maize planting farmer as <u>Bt maize did not render a significantly higher yield</u> – due to low borer pressure and farmer <u>had to pay more for the Bt seed</u>

But:
Difficult to know what the borer pressure will be when seed decision is made

Herbicide tolerant maize - Labour and weed control

•HT maize popular due to labour saving linked to weed control.

•Majority of farmers are elderly and HIV-Aids prevalence is high – labour is a limiting factor

Family labour use man days / hectare

	Herbicide application	Manual weeding
2006/07		
Conventional and Bt	**0.0**	**21.0**
HT (RR)	**4.0**	**0.0**
2007/08		
Conventional and Bt	**0.4**	**13.1**
HT (RR+BR)	**4.0**	**0.8**

Due to Monsanto's training of farmers on the use of herbicides more farmers are also starting to use selective herbicides with conventional and Bt hybrids

Hlabisa farmers according to seed adoption

Season	Farmers surveyed	Number of useable plots	Bt plots	HT plots	BR plots (stacked gene)	Conventional plots
2005/06	**121**	**125**	**39**	**22**	**0**	**64**
2006/07	**87**	**94**	**21**	**35**	**0**	**38**
2007/08	**102**	**97**	**12**	**38**	**19**	**28**
2009/10	**98**	**98**	**0**	**67**	**15**	**16**

•Farmers recognise the benefits of Bt maize, but weeds are a more constant problem / menace

•In areas where stem borer pressure is higher farmers still prefer Bt

•Farmers with enough cash prefer the stacked gene (Bt+HT)

•Many farmers still plant also conventional and traditional varieties

Lessons from South Africa's GM crop experience

- South African farmers were able to benefit from GM crops because SA has GMO legislation and a functioning biosafety framework
- Yes Bt and HT GM technology can work for smallholder farmers
  - It is not a silver bullet or panacea but another production tool for farmers to use.
- The GM technologies / events are very specific – only controls specific problems. Bt for lepidoptera, HT for weeds
- New technologies can overcome production problems like insects and weeds, but not institutional issues
  - Makhathini "technology triumph but institutional failure"
  - Functioning input and output markers are of paramount importance for any production system – no matter if you use traditional, conventional or GM inputs

  (Africa missed the Green Revolution largely due to institutional limitations)

Lessons cont…

- There are conventional technologies that farmers still stand to benefit from – but the institutions are the limiting factors – farmers need markets and support
- If farmers have choice they will adopt the technology that best suite their budget and production limitations.
- Farmers adapt their production systems – intercropping with HT maize

Thank you

Marnus.gouse@up.ac.za