

GM Banana slips in South Africa: key issues and concerns

GMOS in African Agriculture Series



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Contents

Introduction	4
Bananas in the world	4
Bananas in South Africa	6
Marketing channels	6
The banana trade from SA	8
Banana production in Mozambique	9
Key biosafety concerns and unanswered questions	10
The role of banana management in disease control; the metabolic profile of the modified plant; and the fusarium resistance	10
Molecular characterization	10
Additional Biosafety concerns	11
Conclusion	11
Annexure 1	12
Annexure 2	13
References	14

Introduction

Dr Noelani van den Berg of the University of Pretoria, Forestry and Agricultural Biotechnology Institute (“Applicant”) has made application to the South African GMO authorities for permission to conduct the first ever field trials in South Africa involving GM bananas. At the time of writing, the application was still under review by the South African GMO authorities. The rationale for the genetic modification is to combat Fusarium wilt, caused by a soil born fungi *Fusarium oxysporum f.sp cubense* (Foc). The idea is to genetically engineer bananas with a rice gene (NPRI homolog (NH₁)) to confer resistance to the said Foc. The aim of the field trial is thus to evaluate Cavendish bananas that have been transformed to express the NH₁ gene for disease tolerance against Foc.

The Applicant wishes to commence trials involving three transgenic banana lines during the growing season, November 2011-December 2012. The trials are to take place on an existing commercial banana plantation in Mpumalanga, situated 30 km from a national park.

The Applicant has not supplied any biosafety data from previous greenhouse trials involving the GM banana. It does appear as if such data is not available because the Applicant has in fact failed to conduct such greenhouse experiments. With this field trial application, the Applicant is attempting to bypass an important and indeed indispensable step involving greenhouse experimentation where basic biosafety data is usually collected and assessed, before proceeding to open field trials. The application for field trials is therefore hopelessly premature. In any event, the application has been reviewed by a number of independent biosafety scientists who have found the data provided to be sorely lacking in several respects and raise numerous critically important questions the Applicant is required to provide answers to.

We have also reviewed the situation with banana production globally with particular emphasis on South Africa. We are baffled as to the real purpose of the GM banana field trials as there is a multitude of reasons for the decline in domestic banana production, of which disease is only one. It is our view that GM disease resistant bananas cannot overcome the current problems being experienced, ranging from land tenure to competition from more ecologically suitable production areas such as those in Mozambique. This shift in the industry will mean that 24 000 on farm jobs will be lost, which is a huge concern and requires urgent government attention and intervention. This problem is massively compounded by the fact that it appears as if these workers are unprotected in terms of access to unions.

Most of the bananas sold in South Africa are in bulk form, without much scope for value adding and thus we must ask the critically important question: is the use of public funds for these trials justified, particularly in the light that banana farmers are increasingly moving towards macadamia cultivation? We remind the regulators of the insurmountable hurdles faced by the Agricultural Research Council (ARC) in its attempts to obtain clearance for the commercialization of its GM potato. How will a GM Banana be any different?

In the light that the banana industry predicts that the bulk of the South African banana production will shift to Mozambique in the medium term, what will become of these trials and the GM banana? Mozambique has already shown itself amenable to South African agribusiness, and to importing GM crops.¹ Does Mozambique have the capacity to adequately monitor and enforce robust biosafety measures in that country? What will the effect of growing GM bananas in Mozambique have on its potential export markets in Europe?

Bananas in the world

Bananas are one of the world’s most important food crops, with over 130 million tons produced annually. India is the world’s largest banana producer, with nearly 30 million tons produced in 2009,² while Latin American countries dominate the international banana trade.³ However, it is arguably in Sub-Saharan Africa where the fruit makes the most important contribution to health and nutrition,



<http://www.nams.ca/MagiBlog//wp-content/uploads/2010/05/2010.05.01-banana-plantation1.jpg>

providing more than 25% of the energy requirements for over 100 million people. In Uganda, which produces 10 million tons a year, second only to India,⁴ it is a staple food, with many local varieties being grown. Though only 10% of global production is exported annually⁵, the international markets for rice, wheat and maize are more valuable. The international trade in bananas is worth an estimated \$5 billion annually, and it is the most traded fruit in the world in terms of volume.⁶

During the 1990s the international trade in bananas grew at a rate of 4% a year, though this has since declined to around 2.5%, with only Eastern Europe and the Middle East seen as potential growth markets. Latin America and the Caribbean is responsible for 70% of global banana exports⁷, with production in these countries dominated by huge multinational corporations, such as the Dole Foods and Chiquita Brands (both off-shoots of the infamous United Fruit Company). The very term 'Banana Republic', meant to denote an elite controlled spigot economy, is homage to the omnipotence these companies have enjoyed in their host countries in the global south. In Honduras the United Fruit Company was known as 'El Pulpo' (the Octopus).⁸ The highly lucrative banana trade is dominated by just three companies: Dole Foods, Chiquita and Fresh Del Monde, who control 65% of world exports. Noboa, an Ecuadorian company, and Fyffes, from Europe, control a further 10% and 7% respectively.⁹

Bananas have been at the centre for the world's longest running trade dispute, the so called 'banana wars' between the world's largest banana producers in Latin America, and the European Union. In 1993, the EU implemented its banana import regime, which gave duty free access to mostly small producers in former colonies (mostly in the Caribbean). After relentless pressure from the world's largest banana producers, the European Parliament voted earlier this year to cut EU import tariffs on bananas from Latin America by 35% over 6 years, from the current 176 EUR per ton down to 114 EUR per ton.¹⁰ Critics argue that this will decimate banana production in many Caribbean countries, where banana production is the backbone of many of the island economies in the region.

Bananas in South Africa

For optimal conditions, bananas require a warm, humid and frost-free climate, with temperatures ranging between 22C and 31C.¹¹ As such, production is restricted to the provinces of Mpumalanga, Limpopo and coastal areas of Kwa-Zulu Natal, which account for 58%, 20% and 22% of production respectively.¹² The latest figures from the Department of Agriculture, Forestry and Fisheries (DAFF) put total production at just over 397,000 tons, slightly higher than the average for the preceding 5 years of 368,000 tons.

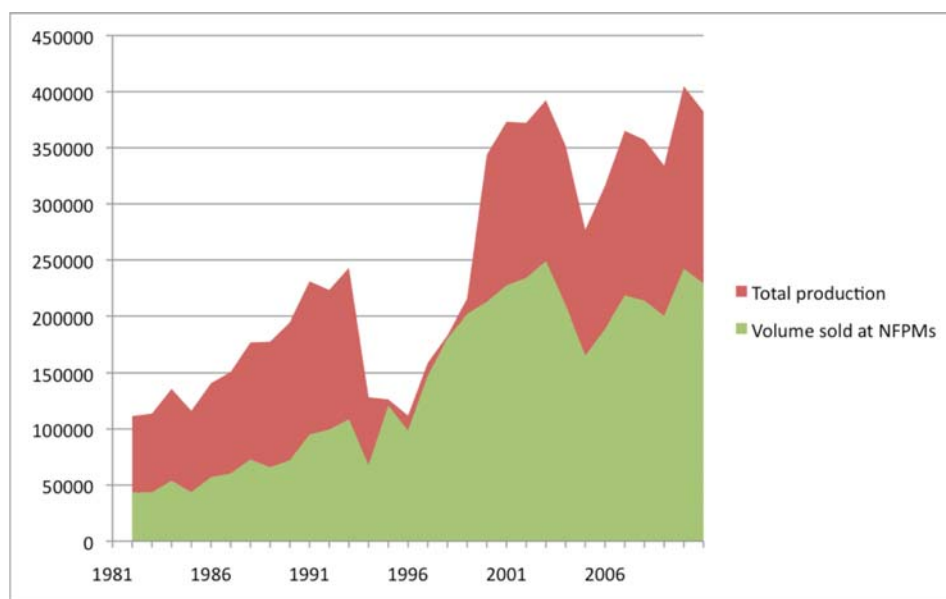
Statistics on the number of banana farmers, or the numbers of people employed on banana farms are difficult to come by. When contacted, the Department of Agriculture, Forestry and Fisheries (DAFF) were not aware of any reliable source of information on this. Figures from Limpopo (from 2003) estimated some 4,000 small-scale banana farmers in the major Banana growing region of the province¹³, though how relevant these statistics are now is debatable. The Food and Agricultural Workers Union (FAWU) currently have no numbers relating in Mpumalanga at least, to the amount of farm workers on Banana plantations, as none of their members work in this sector. According to one of FAWU's negotiators in the province, FAWU has problems accessing workers on these remote farms, and claimed that many of the farmers were 'living in the past'.¹⁴ The Bureau for Food and Agricultural Policy (BFAP), in its agricultural baseline study for 2011, cited Banana production as a 'labour intense winner', and predicted that a 30% increase in the planted area would result in an additional 7,200 on farm jobs, or 2 jobs per additional ha.¹⁵ Using this, admittedly far from methodologically sound formula, would give a very approximate figure of around 24,000 on-farm jobs in the sector.

What is clear, from those in both the retail sectors and industry associations, is that the number of banana farmers in South Africa is declining, and is expected to continue to do so, as production levels in Mozambique have increased by over 200% in the last five years alone.¹⁶ This is expanded upon later.

Marketing channels

During the 1980s, around 40% of all bananas produced in South Africa were sold through the country's National Fresh Produce Market (NFPM) network, with the remainder generally purchased by independent wholesalers. The precipitous decline in production during the mid 1990s could be attributed to a number of factors, with most of them in some way connected to the profound political changes sweeping the country at the time. According to data from the UN Food and Agricultural Organisation (FAO), the years 1992 to 1995 were characterized by a dramatic fall in yield, which had more of a bearing on the total banana output. The area planted did decline during these years, but the drop in yield in their statistics is more apparent.¹⁷ A word of caution, however, as the FAO's statistics for the planted banana area vary considerably with figures from the South African Department of Agriculture, Forestry and Fisheries (DAFF), though figures from the latter are only readily available from 2002.

Figure 1. Total Banana production and sales through NFPMs (tons)



Source: Abstract of agricultural statistics 2011, Department of Agriculture, Forestry and Fisheries.

The liberalization of South African agriculture during the period no doubt also had a bearing on this. For example, the Banana Board, which had operated as a single channel pooling scheme and determined banana prices on a weekly basis, was disbanded in 1994, subjecting the banana trade to market forces. After the turmoil of the mid 1990s, production increased again, and from the late 1990s NFPMs have sold roughly 60% of South Africa’s banana crop every year. For the last decade bananas have also accounted for approximately 70% of all sub-tropical fruit sold on the NFPMs.

In South Africa the majority of bananas are eaten for their fruit. There is little in the way of the processing or ‘value’ adding that happens with, for example, oranges or apples, where processors purchase about 25%¹⁸ and 31%¹⁹ of the entire annual crop.

South Africa’s National Fresh Produce Markets, of which there are 19 nationally, have a combined annual turnover of R10 billion. The Johannesburg Market, the largest of its kind in the Southern hemisphere, accounts for 38% of turn-over, followed by markets in Twsane (17%) and Cape Town (12%). Independent sellers, or agents, operate out of the various markets. Farmers are responsible for the costs of transport to the market, which, in the case of Johannesburg’s Fresh Produce Market (JFPM), is approximately R350 per pallet. Once at the market an agent assigns them a price dependent upon the prevailing market conditions of the day, and sells them on the farmer’s behalf.²⁰ From the final price the agent takes their commission, which is 7.5% in the case of Johannesburg’s markets, while the markets authority takes a further 5% towards the upkeep of the site. ‘Ripening costs’ are also included, which amount to around 26 cents per box.²¹ At JFPM there are 40 ripening rooms, each with a capacity of 30 pallets. The ripening process typically takes 4 – 7 days.²²

The large supermarket chains generally source their bananas directly from farmers, with only ‘ad hoc’²³ purchases occurring to make up the occasional shortfall. In recent years retail procurement from NFPMs has declined to as little as 10% of total procurement, ‘relating to lack of cold chain maintenance, inadequate traceability to the farm level and food safety issues.’²⁴ Shoprite Checkers sources virtually all of its fresh fruit and vegetables (96% according to one of its senior buyers²⁵) through a special procurement arm, Freshmark, which is one of the largest single buyers of fresh produce in the country.²⁶ Freshmark also supplies Shoprite stores throughout Africa.

Freshmark buys bananas directly from producers, either collecting them in their own refrigerated trucks or using third party transport companies. The scale of purchases matches the scale of



http://westcoasthikers.files.wordpress.com/2010/12/img_0954.jpg

Shoprite's operations: A typical load contains about 2.3 tons of bananas (1,350 crates, each weighing approximately 17.5 kg). Shoprite sells anything between 437 and 700 tons of bananas a week, which compares to average weekly sales across all 19 NFPMs of 4,400 tons.²⁷ Shoprite sources its bananas from KZN, and the Hazyview and Komatipoort areas of Mpumalanga within South Africa, and from Mozambique, Swaziland and Zimbabwe.

The impact of the major global banana producers on the South African banana market appears to be minimal at present. Dole Foods established itself in South Africa in 1998, expanding its marketing operations into South African supermarket chains through the purchase of Malembo Fresh marketing in 2005. Unlike in Latin America, Dole owns no land in South Africa, preferring instead to source produce from over 200 independent growers in South Africa, Namibia and Swaziland. The focus of the company's operations in South Africa appears to be for the country's lucrative export markets, rather than domestic markets.²⁸ Dole have previously approached the SA Banana Growers Association (SAGBA) about supplying them with Bananas, though Dole's onerous aesthetic standards, including fruit with 'no bruises', has made them reluctant to take the offer up.²⁹

The banana trade from SA

Banana exports from South Africa are miniscule, rarely amounting to more than 500 tons in a single year, with virtually all of these destined for countries in the Southern African Development Community (SADC). Imports, on the other hand, have increased markedly in the last five years. Between 1999 and 2005 average imports were around 3,000 tons per year. From 2007, imports are now at least 20,000 tons per year, with over 80% of these coming from Mozambique. South Africa has a small but highly proficient Banana tissue culture industry, with over half of all tissue culture produced each year being exported, chiefly to Latin America, West Africa and Taiwan,³⁰ though Mozambique has recently been receiving lots of tissue culture from South Africa.³¹

As previously stated, Banana production in Mozambique has increased dramatically in the last five years, and there are plans to double production again with the next 3 – 5 years.³² A multitude of reasons were given for this, ranging from climatic conditions,³³ land claims, Panama disease,³⁴ labour issues and transport times for exports. For example, Andre Knipe of the SABGA gave the example of a shipment of bananas, which took 24 days to reach Libya from South Africa, and were rotten by the time they arrived.³⁵

Banana producers generally appear to be either relocating to Mozambique, or switching to Macadamia production. For example, Shoprite has been increasing the quantities of its Bananas from South African farmers newly established in the country, while one of the agents operating at JFPM contacted claimed that all of the Bananas they sourced from there were grown by South Africans.³⁶ Many other farmers are switching to Macadamia nuts, as it has lower costs and higher returns.³⁷ The Macadamia industry is among the fastest growing fruit tree industries in the world. South Africa is currently the world's third largest producer, with the gross value of production increasing an astonishing 6 fold between 2005 and 2008. Mpumalanga (51%), KZN (22%), and Limpopo (20%) are the largest growing areas,³⁸ corresponding with the major Banana growing areas of the country.

Though no concrete figures of the numbers leaving banana production are available, the consistency of responses from a wide variety of industry actors indicates it is a significant number. As both production and planted area do not, from the statistics available at least, seem to have declined, it would seem to suggest that the remaining banana producers have consolidated and expanded their land holdings, with likelihood of an intensification of production amongst these dwindling numbers.

Banana production in Mozambique

In the year 2000, just 24 ha were recorded to have been planted to

bananas in Mozambique. By 2009 this had expanded to 1,305 ha, producing just over 33,000 tons. Exports are the primary market, with 73% of production going to this market. The production and trade in bananas in Mozambique is controlled by six companies, with the two largest controlling 61% of the market.³⁹

In addition to re-location of numerous South African producers, the global Banana giants are also seeking to establish themselves there. Chiquita, in conjunction with the US industry support group Techno Serve, and 'local'⁴⁰ company Matanuska, has established plantations there with a view to exporting to Europe and the Middle East. In the long term the company believes it can supply up to 30% of the European Union's Banana imports from Angola and Mozambique.⁴¹

Looking to take advantage of the European Union's (EU) Africa, Caribbean and Pacific (ACP) and Anything But Arms (ABA) programmes, Chiquita, through its local conduits, has acquired a land concession of 6,000 ha in the north of the country, with 3,000ha initially set aside for bananas (this is roughly 25% of the entire area planted to Bananas in South Africa). Chiquita has also been consulting with Technoserve to explore further potential avenues of investment. It is believed that 'small' banana growers are included in this, though in the banana industry that means a farm of at least 50 ha, with a focus on specialty bananas and plantains!⁴²

Maputo has been chosen as the site of Chiquita's African headquarters. Unlike its operations in Latin America, Chiquita will not invest directly in land or cultivation, but will provide 'technical assistance'. Basically Chiquita passes all the risk associated with capital and infrastructure investments onto its local 'partner' and then purchases the produce from them.⁴³

Key biosafety concerns and unanswered questions

The role of banana management in disease control; the metabolic profile of the modified plant; and the nature of the fusarium resistance

1. The banana has been augmented with an exogenous version of NPR1. From the literature list supplied by the Applicant, it is apparent that she previously showed that there are homologues of this gene in banana already, and varieties such as cavendish are already more tolerant of fusarium than those varieties with lower induction of these homologues.
2. NPR1 is activated by a change in redox state in the cell. This is caused by a signal transduction pathway controlled by salicylic acid (SA). Activated NPR1 binds to transcriptional regulators that then induce pathogen response (PR) genes. The nature of the change in the banana is constitutive induction of the pathogen response. This would be equivalent to a constitutive stress response produced natively by the plant. As such, there may be many different anti-nutrients, or amounts of known anti-nutrients and other potential changes with relevance to insects, wildlife and humans that should be investigated. What is the nature and scope of the assessment for non-target effects and human safety? What are the levels of salicylic acid in the tissues and fruit of the plant? Do these levels have a physiological effect on the microflora? If so, is there an association between the microflora on modified plants and multiple antibiotic resistance?
3. Long term expression of the PR genes might select for pathogens and commensals that are resistant to normal levels of PR. The full range of activities of these proteins need to be known to determine how resistance to PR in bananas might affect the spread of fusarium and other microbes, e.g those not pathogenic to bananas but which might be pathogenic to other important plants (including food crops), outside of the banana cultivation area. Has the frequency of resistance to PR been measured? Do resistant microbes have extended pathogen ranges? How does this compare to the frequency of resistance arising in unmodified cavendish? Is the frequency of resistance higher than the frequency of disease outbreaks using other management techniques, e.g., rotation with fallow plantations and mixed cropping?

Molecular characterization

1. The molecular characterization is almost completely missing. There are several experiments that can and should be conducted before considering a field trial, or even a trial in a greenhouse. These include the following:
 - a. the exact construct has not been described (sequence, restriction sites, size of the individual elements, optimized sequences and so forth) either before or after transformation. The genes and the vector were named, but sequences, accession numbers and the cloning scheme were not identified.
 - b. the insertion point(s) of the recombinant DNA in the chromosome of the three lines has not been determined. As a consequence, it is not known if endogenous genes or regulatory sequences were disrupted that alter the transgenic bananas and what the consequences could be.
 - c. The Applicant has not demonstrated that the event can be detected by Southern blot or PCR (as claimed). Probes and primers and experimental conditions have not been specified. The statement that the event can be identified with PCR specific primers is only true for complete and not rearranged inserts. The Applicant has not demonstrated that this is the case. No protocols were supplied that confirm that the Applicant is in possession of the necessary information or has done the experiments in the lab. Detection of all possible DNA inserts should be demonstrated, this is a basic requirement for monitoring.
 - d. The Applicant has not determined if partial inserts are present in any of the transformed lines. This should be done by Southern blot using small probes of the intended transgenic DNA and the plasmid backbone in a low stringency setting.
 - e. Sequencing has not been reported to determine if the inserted DNA is the same as the one used for transformation. Agrobacterium mediated transformation is known to cause

- rearrangements, insertions and deletions both of the incoming and of the host DNA.
- f. In regard to the genomic neighborhood of the inserted DNA, have endogenous genes be disrupted, and if so, which? Are there potential regulatory elements around the insertion site(s) that might alter gene expression in the recombinant plants?
 - g. if new fusion proteins have been created between the recombinant DNA and genomic DNA sequences or by rearrangements in the chromosome due to *Agrobacterium* mediated transformation

Additional Biosafety concerns

1. Why have no contained greenhouse trials been performed or reported (i.e. growth in containment and challenge with *Fusarium*)? This should be done before the organism is released into the environment? A stepwise process, from greenhouse experimentation and collection of basic biosafety data, followed by broader release is a more prudent strategy as recommended by a number of national frameworks on GM risk assessment..
2. The Applicant mentions a fence to prevent theft and signs to prevent people eating the bananas. Does theft occur at this farm (which belongs to a commercial grower)? If so, how frequent is it? How much produce is stolen? What is the literacy level in the area?
3. Are there wild animals around which would eat the bananas (monkeys, birds, insects, bats and so forth)? Negative impacts on wild species have not been evaluated other than the simple statement by the Applicant that it “should not happen”.
4. The stability of the event over time has not been determined including the:
 - stability of the DNA at the site of insertion
 - stability of overexpression of the transgene
 - stability of the phenotype
5. The trial is proposed to be located on a commercial plantation. While this ensures that the people caring for the plants on a day to day basis know what they are doing, it increases the potential for the bananas to reach the human food supply by inadvertent mixture with the commercial produce.
6. No emergency response plans are in place. Monitoring provisions, and the opportunity to address risk management questions raised here is not well elaborated in the field trial plans.
7. In regard to the use of hygromycin as a selectable marker, no information is provided by the Applicant as to whether hygromycin is a medically important antibiotic.
8. NPR1 is a regulator of stress response in plants via the salicylic acid pathway. In *Arabidopsis*, about 10% of genes are transcriptionally activated upon challenge.
 - What does this do to plant metabolism?
 - Is it possible to maintain this response permanently, or will the cells find a way to degrade or inactivate the additional protein given enough time?

Conclusion

The preamble to the GMO Act as amended, indicates that the purpose of the Act is to provide for the responsible development, production, use and application of GMOs. The Executive Council (EC), acting in consultation with the Advisory Committee, as the decision making body has several important obligations to fulfill when considering an application for field trials involving GMOs. These include ensuring that the Applicant has provided a full and complete biosafety assessment of the risks to human and animal health, the environment and to society and has shown that it has taken all the necessary steps to ensure that trials are necessary and that they do not pose biosafety risks. These obligations stem from the GMO Act itself, the Constitution of the Republic of South Africa, various environmental laws as well as the Promotion of Access to Justice Act. Decisions of the EC in approving applications for activities involving GMOs affect fundamental human rights of the public, including, but not limited to, the right to fair decision-making. Having regard to the lack of public interest or commercial justification for the proposed trials as well as the numerous biosafety concerns and unanswered questions canvassed by us in this briefing, we are of the opinion that the EC is obliged in terms of South African law and our Constitution, to reject the application.

Annexure 1

Banana production & NFPM sales

year	Total production	Planted area	Gross value (000s R)	Volume sold at NFPMs	% of bananas sold at NFPMs	ave. price R/t	Bananas as % of total sub-tropical sales at NFPMs
2009/10	382 337	12 195	1 217 775	229 096	60	3 648	76.6
2008/09	404 917	11 600	1 201 011	242 271	60	3 400	76
2007/08	334 205	11 156	989 405	200 204	60	3 914	71.9
2006/07	357 191	11 568	877 444	213 904	60	2 814	71.6
2005/06	365 118	11 568	837 945	218 452	60	2 630	73.7
2004/05	316 258	11 568	708 433	188 904	60	2570	69.4
2003/04	277 034	11 552	642 527	165 411	60	2662	70
2002/03	352 025	12 035	625 383	210 099	60	2085	73.2
2001/02	392 491	11 856	564 078	249 117	63	1643	73
2000/01	372 204		510 849	234 042	63	1583	
1999/2000	373 177		515 028	227 505	61	1 580	
1998/99	343 822		435 177	212 790	62	1 452	
1997/98	215 655		200 979	202 013	94	1 500	
1996/97	183 343		163 269	180 761	99	1 411	
1995/96	158 853		139 174	147 329	93	1 501	
1993/94	126 445		90 153	120 806	96	1 128	
1994/95	111 983		110 816	98 685	88	1 672	
1992/93	128 357		137 212	67 725	53	1 520	
1991/92	243 075		152 018	108 643	45	945	
1990/91	223 413		141 573	99 495	45	937	
1989/90	230 994		116 367	95 091	41	774	
1988/89	194 937		98 659	72 175	37	768	
1987/88	177 859		79 984	65 875	37	694	
1986/87	177 124		71 768	72 901	41	595	
1985/86	150 825		58 771	60 386	40	559	
1984/85	140 823		51 867	57 095	41	539	
1983/84	116 207		44 069	43 739	38	558	
1982/83	135 784		34 647	53 915	40	388	
1981/82	113 714		30 031	43 611	38	386	
1980/81	111 548		25 893	43 441	38	351	

Sources: Abstract of agricultural statistics 2011; Trends in the Agricultural Sector 2002 – 2010;

Annexure 2 – Global Banana production, 2009 (FAOstat)

Area Harvested	Ha	Production	Tones
India	748 100	India	26 996 600
United Republic of Tanzania	534 354	Philippines	9 013 190
Brazil	479 614	China	9 006 450
Philippines	446 400	Ecuador	7 637 320
China	350 224	Brazil	6 783 480
Ecuador	216 115	Indonesia	6 273 060
Burundi	200 000	United Republic of Tanzania	3 219 000
Cameroon	148 828	Guatemala	2 544 240
Uganda	142 096	Costa Rica	2 365 470
Thailand	112 391	Mexico	2 232 360
Indonesia	105 000	Colombia	2 020 390
Democratic Republic of the Congo	85 000	Viet Nam	1 532 420
Madagascar	76 460	Thailand	1 528 080
Mexico	75 810	Papua New Guinea	1 187 020
Papua New Guinea	75 493	Egypt	1 100 000
Colombia	74 112	Cameroon	1 000 000
Viet Nam	71 893	Kenya	843 465
Kenya	68 590	Bangladesh	836 183
Guatemala	59 391	Honduras	690 625
Bangladesh	53 585	Malaysia	625 000
Haiti	51 501	Burundi	620 028

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