Bananas

Production, sustainability and understanding biosecurity importance

A report for

by Paul Inderbitzin
2013 Nuffield Scholar

March 2017

Nuffield Australia Project No 1304

Supported by:

Horticulture Innovation Australia

Scholar Contact Details

Paul Inderbitzin
Kureen Farming
Lot 219 Peninsula Development Road
Lakeland, QLD, 4871

Phone: 0400 965 367
Fax: (07) 4060 2070
Email: paul@kureenfarming.com

In submitting this report, the Scholar has agreed to Nuffield Australia publishing this material in its edited form.

NUFFIELD AUSTRALIA Contact Details

Nuffield Australia
Telephone: (02) 9463 9229
Mobile: 0431 438 684
Email: enquiries@nuffield.com.au
Address: PO Box 1021, North Sydney, NSW 2059

Executive Summary

Every person buying a banana in Australia is buying Australian grown. This makes the Australian banana industry one of the most unique in the world, due strict biosecurity and quarantine laws. The Australian banana industry can be proud of its in surveillance, early detection and effective eradication that has put it in such a favourable position. Unfortunately, it is a never-ending battle.

Australian Consumers are generally high end consumers and retailers pride themselves on sourcing quality, sustainable products. Producers are required to meet strict specification and quality assurances. Timeliness of operations is paramount – ensuring the job is done right, at the right time to protect the fruit at all times. If done well, fruit waste coming from the field can be minimised to less than 5%. Growers must seriously consider the way fruit is handled from the field and packed in the correct size carton for transport.

Any banana waste collected from the packing process is still a valuable resource. Using low cost, simple approaches, this waste can be returned to the field as compost or fertiliser. A more sustainable farming system relies less on external inputs and more on on-farm resources. Growers are making their own liquid ferment fertiliser to reduce dependence on conventional fertiliser.

To throw recyclable rubbish in landfill is a crying shame in this day and age. Banana production uses a significant amount of plastic, a certain percentage cannot be reused. The waste handling systems in Australia are not as clean and green as we all might hope and therefore needs a rethink.

The recommendations in this report give Australian growers tools to implement in their own business, supply chain stakeholders ideas to provoke change and government a prod to act.

Table of Contents

Table of Figures

Foreword

Growing bananas as a third-generation farmer at a young age in Australia is such a privilege. Our family originally came to Australia as dairy farmers from New Zealand, but soon were producing different crops across the Atherton Tablelands and Lakeland. In 1995, bananas were first trialled in Lakeland at a commercial scale and now the crop has cemented itself in the region as a viable crop and is largely responsible for the growth of the area. Bananas grown in this part of Australia provide the industry with greater region diversification to ensure more stable supply in the event of natural disasters such as cyclones.

Growing bananas in areas that are not typically a 'natural fit' for the crop raises different production challenges. Hot, dry, windy conditions can have significant effects on production if not managed correctly. Reduction in fruit quality can occur due to bag rub, point scaring and increased insect/mite pressure. Growers in the area have had to adapt their production techniques/practices to combat the different climate.

In order to increase the productivity of the crop, I felt I needed a better understanding of how to manage fruit quality. It became apparent to me that bananas are vulnerable to threats which could be potentially devastating to our business and wider industry, such as the fungal disease: Panama TR4. We need to understand what TR4 means at the ground level and how best to implement good biosecurity procedures.

Transitioning deeper into bananas growing, I found the use of plastics a necessary evil. The waste produced in our farming system alone is a source of frustration. The biggest frustration is how to manage the plastic waste. Sending plastics to landfill in this day-and-age is almost a sin but when it is your only viable option what do you do?

The personal study travel took the author through Darwin to spend ten weeks abroad in Malaysia, Taiwan, China, UK, Martinique, Costa Rica and Columbia. Each country focused on one or two of the following topics:

1. Banana production and supply chain – Costa Rica, Columbia, China, UK.
2. Sustainability – Malaysia, Martinique, Costa Rica.
3. Biosecurity Importance – Taiwan, Costa Rica, China

Figure 1: Personal travel path over ten weeks

Darwin was the first stop to gain a better understanding of what it meant to farm with the TR4 in Australia. Daniel Borsato, part owner of the only remaining commercial banana farm in the NT, was very kind with his time, discussing the issues around growing with TR4.

In Malaysia, there were two valuable contacts – Ken Bellamy from Vital Resource Management (VRM) and Shamsul Bahar Mohd Nor from Syngas. Malaysia had a great number of farms and businesses interested in organic and plastic waste management. Ken organised meetings with Department of Agriculture representatives and farm tours with local farmers. The author noted the on-the-ground results of VRM's success, regenerating land back to its former state, meaning farmers could once again use it. VRM is making some serious traction in Malaysia and many other parts of Asia with its excellent zero waste systems using microbiology.

Shamsul from Syngas was very generous with his time and his manufacturing site was visited. He demonstrated his future plans of what Syngas has to offer in terms of plastic recycling. He explained how the machine he has designed and built converts plastic back into oil and then to diesel.

In China, the author joined a tour group from Australia organized by the Australian Banana Growers Council (ABGC). The trip was designed for growers to see first-hand the Chinese banana production and to get a glimpse of what the Chinese are doing towards farming with TR4. Mark Jackson organized some great meetings and farm visits for the tour and the group

got to spend time with Chinese liaison Simon Zhang, who works for the largest banana marketing company in China. Some great insights were gained into how their system works (e.g. banana supply chain from each province). In China, there is already 100,000ha of TR4-affected banana farmland, some of the worst affected areas being in Hainan Island, where they are expecting banana production could be completely wiped out within five years. The concern for TR4 varied from province to province and that some places were more worried about frost than anything else.

In England, the author met with Andy Denham-Smith from Fyffes who was very generous with his time and knowledge. The author spent time looking through their warehouses and shipping docks and in meetings, talking about their practices in shipping and marketing bananas globally. A lot was learned about carton design and post-farm supply chains.

In Martinique, the author met with Laurent Gervais from IT2. He was virtually a tour guide and taxi and an array of farms were visited demonstrating sustainable practices. Because Martinique is a small island all sustainability issues are magnified. Couple that with it being a French nation and part of the EU, they are farming under the EU regulations. Martinique farmers have a great agricultural department and get a lot of support from their government.

In Costa Rica, the contact was Alasdair Macleod who introduced the author to Lesley Medina who was a wealth of information, and a great deal was learned in the car as well as talking to growers. Many farms were visited, one of which was farming with moko. There is great importance of on the ground biosecurity at a grower level, bunch protection, recycling and sustainable practices.

In Colombia, Miguel Escalante from Centro Aceros was a contact and guide. The author travelled to Uraba in North West Colombia where there is approximately 80,000ha of bananas. Bananeras De Uraba was visited, which is a 50-year-old company that pioneered bananas in Colombia. In 2001 the company moved to 100% fair trade which they said is very important to the company. Staff happiness is key to the business's success: a lot of resources are focused in that area. They have six plantations totaling 650 ha that produce 1.6 million cartons a year at 2,400 cartons per ha. They focus on the three pillars of sustainable farming: social, environmental and economic.

Acknowledgments

None of this would have been possible without the generous support of my investors Horticulture Innovation Australia (HIA) and Australian banana industry levy payers. They have given me the opportunity of a lifetime and I appreciate the generosity.

I would like to thank all the people who organised, accommodated and gave me their precious time on my Nuffield study tour.

Special mention must go to Marc Jackson for his help with contacts. And to all my family who kept the show running, especially my brother Martin and his family, who had to juggle being in two places at once.

Abbreviations

ABGC – Australian Banana Growers Council

EM – Effective Microbes

EVA - Ethylene-vinyl acetate

IT^2 – Institute Technique Tropical

TR4 – Panama Tropical Race 4

NT – Northern Territory, Australia

UK - United Kingdom

Glossary of Terms

Hand – The group of bananas as they grow on the bunch

Cluster – A ‘hand’ of bananas cut down to a smaller size (generally 3-9 fingers)

Finger – a single banana

Bell – Maroon/purple banana flower

Objectives

The objectives of this research were to:

1. Investigate methods to achieve the highest standards of fruit quality.
2. Consider other sustainable farming practices and methods to utilise plastic and organic waste.
3. Understand the implications of on-farm biosecurity, with emphasis on Panama TR4.

Introduction

Bananas are the most traded and consumed tropical fruit in the world. Globally, Cavendish is predominantly traded because of its ability to survive the supply chain, as well as to meet market expectation. World gross banana exports in 2012 reached 16.5 million tonne (http://www.fao.org/docrep/019/i3627e/i3627e.pdf), with over 75% of supply coming from Central and South America and the balance coming from Asia and Africa. Developed countries of Europe and North America are the largest importers of bananas, accounting for approximately 75% of total product.

Australia is a minor producer of bananas by world standards, currently producing approximately 340,000 tonnes of bananas annually, with close to 13,000ha under production. Bananas are grown in both the tropical and sub-tropical regions with over 95% of the industry concentrated in North Queensland, 3%in northern New South Wales, and the remaining 2% in southeast Queensland, Western Australia and Northern Territory. The main variety, 'Williams Cavendish', accounts for approximately 95% of the market with the remaining 5% made up of Lady Finger and other niche market verities such as Goldfinger, Ducasse, Red Dacca, Sucrier and Pacific Plantain (Margetts, 2014).

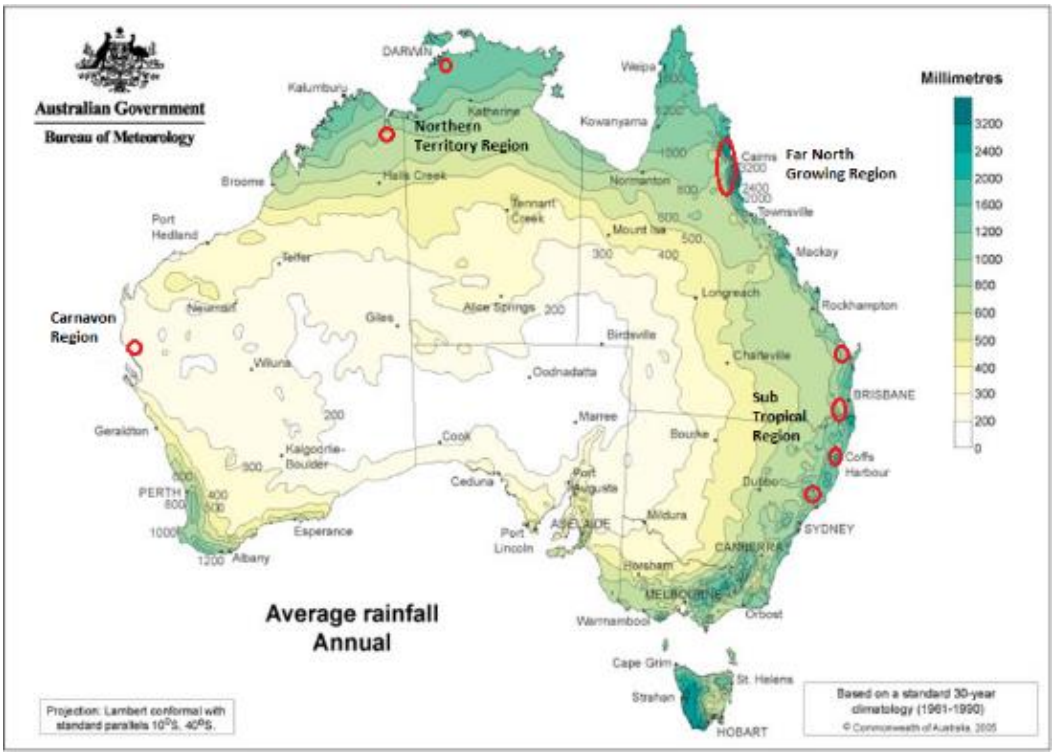

Figure 2: Australia's average annual rainfall and production areas. Source Australian Government - Bureau of Meteorology, 2014

For many produce categories, it is now more complex to keep up with today's consumer trends. High fruit quality and assurance has gradually become a fixed expectation in world markets and Australia is no different. If high-end markets are the target, then producers must be able to guarantee consistent high quality produce. Furthermore, they need the confidence that before entering produce into the supply chain, it will move through the system smoothly. Production and processing methods must be timely and best practice to ensure produce is delivered in accordance with specification and therefore consumer satisfaction. When retailing bananas, it is important to understand that bananas have not undergone much change. Varieties aren't changing every five years for customers and consumers, and therefore they have a very traditional expectation. With a market penetration of 94% there is little room for growth for the number one fruit. Australians rank among the highest banana consumers in the world, eating 15.1kg/person/year (Margetts J., 2014). Meeting this customer expectation every time is part of the focus of this report.

Sustainability focuses on two aspects of the production system – inputs and waste - and relies in the execution of the producer and the commitment they have to maintaining the environment. Fundamentally it comes back to the business bottom line and what options the business has to reduce, reuse and recycle. Some farmers are changing fertiliser use by moving to low technology, cheap bio-fertilisers that are made on-site and applied regularly. Recycling crop waste is a simple strategy but can be costly. Plastic waste management in Australian horticulture is varied, depending on proximity to waste handling sites. Other waste handling or recycling systems are required in Australia to custom fit our large country and therefore incur substantial freight costs.

A greater understanding of biosecurity is needed, as it is a significant factor in the industry's longevity and success. This report will focus on how other countries are dealing with biosecurity threats, what systems are in place to prevent incursions, or in many cases, what can be done to minimise the impact once the incursion is occurred.

Chapter 1: Quality fruit production

Fruit quality was the focus common to all growers visited. Export quality fruit was the ultimate aim of the growers and to achieve this, the fruit has to be almost completely clean of marks and bruises.

Figure 3: Harvested bunch ready for processing, Costa Rica. Source Inderbitzin, 2013

The majority of consumers purchase fruit based on appearance. The retailer sets a 'specification' and it is a grower's responsibility to match these specifications. To achieve this, much attention must be given to timeliness and quality.

The common theme on all the farms visited overseas was the relationship between the number of staff and fruit quality. The staff per hectare ratio is significantly higher than commonly found in Australia. This high staff/hectare ratio is made possible by lower labour costs in less developed countries and enables the fruit to be cared for with greater detail right through production cycle, until it is packed into a carton.

Waste audits conducted in the north Queensland banana industry found that on-farm waste streams are between 10-30% of the crop. Of this, 80% was due to 'cosmetic imperfections' deemed unsaleable by retailers (White, A et al. 2011)

Bunch Protection

Six tasks that need to be carried out during bunch growth to ensure fruit, free of cosmetic imperfections are achieved are:

1. Bell Injection (BI)
2. Deleafing (DL)
3. Bunch pest control
4. Flower Removal
5. Finger Pruning
6. Bagging (applying a bag over the bunch)

The systems that resulted in near-perfect fruit were observed in South and Central America. Their waste target threshold is less than 5% bunch waste, not including stalk. (Medina, L., Personal communication, 2013). Each of these tasks requires a separate visit to the bunch and in some cases more than once at different growth stages.

Bunch Growth Stage	**Australia**	**Central/South America**
Bell Emergence	Bell Injection	N/A
Bell Drop	Deleaf	1. String applied 2. Bifenthrin impregnated bunch cover applied 3. Deleaf
Quarter bunch open		1. Outer fingers pruned 2. **Flowers removed**
Half bunch open		1. Outer fingers pruned **Flowers removed**
Full bunch open	1. Prune to desired no. hands, 2. Insect protection applied, 3. Plastic protection applied between hands (optional) 4. Bunch cover applied	1. Balance of **flowers removed** 2. Bunch pruned to desired no. hands

Figure 4: Tasks carried out on banana bunch – Australian/Central/South American Comparison

Figure 4 demonstrates the extra work carried out by the farmers in Central and South America. Better fruit quality comes at a price, which is measured in time. Timeliness of operations is paramount and evaluating waste streams with the aim to minimise waste are essential to improving growers' bottom lines.

In Australia bunch protection starts from the point at which a bell (banana flower) is emerging from the top of the tree's throat, before it drops. Bell injection is a largely necessary task to ensure thrips do not mark the early developing fingers of fruit. In other countries visited, this was not the case as they do not have the same thrips as we do. Instead, bunches are bagged from bell emergence. These bags are commonly impregnated with insecticide which gives immediate insect control once the bell has dropped. These bags have been trialled in far north Queensland, Australia, but by and large they have not been a reliable control.

With the bunch a quarter and halfway opened the bunch is visited again and the flowers are removed. At this time, the outside fingers on the top three to four hands are also removed (these bananas typically have a different shape/curve and thus are more difficult to pack). Three to five days later, the bunch is visited for a third time and the remaining flowers are removed and the bunch pruned (two to three hands removed). Most farms aimed for an eight hand bunch. Anything over this size would result in too much bruising from handling. Some farmers in China would apply tissue paper to flower ends to prevent sap staining the fruit.

Some growers, depending on growing region, would apply a plastic slip to the lower whirl of each hand to protect it from point scaring at this third and final visit to the bunch. A worker applying bunch covers in this system would complete six ha per day at approximately 50 bunches per ha.

Figure 5:Bunch cover applied at bell drop, Costa Rica. Source, Inderbitzin, 2013

Figure 6: Plastic sleeve protectors between hand whirls, Taiwan. Source, Inderbitzin, 2013

Figure 7: Tissue paper applied after flower removal to stop sap falling and staining fruit, China. Source, Inderbitzin, 2013

Figure: Paper sleeve protectors between hands and cloth lined bunch cover for temperature and wind protection, China. Source, Inderbitzin, 2013

Harvesting

Banana harvesting is a labour-intensive task and handling banana bunches can be awkward and heavy work; however, it is a necessary process that can greatly influence waste. Throughout the world harvesting systems differ depending on the terrain the farm is on. In general, there are three types of harvesting systems – cable way, harvest trailers and a very simple method simply using a 'carrying pole'.

Costa Rica

All farms visited in Central and South America used a cableway system for harvesting. All bunches are suspended from the cableway at an even distance apart and travel to the packing facility along a cable in long 'trains'. Train length varies from 25-60 bunches depending on the

distance to pack house and what is being used to pull the train - a donkey, mechanical donkey (tractor) or person.

Figure 8- Harvested Bananas being transported to packing shed by cableway (source Inderbitzin, 2013)

All farmers emphasised the importance of bunch handling care when harvesting, ensuring minimal marking and bruising occurred. Bunches either had plastic sleeves between hands inserted early when the bunch is first maturing (Figure 6) or EVA (Ethylene-vinyl acetate) pads between each hand prior to the bunch being harvested (Figure 8). To insert the EVA pads the bunch is first carefully lowered to working height, resting the stem on a harvesting pole. Using this harvesting technique, it was evident to me that it was slightly slower than our techniques in Australia, but would definitely result in less bruising. For example, a harvesting crew of three people, can harvest 250 bunches per ten-hour day (Medina, L 2013).

Figure 9: EVA pads being applied. Source, Inderbitzin, 2013

Figure 10: Protected bunch being transported to cableway. Source, Inderbitzin, 2013

Martinique

Some growers in Martinique, such as Frederic De Reynae from Eden used a specialised picking trailer. The bunches hung from the top of the stalk while padding between each bunch prevented collision. This trailer was mechanically sophisticated and appeared to be very effective in minimising fruit damage.

Figure 11: New model harvest trailer. Source, Inderbitzin, 2013

Figure 12: In field harvest trailer almost fully loaded. Source, Inderbitzin, 2013

China

In China, all fruit was carried manually to a mobile packing facility that is located adjacent to the field being harvested. This was a novel low cost approach to both harvesting and packing the fruit. The advantage with this system is the relatively short distance fruit must travel before it is packed into a carton.

Figure 13: Harvested bunches transported on a carrying pole. Source, Inderbitzin, 2013

Figure 14: Mobile packhouse situated in field. Source, Inderbitzin, 2013

The three different harvesting methods listed above all follow the same principle – transport the fruit the same way the fruit grows – hanging vertically. The Australian system doesn't follow

this logic. Instead it evolved from the sugar cane industry with roll-on/roll-off tops, which resulted in the fruit sitting vertically on itself, stacked side by side.

Packaging

Cardboard cartons are the most common form of packaging. They offer the most efficient use of space for palletisation and transportation (Procarton, 2014). Visiting the Fyffes Basingstoke facility in England proved how many different carton designs were being used. The most-used carton is the 18kg. However, the range of two piece cartons is driven by the sheer number of retailers all trying to have their own carton specifically designed to suit their Distribution Centre's (DC) or shelving.

Carton Design

The essential function of the carton is to protect its contents and so the two major carton design focuses are size and strength. The traditional export-size carton used globally is the 18kg (40lbs) carton. It is a deep carton allowing four rows of bananas to be packed into it on top of each other without resulting in the fruit sitting proud of the carton's top edges. This is critical for palletising purposes so the fruit is not damaged by compression.

The table below illustrates careful placement of fruit in the carton, carefully avoiding the hard crown of the cluster touching fruit. The use of plastic and cardboard liner between the top and bottom two rows. Also of note is the black EVA pad used during packing to space the bananas, leaving room for the hard crown to be slotted into place. The plastic liner is finally twisted to limit fruit vibrating and causing skin blemishes.

		
First row, packed against EVA pad	**Second row added, EVA swapped to behind 2nd row**	**Cardboard/plastic liners between rows 3 &4**

	
Third row added	**Fourth row added and plastic bag twisted tight**

Figure 15: Steps to packing 18kg carton. Source Inderbitzin, 2013

Chapter 2: Sustainability

Our food supply chains have become bigger and more complex, yet the job of the producer to uphold the most sustainable farming practices possible has never been more difficult. Consumers want to know they are buying not only sustainable, but ethically grown, food and retailers therefore demand the same. This has led to systems such as GlobalGAP becoming the base accreditation standard required for many businesses enter such markets.

GlobalGAP is a pre-farm-gate business to business voluntary standard. It has established itself as a key reference for Good Agricultural Practice (GAP) that concerns aspects of food safety, environmental protection, worker's health, safety and welfare, and traceability (FoodPLUS and GTZ, 2008) in the global market place. The GlobalGAP standard outlines requirements for 'good agricultural practices' in places of primary production where international standards are scarce (Henson and Humphrey, 2009). In countries including Austria, Chile, Denmark, France, Germany, Japan, Kenya, Mexico, New Zealand, Spain, and the UK, the GlobalGAP has been incorporated into their domestic GAP standards, usually in the form of public-private joint ventures (Mitchell, 2008). Initially started as EUREPGAP in 1997 by retailers associated to the Euro-Retailer Produce Working Group (EUREP), it was renamed as GlobalGAP in 2007 as more and more producers and retailers around the globe were connected over time.

Sometimes it is thought that only first world countries can achieve sustainable farming practices but that simply is not the case. It could be seen that most of the farms visited were serious when it comes to sustainability. Operating under EU rules and regulations, Martinique growers have implemented interesting and effective methods in organic, plastic and chemical waste management.

Organic Waste

All growers aimed to return packhouse waste to the paddock. Of note was the relatively small amount of waste generated. Because of the effort and focus on bunch protection and fruit quality, there was very little fruit waste at the packing shed. Most waste was stem only. Growers focus on fruit waste levels less than 5%.

Compost

Most farms visited had some form of on-farm composting taking place as part of their fertilizer program. The most developed composting operation observed was at Bertrand Aubery's farm in Martinique. He owned a centralised composting facility, using waste from his company's seven, 60 ha farms. The banana waste was crushed, and during this process it was inoculated with water, molasses and Effective Microbes (EM).

Figure 16: Centralised composting site, Bertrand Aubery, Martinique. Source – Inderbitzin 2013

This inoculated waste was mixed with bagasse 50/50% by volume and windrowed and turned for two to four weeks. The final composting process was done on an aerated concrete slab for approximately four weeks.

Figure 17: Turned Compost site, Bertrand Aubery, Martinique. Source – Inderbitzin 2013

Figure 18: Compost turner, Bertrand Aubery, Martinique. Source – Inderbitzin 2013

Figure 19: 25kg bags of Compost ready for application. Corbana, Finca San Pablo Farm Source Inderbitzin 2013

Figure 20: In field composting, all trash deliberately heaped together. Corbana, Finca San Pablo Farm. Source Inderbitzin 2013

Corbana farm used compost as an important part of their fertiliser regime and also used it as a tool to improve soil organic matter. The placement of leaves and cut stem in the centre of the hexagonal plant pattern was also a deliberate strategy to improve the soil organic matter in the plant growing area. The application of compost in Central and South America was done by hand using 20kg bags. In Martinique machine spreading was practised.

Simple composting observed in Costa Rica involved cow manure, sawdust and microbes. Sawdust was used as bedding material and cattle lived on the material for eight days, thus mixing the manure and sawdust. Each day the bedding material was sprayed with microbes to aid the composting process. At the end of the eight-day cycle the manure and bedding material had started to compost and so was collected and applied directly to banana plants at a rate of 10kg/plant. In a year, this equated to 20t/ha.

Bio-fertilizer

Bio fertilizers are manufactured on farm using relatively cheap and easily sourced materials. In its simplest form, bio-fertilizer is a liquid ferment which encourages the multiplication of specific beneficial biology. The liquid can then be applied to the crop both as a fertiliser and as a foliar spray.

Figure 21: Storage shed of biofertiliser fermenting

Figure 22: Healthy batch of biofertiliser ferment

Corbana extensively used bio-fertilizers in their foliar and fertilizer program on their Finca San Pablo farm. A basic bio-fertiliser recipe is fermented for 30 days and consists of the followingcomponents, mixed in a 200 litre drum:

- 8 L molasses
- 90 kg of rice husk flour
- Powdered Milk
- 8 L of EM

With biofertilizer the best results are achieved if it is used regularly to maintain the population of the beneficial biology in the system. Corbana was one of the most advanced in the use of bio-fertiliser, using approximately 7,500 l/ha per year. They had reduced conventional nitrogen, phosphorus and potassium fertiliser input to approximately 350, 0 and 300 kg/Ha respectively whilst maintaining an average yield of 55 t/ha. Biofertilizer seems to be a novel approach to maintaining plant health and appeared to have the potential to complement existing fertiliser programs.

Plastic waste management

Plastic in the banana industry is a necessary evil; it is such an effective tool in protecting fruit to meet quality specifications. Producers are using more of it because of the waste savings achievable. The table below outlines the many instances plastics are now used.

Field	Packaging
Bunch cover - protects the bunch from the sun	Carton liner
Clip slips – between hands to prevent bruising and scaring	Slip sheets between banana clusters
String - to tie the trees together for wind strength	

Figure 23: Plastic application

Collection of plastic waste from the field

In most cases plastic is collected during harvest; the cutter collects all plastic together and the carrier loads it onto the cable way or harvest trailer. From time to time a special effort is made to walk through the plantation and tidy up. In Columbia, Bananeras De Uraba sub-contract out

the plastic collection task, because plastic is worth enough money to recycle. This is an interesting concept as it proves they have enough labour in the area to make this a separate job.

Recycling facilities

Major growing areas of Costa Rica and Columbia both have plastic manufacturing and recycling facilities near banana growing areas. Returning used plastic is therefore widely practiced. In Australia freight costs make recycling a lot harder. Plastic recycling increases the cost by $25/tonne, which includes the cost of collection, baling and carting up to 30 km.

Syngas

Syngas in Malaysia is an innovative company focused on waste-to-energy processing technology. Essentially it takes waste plastic, chops it and feeds it into a conversion machine. The machine melts the plastic back to oil where it is heated again to a gas and captured as a liquid – diesel. This technology is still in its early stages but is definitely a future option. The appeal of this technology is the product can be used directly on farm, as shown below.

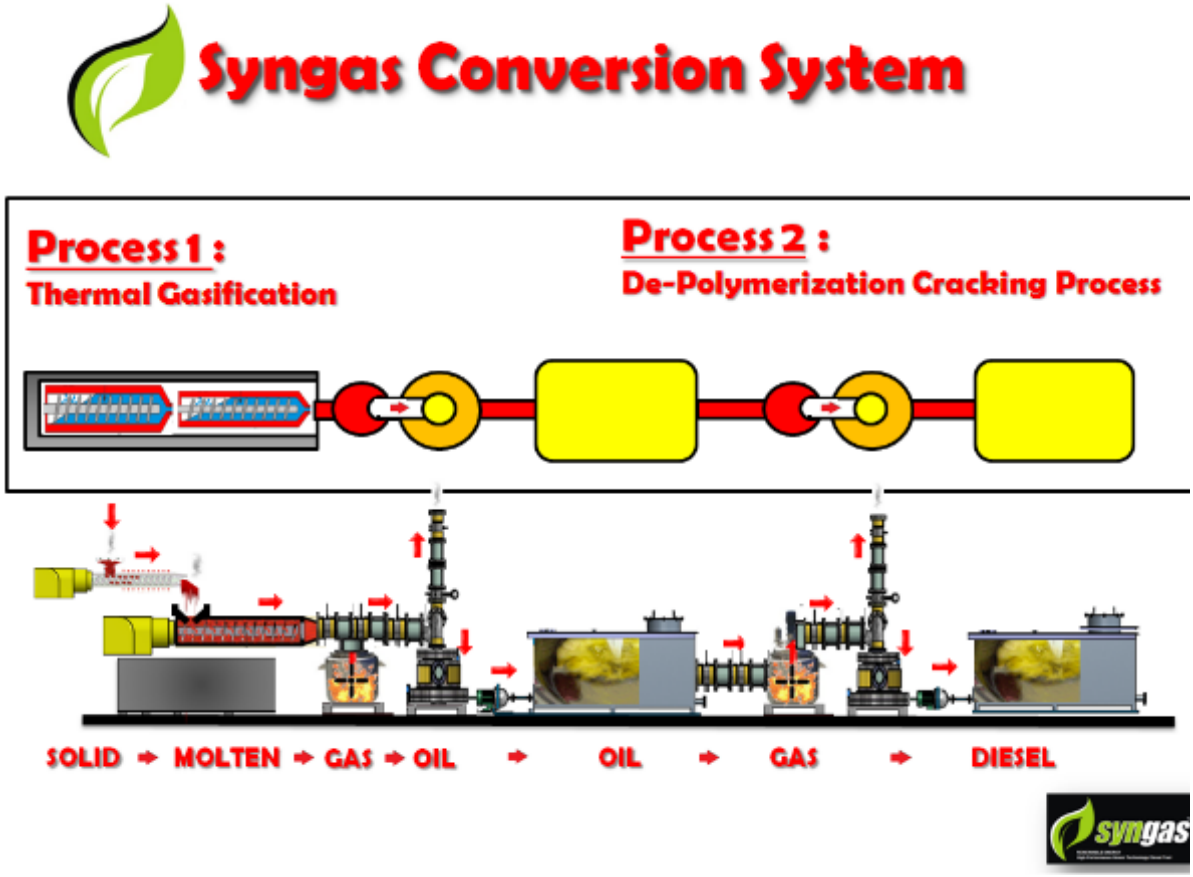

Figure 24: Conversion machine process. Source Mitchell, 2013

1	Plastic feedstock is fed into extrusion machine
2	Molten plastic is fed into a reactor set between 400-600 degrees Celsius
3	Plastic undergoes gasification in reactor into hydrocarbon gas
4	Gas is flows into catalyst chamber to interact
5	Clean gas is run through distillation chamber
6	Gas is condensed and diesel captured

Figure 25: The conversion process, Source Bahar Mohd Nor, S, 2013

Plastic feedstock and efficiencies

The plastic used on farm fits the criteria for the conversion process; that is, it consists of polyethylene and polypropylene. This gives the banana industry the perfect opportunity to get the best efficiencies from the system. Test results in Malaysia indicate that 85% conversion rate can be achieved on clean feedstock (Source Bahar Mohd Nor, S, 2013). Given that many different plastics will be used, trials need to be conducted to gain a better understanding of the practical application in our situation.

Designed for transport

Syngas has designed their machine to fit the dimensions of shipping containers, allowing the machine to be easily transportable. This could change where growers send their waste. Instead freighting plastics to landfill, waste could be stockpiled on farm, or at central points in the growing region and the conversion machine transported to it. It would most likely need to be transported with a portable shredder. Shredding the plastic is important to maintain even feed speeds into the conversion machine.

Figure 26: Conversion machine in construction, Source Mitchell, 2013

Chapter 4: The importance of biosecurity

The main diseases and pests of quarantine concern, as listed by Biosecurity Australia for bananas, are Moko, black Sigatoka, Freckle, Mealybugs, Armoured scales, Spider mites and Thrips (Australian Government, DAWR 2011). Panama TR4, a fungal wilt, is left off the official list as Australia already has TR4 in Darwin, in the Northern Territory (NT). It is however considered the biggest threat to the industry because there is no known control.

Australia's success

Australian banana industry has an enviable reputation when it comes to biosecurity. Australia is the only country to have eradicated Black Sigatoka. In 2001, an incursion was detected and by 2005 the industry was disease-free. The early reaction by industry and its ability to work together to overcome the disease is an example to the world. The success is a result of early detection, surveillance and eradication. With these three things as the focus of any biosecurity incursion, there is a high probability of eradication, or in the case of TR4, effective suppression.

Costa Rica – Moko

Dona Dorra is a plantation in Costa Rica with an effective system in dealing with Moko, a bacterial wilt. The farm was forced into a position where it had to implement a control system or it would be lost to the disease. A Moko inspector was appointed to cover the entire farm each week. If any disease was suspected it was dealt with in the same week. Everything was well documented to ensure there was record of the disease spreading. The system was designed around early detection and effective removal. Strategies were implemented across the farm to reduce disease pressure. Farming practices had to change; for example harvesting tools are disinfected from plant to plant, and weed control is now 100% chemical. *'The system is working because they no longer have the disease in the fruit, they have only found it in the mother plant and follower'* (Medina, L, 2013).

Biosecurity responsibility

Growers, industry and government, as a collective, must remain vigilant. Growers have a massive responsibility to understand what threats exist and what can be done to prevent incursions on their farm. Industry has the responsibility to disseminate the appropriate

information to allow growers to make the correct decisions. Government is responsible for listening to growers and industry and enabling research and development where it counts.

Conclusion

If high-end markets are the target, fruit quality must be of the highest standards. If we can meet consumer demands in Australia than we can surely play on the world stage. This industry is shackled to protecting its domestic market but if this country is to move with the times the Australian industry must look at export markets.

Over the next 10 years, Australian bananas need to establish a solid international market. We have the tools to achieve high quality that rival the best; the next step is understanding the supply chain. To do this we must invest in the correct people with the right skills to placer-position the industry. We need to work through the supply chain logistics, perhaps even partnering with other Australian products that share similar cool-store supply chain parameters. It will require some serious investment by the industry but the author feels that we are seriously lagging behind other horticulture crops. This however does have its advantages – we can partner with other horticulture crops and learn from them.

Waste streams need to be researched and valued. This is the first step to understanding the economics of the processes. At a grower level, all bunch weights should be recorded, only then can the full picture of waste be quantified. The waste that cannot be avoided must be returned to the field – there is no better place for it. Other forms of waste, such as plastic, need to be recycled. Governments need to provide more pilot waste recycling programs in the far north, where 90% of the industry operates.

Biosecurity is what Australian bananas are built on. The industry is in a unique position, as it is isolated from world markets. The banana industry needs the continued support of the Department of Agriculture and this cannot be done without funding. More R&D is needed to prevent TR4 spreading. Biosecurity systems need to be put in place now to ready the industry in the case of a disease incursion occurring in the major grower region of north Queensland.

Recommendations

- Growers need to protect the bunch, protect the bunch, protect the bunch! This needs to be done in the field to reduce waste and improve efficiencies. The shed is not a hospital.
- The different harvesting methods observed all follow the same principle – transport the fruit the same way the fruit grows – hanging vertically.
- The industry-standard carton must change to a new carton that does a better job in protecting its contents.
- Bio-fertiliser is a low-cost and novel approach to reducing conventional fertiliser use, that can complement existing fertiliser programs.
- Recycling systems need a rethink – smaller localised facilities are needed to avoid senseless freight costs.
- Biosecurity systems need to be implemented prior to an incursion, so must be planned in advance.
- To overcome biosecurity incursions, three things are important – constant surveillance, leading to early detection, and effective eradication.

References

1. EMRO. (2015). What is EM? emrojapan.com/page/7-whatisem/

2. White, A., D. Gallegos, and T. Hundloe, *The impact of fresh produce specifications on the Australian food and nutrition system: a case study of the north Queensland banana industry.* Public Health Nutrition, 2011. 14(8)

3. Medina, L (2013) Personal Communication. Banana Technical Manager, Fyffes, Costa Rica

4. Procarton, 2014. Fact File Part 6 – Folding Cartons *Procarton.com/files/publications_item/fact_file_71.pdf*

5. Margetts, J 2014, Australian Banana Industry Strategic Investment Plan, abgc.org.au/projects-resources/strategic-plans/

6. Australian Government – Bureau of Meteorology, *http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall/index.jsp*

7. http://www.freshforkids.com.au/fruit_pages/banana/banana.html

8. Australian Government – Department of Agriculture and Water Resources, http://www.agriculture.gov.au/biosecurity/risk-analysis/plant/banana-philippines/biosecurity_policy_determination_for_bananas

9. Mitchell, C (2013) Personal Communication. Managing Director, Syngas, Australia

10. Bahar Mohd Nor, S (2013) Personal Communication. Managing Partner, Syngas, Malaysia

11. http://www.fao.org/docrep/019/i3627e/i3627e.pdf)

Plain English Compendium Summary

Project Title:	**Name of project: Bananas. Production, sustainability and understanding biosecurity importance**
Nuffield Australia Project	1304
Scholar:	Paul Inderbitzin
Organisation:	HIA and industry levy payers
Phone:	+61 400 965 367
Fax:	+61 7 4060 2070
Email:	paul@kureenfarming.com
Objectives	1. Investigate methods to achieve the highest standards of fruit quality 2. Consider other sustainable farming practices and methods to utilise plastic and organic waste 3. Understand the implications of on-farm biosecurity, especially Panama TR4
Background	Banana production is a high-risk crop and consumers want a blemish free product – what more can the supply chain do maintain the value of the humble banana? What more can the grower do to minimise waste and utilise sustainable practices? How important is biosecurity?
Research	Mainly focusing on the banana producing parts of the world, but also covering more of the supply chain, cartons for transport and plastic recycling.
Outcomes	Protect the bunch, correct size carton for packaging is critical, understand your supply chain, waste has a value, biosecurity vigilance is essential
Implications	By putting more resources into protecting the bunch, growers can potentially save by minimising waste. Plastic waste streams could soon be a valuable resource to farmers, just like organic waste is now. Biosecurity relies on growers, industry and government working together.