AERIAL APPLICATION ASSOCIATION OF AUSTRALIA LTD

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Aerial Application and AAAA

Aerial application is the broad term for a range of aviation activities that include the application of material from aircraft, including spraying of pesticides, application of liquid and granular fertiliser and trace elements, sowing seed such as rice and firebombing of bushfires.

The Aerial Agricultural Association of Australia (AAAA) was formed in July 1958 at a meeting jointly convened by the then Department of Civil Aviation and the Bureau of Agricultural Economics. AAAA's mission is to promote a sustainable aerial agricultural industry based on the professionalism of operators, pilots and staff and the pursuit of industry best practice.

- Membership of the AAAA consists of operators and pilots of agricultural aircraft. There are approximately 130 active aerial application operators in Australia, and approximately 300 application pilots. AAAA has over 75% of all application operators and pilots as members, controlling over 90% of aircraft in use. AAAA is therefore widely representative of and qualified to speak on behalf of the aerial application industry.
- Capital investment in the industry exceeds $200 million. Agricultural aviation directly employs 2000 personnel comprising pilots, field staff, maintenance staff and administrators. A further 2000 people enjoy part time employment. The industry uses more than 300 specialist aircraft with supporting vehicles and equipment, together with established aircraft maintenance facilities throughout the agricultural areas of the country.
- The Association has its national office based in Canberra and is governed by a Board of Directors with representation from each State and Territory of Australia. The Board is in constant consultation with the CEO and local agricultural operators and meets formally on a quarterly basis.
- The industry has progressed considerably in knowledge, skill and degree of professionalism since the late 1940's when the image of the 'crop duster' was daredevil.
- Today's application pilot is highly trained and licensed under both Federal and State legislation. No other applicator of agricultural chemicals has the degree of training of the application pilot, who is required to have a commercial pilot's licence, an agricultural rating and a chemical distributer's licence. The majority of operators and pilots are accredited under the AAAA "Spraysafe" program. AAAA's latest program—the Air Improvement Management System—AIMS— is an integrated quality and safety assurance system based on independent audit and accreditation.
- One of AAAA's key roles is to enhance education and professional development throughout the industry. The Association therefore conducts a comprehensive program of conference and convention activities to keep members up-to-date with legislation, practices and other developments. Meetings include sectoral Air Improvement Meetings (AIMs) for rice, cotton, Far North Queensland and top dressing, State Conferences and the Annual Convention.

Further Information:

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Aerial Application – An Innovative Industry

From Tiger Moths to turbines and beyond

In its 50-year history, aerial application in Australia has constantly improved its technology and management systems to become a highly efficient industry. Largely through the innovations created by members from within the industry, aerial application now enjoys the results of a modern, safe and environmentally friendly industry.

Five revolutions are prominent in the development of aerial application:

1. **Improved aircraft:** Aerial application has benefited greatly from improved aircraft performance and safety over the years. The first aircraft used in Australia for dusting in 1947, spraying in 1948 and spreading the following year were DH 82 Tiger Moths. Originally designed as two-seater military aircraft, the planes had to be modified by removing the front cockpit and replacing it with a hopper. These bi-planes were slow, powered by a 130hp engine, and had a limited payload of 33 gallons of spray or 330lb of super-phosphate. They were phased out by 1965 because of their high accident rate and the availability of safer, more suitable alternatives. In the 1960s, purpose-built aircraft were introduced to the market, allowing for a larger hopper size and greater pilot safety.

2. **Turbine Power:** It was not until the 1980s that heavy piston engine aircraft were supplemented with the lighter turbine engines that doubled the aircraft's power and decreased its weight. This development vastly improved the reliability, safety and productivity of the aircraft.

   Unfortunately, the level of sophistication required in the manufacture of turbine engines makes them significantly more expensive than piston engines. With all turbine engines being manufactured outside of Australia, mainly in the USA, the dollar exchange rate also has a dramatic effect on cost. The cost of a brand new turbine engine ranges easily between AUS$490,000 and AUS$900,000, with the engine's cost comprising at least half of the total aircraft cost.

3. **Global Positioning System (GPS):** In the early days of aerial application, human markers had to use flags to direct pilots across crops and fields. Two markers, or people, were placed at opposite sides of the field and moved across at regular intervals to guide the planes accurately. Naturally, the method was somewhat inaccurate and proved problematic with occasional overlaps or gaps in spray patterns across odd shaped fields.

   With the advent of the Global Positioning System (GPS), a free service inaugurated by the United States Department of Defence, sub-meter guidance for aerial applications became a reality in the early 1990s and eliminated the need for human ground markers. Based on references transferred by a series of satellites orbiting the earth on a 24-hour basis, GPS allows pilots to calculate their exact position through an on-board computer. Using a minimum of four satellites, the computer can be used for pre-flight planning, in-flight guidance and recording flight path data for later evaluation (Source: Aerial Agriculture in Australia, Derrick Rolland).

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Aerial Application – An Innovative Industry

One of the major advantages of GPS is that the pilot can now change their application pattern or direction at any time, dictated by wind shifts or other reasons, without wasting valuable flying time waiting for ground markers to be repositioned. Pilots can punch in the key points of the field's layout and the swath width required and leave it to the computer to indicate when the pilot should position the aircraft to carry out the spraying within centimetre accuracy. The same course can be flown over and over again with sub-metre accuracy – that is, less than one metre's difference in the flying course no matter how much time passes between flights.

GPS also allows for accurate mapping of paddock shapes, hugely improving the accuracy of spraying and therefore the productivity. Furthermore, data logging through GPS has allowed pilots to prove what was sprayed and where it was distributed. This allows for greater accountability and transparency in the industry.

Innovative developments for GPS are already in use, including precision applications that match the product application rate to a prescriptive map from an agronomist based on Geographic Information Systems (GIS). Variable rate technology is now a reality, with farmers and agronomists better able to match product placement with crop requirements.

4. **Better management systems:** With improved aircraft in the industry came better management systems. This change incorporated sound management principles and computer programs to improve flying safety and chemical management. Application businesses are early adaptors to improved systems, with a number of companies maintaining various ISO quality and environmental assurance accreditations. Application operators and pilots have developed a greater understanding of how droplet size, wind and weather can affect drift, and they are trained to implement an Application Management Plan (AMP) on any property before spraying to prevent drift. This revolution is ongoing with the latest AAAA program—the Aerial Improvement Management System—AIMS—featuring a fully integrated risk, quality and safety assurance system backed by independent auditing and accreditation.
5. **Better technology:** Better controlling drift and increasing spray efficacy has been the industry's focus for decades. Managing droplet behaviour is now a significant part of an application pilot's training. Application pilots require a detailed knowledge of the variables that affect spraying such as changing meteorological conditions including atmospheric stability and the effect of water added to the chemical, the number of droplets required and the droplet size.

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Aerial Application – An Innovative Industry

Developments from within the industry

Riverina Airwork/ Field Air – The Bickley Boom

Thanks to an invention by Bickley Thomas of Finley, NSW, aircraft can now play a more significant role in the distribution of chemicals over rice fields. The Bickley Boom had its first year of commercial use in 2001, much to the delight of farmers and operators in the Riverina used area. The new boom allows aircraft to use the "squirt" method of rice spraying previously only by motorbikes and helicopters and reduces aerial drift by 90 per cent. Instead of using the full length of the wing, the Bickley Boom has only one nozzle in the middle of each wing to spray the chemical onto the water below. Since the chemical only needs to come into contact with the paddy water, instead of the entire field or crop, the chemical only needs to be sprayed at 25 metre intervals to take effect.

The nozzles have been lowered below the trailing edge of the wing by 40cm, allowing the spray to come out into "clean air" – air unaffected by the windshear off the plane. The two streams from the nozzles contain large droplets of the chemical solution, thereby reducing the drift and making aerial distribution a very competitive option for application. The new boom has also enabled aircraft to distribute certain chemicals that were previously limited to motorbike and helicopter rigs. Bickley says the new squirt method of the boom is a completely different method of application for aerial application operators who are used to the traditional spraying technique that aims for complete coverage of the crop or field.

Jones Air Rotating Boom—JARBA

The rotating boom allows pilots to adjust droplet size and turn sections of the boom off in-flight. The rotating boom uses the windshear to break-up or protect droplets, thus adjusting their size. Previously, pilots had to land to adjust nozzles to reduce or increase droplet size to suit the conditions.

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Aerial Application to the Rescue

Aerial attacks on plagues, fires and spills

Across Australia, aerial application aircraft have proven invaluable in fighting fires, plagues and oil spills. Pilot skill, aircraft maneuverability and adaptability have made application aircraft an essential resource in combating threats to Australia's agriculture and environment.

Locusts

Locust plagues can devour crops at an enormous rate and the highly mobile nature of swarms and their ability to migrate over large distances means that virtually all agricultural areas are at risk from damage.

Aerial application operators are essential to Australia's fight against plague, migratory and spur-throated locusts, with aerial spraying of insecticide as the principal method of control. Swarms are sometimes located in rugged terrain and must be stopped before they reach cropping areas. Application aircraft are rigged to disperse the appropriate chemicals in a professional and accurate manner and are the quickest and most efficient means of attack.

Application operators carry out spraying under contract to the Australian Plague Locust Commission and various State Government agencies. GPS units are also fitted to spray aircraft to ensure the precise application of insecticide within the target area.

Fire Fighting

Application pilots and aircraft have played a vital role in fire fighting in Australia for the last 50 years. The experience and training of application pilots is valuable in fire fighting, as is the maneuverability of the aircraft—whether a fixed wing aircraft or a helicopter.

Dropping foam to suffocate the fire or retardant to prevent trees from burning, the application aircraft will fly 10 to 20 meters above the fire, controlling the drop to suit the conditions. A sophisticated computer-controlled door on a fixed wing aircraft can manage a 3000 litre drop in two to three seconds, split the load over different areas, or trail the load over five hundred metres. Tanks or buckets on helicopters allow extremely accurate placement.

Fast initial response and aggressive attack in the early stages of a fire can stop the fire's progress. Aerial application is recognized world-wide as an important tool in every fire agencies toolkit for ensuring bushfires are extinguished as soon as possible.

The aircraft's ability to reach rough and remote terrain to control the fire until ground units arrive is a critical advantage in fire fighting. The appropriate use of aircraft can prevent millions of dollars of damage and protect a wide range of assets that would be otherwise vulnerable.

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Aerial Application to the Rescue

Mice and rat baiting

The day-to-day checks and controls applied to aerial application have prepared operators and pilots for safe distribution of a number of chemicals and baits, including mouse and rat baits.

In Queensland, mouse bait can only be applied by air and at a low rate of 1kg per hectare. Each plane load of Mouseoff™ bait is dropped from about 20 metres and can cover 2000 acres very quickly, targeting mice with four grains per square metre – killing at least four mice per square metre. GPS systems are used to mark the target area and report on drop areas.

Mouseoff™ contains sterilised wheat grains, coated in zinc phosphate powder and encapsulated in sunflower oil.

Oil Spills

Australia has used aircraft to combat oil spills since the late 1970s, but in 1996 Australia's aerial application industry won the nation-wide contract to combat oil spills in Australian waters.

The aircraft are used in a similar manner to other application situations, except in a marine environment. Dispersants are sprayed on the oil spill to reduce the size of oil drops so that they may be more readily consumed by bacteria and decrease or prevent the spill's impact on the shoreline, birds and marine life.

Application aircraft and pilots are perfectly suited to controlling oil spills because there is a wide spread of operators within striking distance of the coast and the aircraft are already rigged for chemical spraying.

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Aerial Application – Cotton Fact Sheet

Protecting Australia's cotton industry

Australia's cotton growers rely on aerial spraying to gain the greatest possible yield of cotton from their fields.

The speed and safety with which application aircraft can cover the vast areas of cotton that must be protected by pesticide application means aerial application plays a critical role in the cotton industry.

A field that would take a ground rig several hours or longer to complete can be more effectively covered by an aircraft in less than an hour.

When taking into account environmental and drift management considerations, the available windows for spraying in optimum conditions are considerably reduced. This makes it even more critical for aircraft to be used to deal with the problem and ensure the minimal possible threat to cotton yield.

The comprehensive training of application pilots on all issues relevant to accurate application and sound drift management is supported by key AAAA programs that provide ongoing professional development, and audit and accreditation through the Spraysafe and AIMS programs.

These programs also support the system based approach to Best Management Practice through Cotton Australia programs, including the consistent use of Application Management Plans for every application onto cotton.

Insect attack is the greatest threat to successful cotton growing in Australia, with more than 30 types of insect pests. Heliothis caterpillars are the most destructive pest, eating the cotton bolls and destroying the cotton lint inside, while native budworm, cotton bollworm, spider mite and cotton aphids are the most common problem insects. (Source: Aerial Agriculture in Australia Derrick Rolland)

As Australia's cotton growing industry has developed across New South Wales and Queensland, application aircraft have become more involved in the application of fertilizers and trace elements in addition to applications of insecticides, herbicides, fungicides and defoliants.

When the cotton bolls have opened, pilots spray defoliant on the plants to speed up the plant's process of dropping its leaves. This makes it easier to pick the cotton without its leaves contaminating the lint.

All aircraft used in cotton spraying are fitted with on-board GPS to guide the aircraft accurately across the fields.

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Aerial Application – Operation Spraysafe

A Professional Education and Accreditation Program

Operation Spraysafe was initiated in early 1985 when AAAA convened a meeting in Canberra with aircraft operators, chemical companies, the Departments of Primary Industries, Agriculture, Environment and conservation groups. At this meeting it was identified that the agricultural industry needed an initiative to establish increased professionalism and a framework for continuing improvement in the application of agricultural chemicals by aircraft.

The Operation Spraysafe campaign commenced with limited resources and the following priorities:

- education and training of industry personnel,
- an accreditation program for aircraft operators,
- to take control of our own industry in the eyes of the regulatory authorities and the general public and
- to educate all our clients with regard to aerial application.

In response to the perceived lack of knowledge within the industry regarding the chemicals in use and the methods of aerial application, the AAAA published a *"Pilots and Operators Manual"*. This manual provides the agricultural pilot with the required guidance necessary for him to avoid off-target contamination and a detailed knowledge of the chemicals in use and their effect on the environment.

Since its inception, AAAA and Spraysafe have trained over 900 application pilots and approximately 250 mixers in safe chemical handling and application.

In 2002, AAAA introduced the Professional Pilots Program (PPP) which requires participating pilots to participate in a range of ongoing professional development opportunities every three years to secure the renewal of the Spraysafe accreditation, which in turn is accepted by all States and Territories as a competency prerequisite for holding a chemical distribution licence.

The Spraysafe pilot level accreditation has been independently mapped against the relevant national competency standards and assessed as meeting all competencies to the AQF Level 5 standard. Spraysafe is now recognized by all chemical regulators as the de facto national competency standard for aerial application pilots.

Accreditation Levels Under Spraysafe

Accreditation of Operators

Operators are required to meet stringent guidelines in order to achieve Spraysafe accreditation, including a full inspection of the operators' facilities.

Initial and ongoing accreditation requires the completion of an independent evaluation of the facilities and systems of the company against the AAAA Spraysafe checklist.

Approximately 80 operators have been accredited with Spraysafe.

Continued over …

Aerial Application – Operation Spraysafe

Accreditation of Pilots

Agricultural pilots are required to have a comprehensive knowledge of industry-related issues and practices.

Pilots are examined on their knowledge of the 270 page *"Pilots and Operators Manual"* with a two-hour exam. This exam is externally supervised, returned to and marked by the AAAA office. The pass rate required is 70%, and upon successful completion of the exam a certificate is issued to the pilot.

To date, over 900 pilots have successfully completed the Spraysafe exam since inception of the program.

Accreditation of Loader / Mixers

In order to promote safe procedures on the ground, loaders and mixers (ground support staff) AAAA produced the second Spraysafe manual — *"Chemical Handling Manual for Agricultural Aviation"*.

The loader / mixers are tested on their knowledge of this manual, examined for two hours and receive certification upon successfully completing the exam. Again the pass rate is 70% and 119 have so far been accredited.

Both the *"Pilots and Operators Manual"* and the *"Chemical Handling Manual"* were comprehensively reviewed and updated in 1998 by the University of Queensland's Centre for Pesticide Application and Safety (CPAS).

A further initiative of the Association under Spraysafe has been the education of our clients - farmers, farm advisers, agronomists and consultants. These key stakeholders play a critical role in ensuring no application pilot or operator is pressured into applying chemicals under adverse or unsafe conditions.

In summary, the Spraysafe program is aimed at ensuring applicators, pilots and support staff meet agreed standards in a number of key areas.

The Spraysafe program is a significant education program for the continued professionalism of the industry and has excellent support from all levels of the industry and key stakeholders and regulators.

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Aerial Application – Protecting the Environment

Maintaining a rigorous environmental management standard

Australia's aerial application industry is the most highly regulated, trained and environmentally responsible industry working in the chemical application field today. Not only do pilots, loaders and operators have in-depth and regularly updated knowledge and training, but the chemicals, aircraft and management systems meet strict environmental and safety requirements.

Chemical assessment: Before any spraying or spreading can begin, the chemicals used must be approved by the Australian Pesticide and Veterinary Medicines Authority (APVMA). The APVMA evaluates, registers and regulates agricultural and veterinary chemicals in Australia. Before an agricultural or veterinary chemical product can enter the Australian market, it must go through the APVMA's rigorous assessment process to ensure that it meets high standards of safety and effectiveness. Ensuring that agricultural and veterinary chemicals registered for use in Australia are safe for humans is a fundamental objective for the APVMA. (Source: APVMA website)

Aircraft safety: The Civil Aviation Safety Authority manages the licensing of Australia's aerial application operators. Before a person or organisation can conduct aerial application operation, they must hold an Air Operators Certificate (AOC) issued by CASA. The operator has to satisfy CASA that they can provide and maintain the personnel, documentation, equipment and facilities necessary to engage in the work. (Source: Aerial Application Pilots Manual).

Pilot licensing: By world standards, Australian application pilots are required to have the highest application pilot qualifications. All aerial application pilots undergo rigorous training and regular re-education to be able to work in the industry. Firstly, the pilot must have a commercial pilot's licence and attend a CASA approved school for intensive agricultural flying and theory. Following successful completion of written and flown examinations conducted by CASA, the pilot gains an Agricultural Class 2 Rating. During the pilot's introduction to the industry, he or she operates under the supervision of a CASA approved Chief Pilot. After attaining 1000 agricultural flying hours, the pilot is re-examined and may be issued with an Agricultural Class 1 Rating.

All States also require the pilot to hold an Agricultural Chemical Licence or Rating. This involves an examination conducted by the AAAA and accepted by the regulatory authorities such as Primary Industries and Environment.

The majority of pilots are accredited under the AAAA "Spraysafe" program, which trains the application pilot to avoid off-target contamination and provides them with a detailed knowledge of the chemicals in use and their effect on the environment. The majority of operators, loaders and mixers are also accredited under Spraysafe (See Operation Spraysafe Fact Sheet)

In addition, pilots and operators benefit from regular industry Air Improvement Meetings, safety courses and conventions run by the AAAA.

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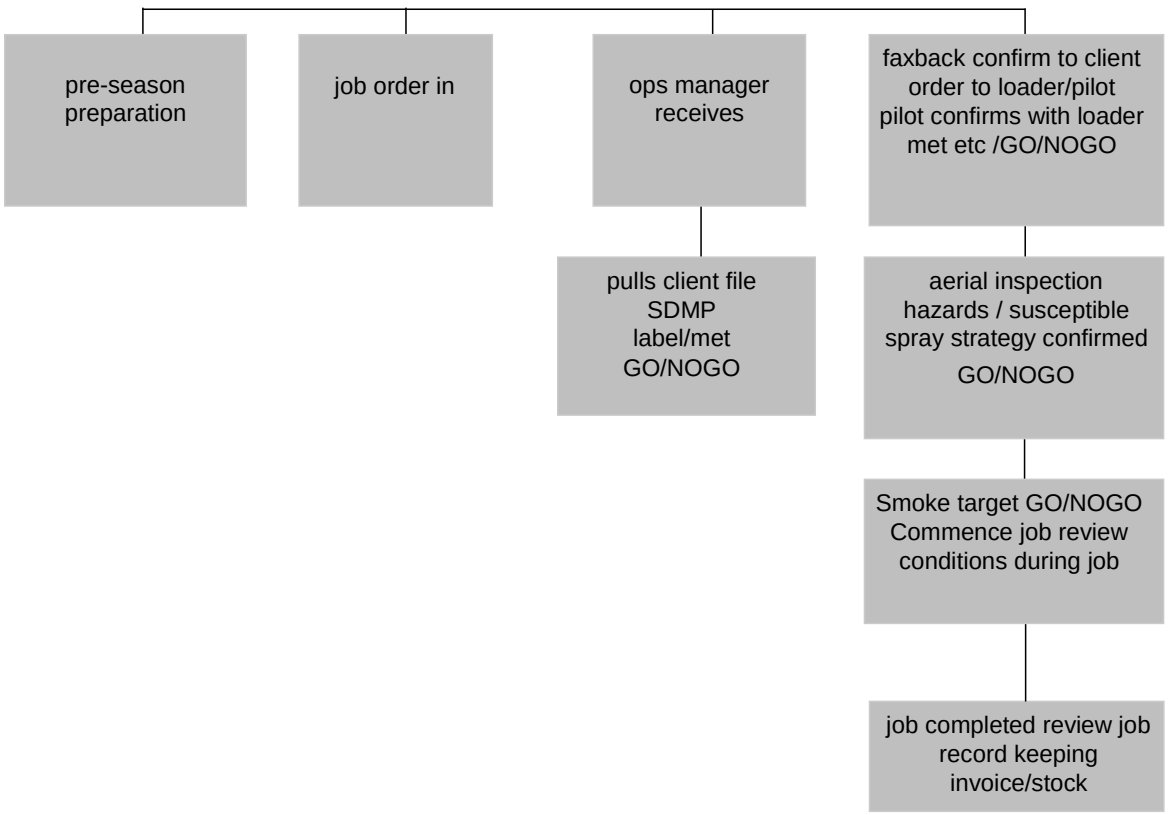
Aerial Application – Protecting the Environment

Planning and responsibility: The AAAA and industry are committed to continued improvement, development and promotion of best practice in aerial application. A key to best practice, and a feature of the work of most operators, is the Application Management Plan (AMP).

An AMP of a property is done before carrying out any work on that property. It includes a map of the property, including any watercourses, trees, buildings and power lines, and details the contingencies for spraying under varying weather conditions and wind directions. Combined with on-board GPS to guide the pilot, the AMP is the farmer and pilot's record of due diligence.

The cotton industry, for example, has developed a Best Management Practice (BMP) program covering all facets of cotton growing, including pesticide application, requiring the use of an AMP.

A Typical Aerial Application System that helps protect the environment



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Aerial Application – Tropical Crops

Saving bananas from Black Sigatoka

Aerial application operators and pilots in tropical North Queensland are not only part of the routine protection of bananas, they have played a key role in the future of the fruit in Australia. Application pilots were the lynch pin in a fight against the devastating Black Sigatoka fungal disease that had been found in the Tully banana growing district.

- The majority of aerial application spraying in North Queensland, the tropical area of Australia, involves bananas. Cane is the second major wet season crop which is aerially sprayed with herbicides to kill grasses, weeds and vines growing in the cane field. Spraying is conducted to a lesser extent over peanuts on the tablelands, potatoes, melons and pumpkins.
- Bananas are the only intensively sprayed tropical fruit, almost exclusively receiving their preventative spraying of fungicide by air. They are one of the few crops where the use of aerial application is not only a beneficial method of spraying, but the only practical and safe method.
- Since banana crops are often surrounded by rainforest and tall timber and located close to water, they have unusual shaped paddocks that demands a lot of maneuvering by the application pilot.
- With an average rainfall in the area of 4.5 metres, one of the highest rates in Australia, the soil is too moist for ground rigs. The massive rainfall allows only small windows of opportunity for spraying, so farmers prefer aerial spraying to complete the job much more quickly.
- Black Sigatoka is an airborne fungus that attacks the leaves of the banana plant from above and can cause premature ripening and dead leaves and prevent fruit from forming. Because of the banana tree's height and the airborne nature of the fungus, aerial spraying is the only effective means of combating the disease.
- Application aircraft were used to spray all banana farms in the Tully district of North Queensland with a curative and a preventative fungicide on alternate seven-day rotations for six months.
- While Australian bananas have withstood the more common Yellow Sigatoka disease for the past 20 years, their future depends on the eradication of Black Sigatoka, which is eight times more virulent. The economic consequences of the disease, if established, could be devastating.

Further Information:

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Aerial Application – Pattern Testing

Improving accuracy and reducing waste

Aerial application operators routinely undertake spray and granule pattern testing of their aircraft to ensure the performance of the spray pattern in the field is safe, efficient and effective.

Pattern testing allows operators and pilots to manage the equipment so as to offset any potentially negative effects of aircraft near wake turbulence and to establish a known spray quality for a given aircraft set-up.

While application pilots have always sought to improve their accuracy and efficacy, it was not until the 1980s that computer-aided, formalised pattern testing technology and procedures developed in earnest in the USA.

While the equipment and array varies, the principles are similar, in that the aircraft is flown over an array with its dispersal equipment functioning. The array allows the collection of data, analysis by a trained operator, adjustments to equipment to be made, and then the process repeated until an optimum application pattern is established.

Pattern testing can determines a plane's swath width, droplet size, volume of application, water rate and evenness of application. The data can also be used to determine an aircraft's optimum height, speed, and nozzle placement and selection.

While much of this information can be predicted with some accuracy using computer modeling such as AgDrift or AgDisp, field testing is still a relevant and valuable means of establishing a particular aircraft's performance.

There are three common methods of pattern testing:

- **Droplet analysis:** Water sensitive paper is placed strategically across a field or through a canopy from top to bottom. The aircraft then makes a pass over the field and the paper, which reacts to moisture, reveals dots where it has been sprayed. Using a high-resolution scanner, computer and software, the droplet size and number per paper can be established and extrapolated to the application rate recovered and the amount lost to evaporation or downwind deposition by the particular aircraft.
- **String analysis**: String is an efficient collector of spray. A 1mm diameter cotton string, suspended in the air, is a more efficient collector of spray drops than flat surfaces such as paper cards. This is because it only requires support at either end and can be put out in different lengths, locations and ways depending on the pattern sampling need. For example, string can be suspended vertically from the top of a canopy to ground level to gauge the penetration of the canopy. It can also be suspended vertically to determine the downwind deposition of spray.

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Aerial Application – Pattern Testing

- Once the string is in place, the aircraft sprays a fluorescent dye over the string to reveal the rate of application. The string is then run through a fluorometer which measures the amount of fluorescence that comes from the string with a data point at every four inches. A profile of the spray pattern is then graphed by the computer and interpreted so that adjustments can be made to improve the pattern.
- **Granule collection and analysis**: The pattern of spreaders can also be calculated by comparing data from the aircraft and spreader with on-ground collection tubes. Again using state-of-the-art computer and analytical technology, deposition can be accurately established and where required, corrected by adjustments to the aircraft spreading equipment.
- The instantaneous results from pattern testing allow the operator and pilot to adjust nozzles or other equipment immediately to achieve an even spray pattern. Greater evenness of the spray pattern means better application of the spray and less waste.
- AAAA often works with its preferred pattern testing company and the only SAFE accredited (by the AAAA's sister organization in the US) company—Spraycheck—to run spray pattern clinics for members. The process enables Spraycheck to test several aircraft per day and for pilots and operators to learn more about their aircraft, the latest technology and equipment options, and the details of spray droplet behaviour.