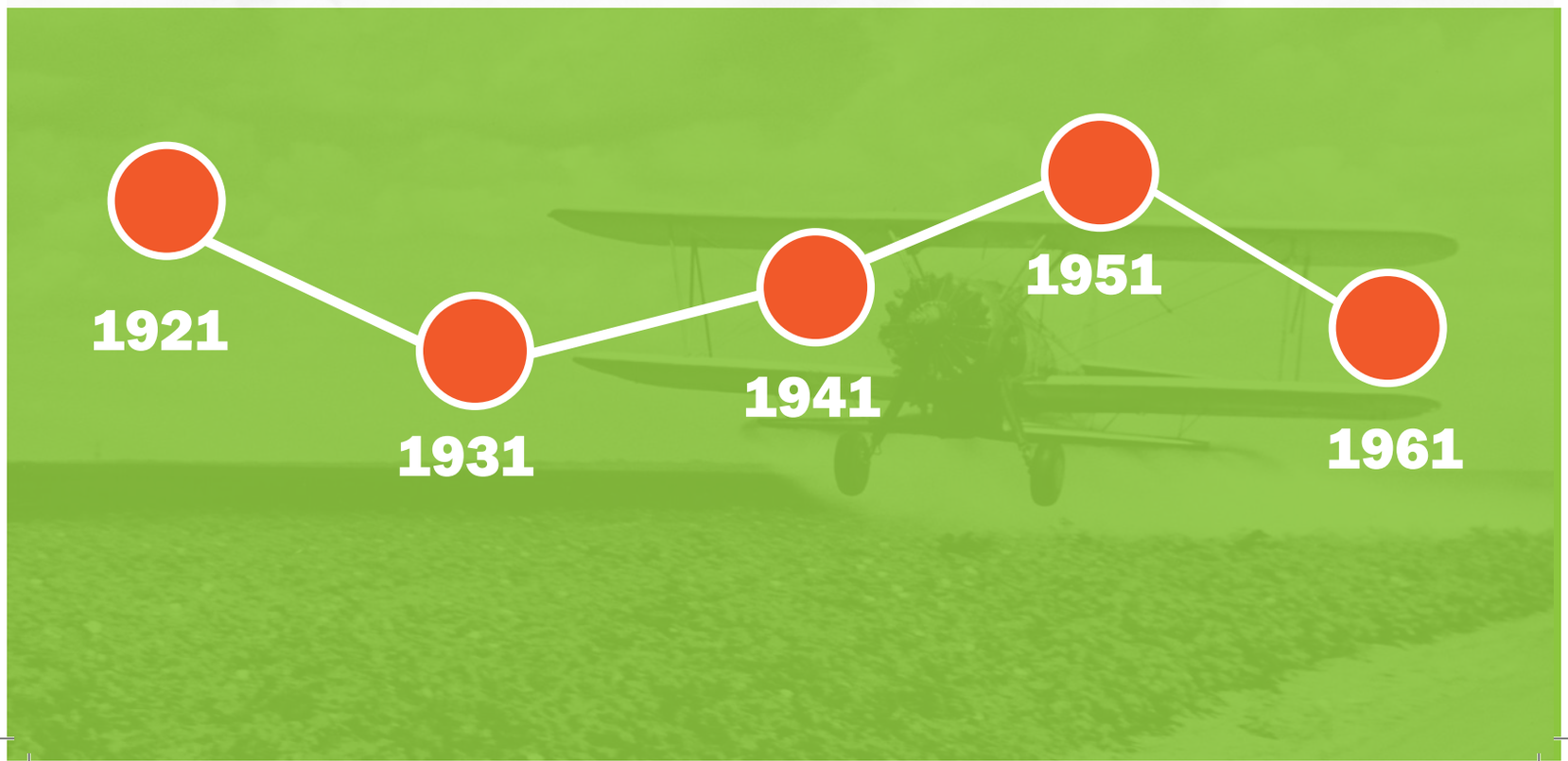
A CENTURY OF AGRICULTURAL AVIATION
1921-2021

Looking Back | Thinking Forward

A Century of Technological Evolution Protecting Farms, Forests and the Public Health



A CENTURY OF AGRICULTURAL AVIATION

Ag Aviation's Legacy

A Tour Through the Decades

1921

A modified Curtiss JN-6 "Super Jenny" airplane spreads lead arsenate dust over catalpa trees in Ohio in a successful experiment to kill sphinx moth larvae.

Curtiss Jenny in flight, 1923

- C.R. Nellie, an entomologist with the Ohio Department of Agriculture, came up with the idea of combating pests with an airplane. The concept was met with skepticism at first, but eventually a cooperative project was arranged to test Nellie's idea from the Federal Aviation Experiment Station at McCook Field in Dayton, Ohio.

- An outbreak of a destructive moth known as the Catalpa Sphinx in nearby Troy, Ohio, would serve as the test case. The first crop dusting test flight targeted a catalpa grove infested by the moth. Catalpa trees were an important natural resource whose wood was used for building fence posts, telephone poles and railroad ties.

- The plane used for the test was called a "Jenny," the nickname for an ex-military biplane trainer (officially the Curtiss JN-6). Lt. John A. Macready piloted the Jenny while passenger Etienne Dormoy manually dispensed the lead arsenate. Dormoy designed a crude metal hopper with a hand crank that was bolted to the plane's fuselage. The hopper's capacity was 32 gallons. On Aug. 3, 1921, Lt. Macready flew from McCook Field to the nearby catalpa grove to conduct the crop dusting experiment. In all, the dusting plane passed the grove six times and distributed about 175 pounds of the insecticide. After the 54 seconds it took to apply aerially, less than 1% of the insects remained alive on the catalpa trees after six days of observation of the targeted area. The speed, efficiency and overwhelming effectiveness of the aerial dusting experiment spawned the birth of the agricultural aviation industry.

1922

Curtiss biplanes are used to dust cotton fields to control boll weevils.

Illustration of a boll weevil on a cotton boll. It was the boll weevil that drove aerial application in its early days.

- By the early 1900s boll weevils had become a scourge to American cotton fields. The boll weevil is a perfect cotton-killing machine. Boll weevils left little standing in their path and disrupted entire local economies throughout the South. Better technology was badly needed to combat the boll weevil, a resilient pest whose path of destruction extended across the Cotton Belt. Approximately 614,000 square miles had been infested by the boll weevil by the end of 1922, leaving only 91,000 square miles of cotton-producing territory not infested.

- After the successful McCook Field experimental crop dusting flight, many more crop dusting tests were conducted at the USDA's Delta Lab in Tallulah, Louisiana. They conducted hundreds of dusting tests starting in 1922 at Scott Field, outside of Tallulah. The trials helped researchers fine-tune more effective insecticide mixes and improve ways of storing and releasing them.

- According to a 1929 report from the Texas Agricultural Experiment Station, aerial crop dusting of calcium arsenate increased cotton yields an average of 117 pounds per acre from the average untreated yield of 780 pounds per acre, a 15% increase in yield.

1924

Huff-Daland Dusters Inc.—the forerunner to Delta Air Lines—is the first known aerial application business established. It does the first commercial dusting of crops with its own specially built aircraft, the Puffer.

Huff-Daland Dusters Inc.

1930s

In the first use of aircraft for forestry seeding, aircraft were used in Honolulu, Hawaii, to seed mountainous forests that had been severely damaged by fire.

1930s–40s

Before and after World War II, planes used to spray crops were either civilian or military aircraft modified and equipped to apply liquid or dry materials. One of the most familiar was the open-cockpit Stearman biplane.

Stearman dusting cotton

- In the mid-1930s, the Army Air Service adopted the Stearman aircraft as its primary trainer. More than 10,000 were built before production shut down around 1943. In 1946, after the end of WWII, thousands of Stearman biplanes became available on the surplus market. Many of the planes were in like-new condition. Crop dusting companies began snapping them up at prices ranging from $250 to $875 per plane.

- Modifications were required to convert the Stearman from a military trainer to a crop dusting plane, yet few commercial firms existed that could perform such work. Several companies stepped into the breach to specialize in such conversions. These firms also began to install liquid-dispensing equipment on a custom basis, which meant for the first time that agricultural flying companies could obtain dusting and liquid-spraying equipment for their newly acquired aircraft. This development contributed significantly to the growth of agricultural aviation and the term aerial applicator was later developed, better encapsulating the work conducted by the industry.

- Stearmans became a favorite of many aerial applicators because they were affordable and easy to fly. It wasn't uncommon for aerial application operations to have several Stearman planes in their ag fleet.

Late 1940s

Helicopters begin to be used for various forestry operations.

- Helicopters were used for baiting in reforestation efforts. Baiting involved spreading wheat seeds soaked with a rodenticide (pesticide designed to kill rodents) in recently planted forests to give the tree seeds the opportunity to germinate and grow. This ensures the planted trees establish quickly, which in turn helps prevent soil erosion.

- Helicopters were used in various firefighting efforts, including dumping fire-retardant chemicals on fires, transporting people and equipment, and observing the fire from a high vantage point.

Late 1940s

Aerial seeding was particularly helpful on less-than-hospitable terrain. Aerial seeding was used to assist reforestation efforts in Oregon following the Tillamook State Forest burn. The Massabesic Experimental Forest research station in Maine experimented with aerial seeding in forest destroyed by fire following a drought. They concluded that aerial seeding of burned-over timberland is economically feasible and provides rapid seed distribution.

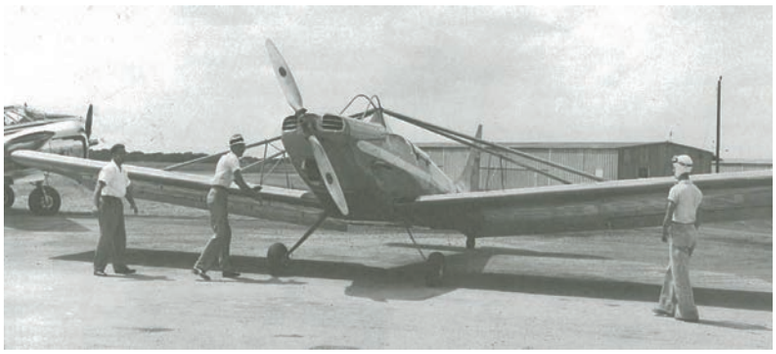
1947

The first nighttime aerial application takes place in California when a Stearman is outfitted with two 450-watt lights.

1950

The first flight of the Ag-1, the first plane built specifically for agricultural aviation, takes place Dec. 1, 1950. It was built under the guidance of Fred Weick at the Texas A&M Aircraft Research Center.

- The Ag-1 had a 39-foot wingspan and was powered by a Continental E-225 engine. Typical operating speeds were 60 to 90 mph, but it could attain a maximum speed of 115 mph.
- During the summer of 1951, the Ag-1 embarked on a countrywide agricultural tour where about 650 pilots flew it to test its capabilities. Since it was a single-seat airplane, the pilots had no way to receive dual control instruction or be checked out by a pilot familiar with the aircraft. After going through so many test flights, Weick observed, “The mere fact that the Ag-1 survived this treatment and returned to College Station appears to be some vindication of both its handling characteristics and its ruggedness.”
- The Ag-1 was a one-of-a-kind aircraft, and that is how it remains today, as it was the only one ever built. Weick knew from the start the Ag-1 was never intended to be the final product. It was designed to be a learning instrument as they developed and produced a finished commercial aircraft. Many of its features were later incorporated into nearly every new commercial ag airplane model built.



Leland Snow and the Snow S-1 in Texas, 1953. Snow was 23 years old at the time and had numerous aviation achievements to his credit which far exceeded his youth.

1951

Leland Snow, the godfather of the modern ag aircraft, begins designing his first ag airplane, the S-1. The 23-year-old Snow completed test flights with the S-1 in 1953. Snow flew the S-1 on dusting and spraying jobs in the Texas Rio Grande Valley and in Nicaragua until 1957. He followed up the S-1 with the models S-2A and S-2B, which were built when Snow moved production facilities to Olney, Texas, in 1958.

Early 1950s

Aerial applications at night in the San Joaquin Valley of California expand in order to protect bees during applications of parathion. Bees were present during the few hours of working daylight when applications could be made. Equipping ag aircraft with lights and flying at night allowed applicators to protect the bees. Bee kills became almost nonexistent, which pleased growers. From there, night applications continued to expand in another part of California to keep up with the work demand during busy parts of the season.

Leland Snow in 1956

Five expert duster pilots assisted our check pilot in his analysis.

The Agricultural "CUB" PA-18A

By ED HOADLEY

Reproduced with permission from FLYING magazine.

1952

The Piper PA-18A Super Cub was introduced as a sub-model of the PA-18 Super Cub series of aircraft. The A stood for Agricultural and the model had been modified to allow a hopper. The original Super Cub from Piper Aircraft went into production in 1949. The Piper PA-18A Super Cub remains a popular aircraft to start new ag pilots in before moving them up to bigger, faster ag aircraft.

1953–57

Howard Piper of Piper Aircraft approaches Fred Weick to see if Weick and Texas A&M would be interested in developing a new agricultural aircraft sponsored by Piper. Weick agreed and eventually joined Piper Aircraft as chief engineer of its development center. He produced his most famous model, the Ag-3, at Piper. Weick had envisioned the Ag-3 as being a smaller version of the Ag-1, but it became known by another name: the Piper PA-25 Pawnee. The Pawnee became the backbone of Piper's ag aircraft production.

Piper PA-25 Pawnee

1955

The first use of a fixed-wing ag aircraft for firefighting occurred when a Boeing Stearman was used to help contain a fire in the Mendocino National Forest in California. Willows Flying Service removed the spraying valves from the aircraft, and the pilot released the fire retardant from the 170-gallon tank using a hinged fire gate that was opened with rope.

1956–59

The use of agricultural aircraft for firefighting continued to increase. A 1956 report from the USDA Forest Service documented its effectiveness. In 1956 following the success of Willows Flying Service's Stearman for firefighting, six more agricultural aircraft were converted to air tankers in California. These aircraft became the Willows Air Tanker Squadron and were a critical part of the firefighting force there. These aircraft, piloted by agricultural aviators from northern California, dumped 83,000 gallons of water and 66,000 gallons of fire retardant on 25 different fires. In 1957 the squadron expanded from seven to 12 aircraft and their success began to inspire other states to start their own aerial firefighting programs. By 1959 the aerial firefighting industry was well on its way.

1956

The Transland Company produces the Ag-2 ag airplane.

The designers of Transland's Ag-2 emphasized greater payload and a design that could be produced in volume. Airframe construction began in 1954.

- The success of the Ag-1 plane from Texas A&M caught the attention of the Transland Company. Founded in 1945, the Torrance, California, company found success converting surplus World War II aircraft into crop dusters. Transland worked with Texas A&M on designing and building the Ag-2, which also became known as the Transland Ag-2. Construction began in 1954 and the first test flight was on Oct. 11, 1956, in Torrance, California.

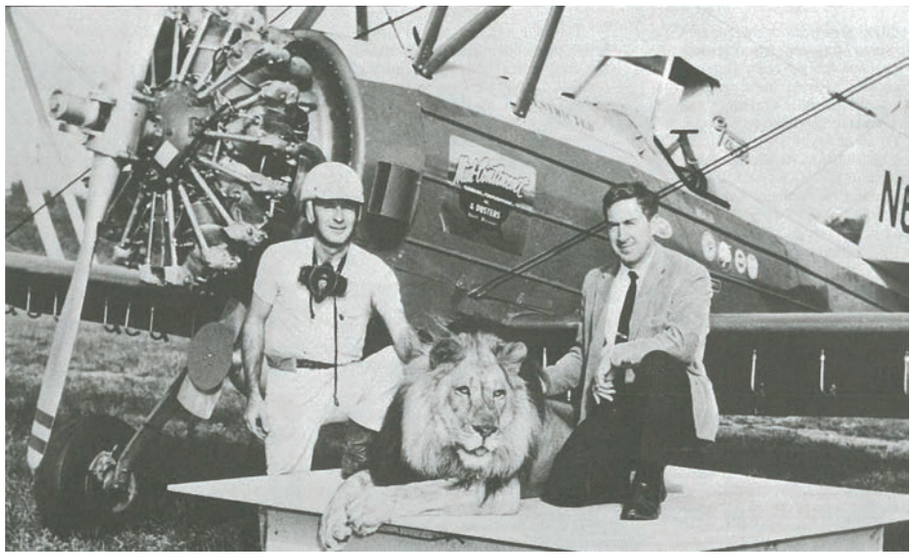
- The idea behind the Ag-2 wasn't just to create a much-improved ag plane. Transland also wanted a tanker plane that could assist with fighting and controlling fires. That required a much bigger storage tank, which meant it needed much more power than crop dusting planes typically had then. Transland incorporated a Pratt & Whitney R-985 450-horsepower engine, though that would later be upgraded to 600 horsepower. That increased the Ag-2's payload to 3,000 pounds. It also boasted a wingspan of 42 feet, a length of 28.5 feet and a gross weight of 7,700 pounds.

- In 1956, an Ag-2 was used to help control a major brush fire near Malibu, California. During the blaze the Ag-2 dropped more than 25 tons of fire retardant on the fire. The Ag-2 was far ahead of the other crop dusting aircraft conversions at the time, but it was also expensive. The Ag-2 was priced at $25,000 new, far more than the investment cost of $5,000 for buying surplus military aircraft on the market.

- Despite several impressive feats of engineering, including several safety features, the Ag-2 never became a commercial success. Conrad Barlow, who had started with the company in the mid-1950s and eventually became Transland's owner until his death, felt the Ag-2 got crowded out of the market by the offerings of major aircraft manufacturers such as Grumman, Cessna and Snow, which were getting into the agricultural aircraft market in a big way.

1957

The Grumman G-164 Ag-Cat is the first aircraft specifically designed by a major aircraft company for agricultural aviation. The purpose-built ag aircraft represented a huge step up in safety and reliability from converted dusters. Grumman originally considered marketing the G-164 aircraft under the name "The Grasshopper." However, an aerial applicator named Dick Reade in Missouri suggested "Ag-Cat," following the naming convention Grumman used of adding the suffix "-Cat" to its other aircraft names, such as the F6F Hellcat. Grumman agreed and the Grumman G-164 became known thereafter as the Ag-Cat.



Dick Reade always had a preference for cats—whether they be large animals or ag aircraft. Pilot Al Honeywell (left) and his pet lion visit Reade to promote the Ag-Cat. Reade would probably be more comfortable in the cockpit.

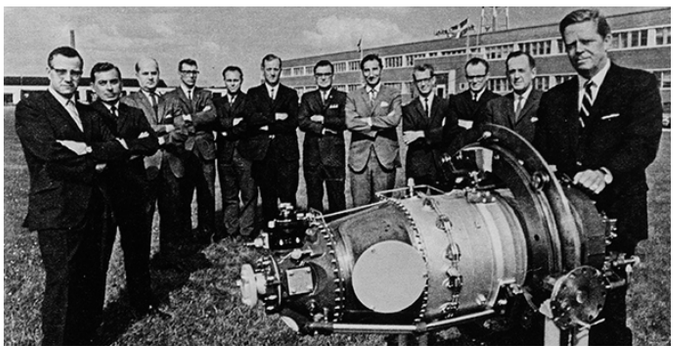
- During the years following the rugged biplane's introduction in 1957, thousands of updated Ag-Cats were built. Schweizer Aircraft Corp. built more than 2,600 Ag-Cats, including 1,730 G-164s and 165As for Grumman between 1959 and 1980.

- In 1980, Grumman management divested itself of its agricultural line and transferred all properties in inventories to Schweitzer Aircraft Corp.

- In 1995, Schweizer sold the designs to Ag-Cat Corp. of Malden, Missouri, which went bankrupt before producing any new Ag-Cats. The Ag-Cat designs went to Allied Ag-Cat Productions Inc. of Walnut Ridge, Arkansas, in 2001. Allied Ag-Cat Productions has not produced any either.

- Today, while they are no longer manufactured, the Ag-Cat remains a staple of agricultural aviation. Many radial and turbine powered Ag-Cats are still in use. The Ag-Cat's popularity is due to its 300-plus-gallon hopper and ease of flying.

Early Grumman Ag-Cat spray demonstration



Twelve key men aiding on the design of the first ag turboprop engine, the Pratt and Whitney Canada PT6: Gordon Hardy, Jim Rankin, Fernand Desrochers, Fred Glasspoole, Ken Elsworth, Allan Newland, Pete Peterson, Hugh Langshur, Jean-Pierre Beauregard, Elvie Smith, Dick Guthrie and Thor Stephenson. © Library and Archives Canada. Reproduced with the permission of Library and Archives Canada. Credit: Bruce Moss/Weekend Magazine collection/PA-167966.

1957

Pratt and Whitney Canada assembled a team of 12 talented young engineers after studies showed a market opportunity for 500 shp (shaft horsepower) class turboprop engines in the aircraft market then powered by piston engines. Pratt and Whitney Canada channeled some of the profits from its piston engine spare parts business toward the development of gas turbine engines smaller than those made by its U.S. parent. About a decade and a half later, ag aircraft embraced the technology.

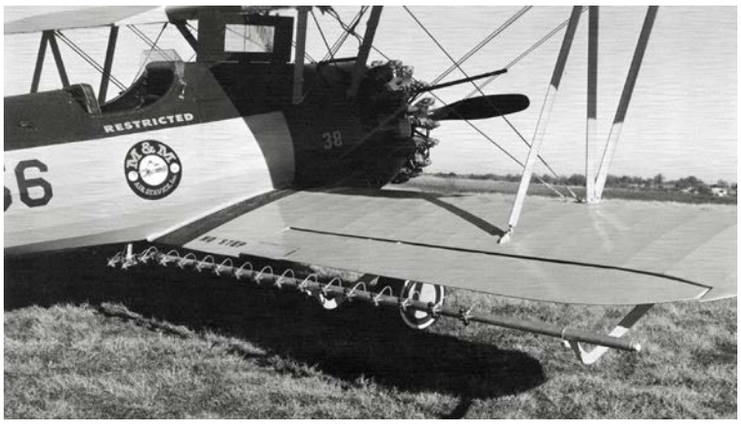
1960s

Pawnees and Cessna Ag Wagons are introduced, further increasing aircraft options for the agricultural aviation industry.

- Cessna Aircraft entered the agricultural aviation sector in the mid-1960s. Its first aircraft designed solely for agricultural aviation was the Ag Wagon, which quickly became popular with aerial applicators.

- Building upon the original 150-gallon-hopper Piper Pawnee, future iterations in the 1960s brought more improvements and power. In 1964, the Pawnee B was upgraded to a 235-horsepower Lycoming O-540-B2B5 six-cylinder engine. The hopper increased in size to handle 1,200 more pounds. Three years later, the Pawnee C came out followed by the Pawnee D in 1974. Almost 5,200 Pawnees were built between 1959 and 1981, when production ended—32 years after Fred Weick started his Ag-1 project at Texas A&M.

Cessna 188 Ag Wagon



The USDA Agricultural Research Service conducted an early research project on a bi-fluid spray system with M&M Air Service of Beaumont, Texas, using a circa 1964 Stearman.

1964

The origin of what would become the USDA Agricultural Research Service's Aerial Application Technology Research Unit begins work at College Station, Texas. The roots of ARS aerial application research can be traced to the beginnings of the United States' involvement in the Vietnam conflict. Dense jungle vegetation, which provided cover for enemy forces, posed a serious challenge to air support for U.S. ground forces. The Department of Defense requested USDA-ARS assistance to find ways to defoliate jungle areas in Vietnam. This required research to find the most effective herbicides and spray methods to get effective spray doses into the canopy. As research continued, the USDA-ARS explored new methods for assessing spray penetration and movement. Early flight testing used an Ag-Cat. Wind tunnel testing of aerial technologies was part of these early research efforts, the first testing of this kind in the world.

- Throughout its existence, the USDA's aerial application research arm has made aerial applications more efficient, effective and precise. The USDA-ARS Aerial Application Technology Research Unit (AATRU), as it is known today, conducts a variety of research projects related to aerial application. It is the largest aerial application research group in the country and has access to resources that no other research group has available.

- The work of the USDA's aerial application research arm helps the aerial application industry improve technologies and best management practices. Information supplied by AATRU is used by aerial applicators to improve the quality of their applications. For example, aerial applicators consult with aerial spray nozzle decision support tools developed and updated by the Aerial Application Technology Research Unit to determine the right nozzle or settings for their nozzle of choice for the application job.

- The USDA's AATRU also serves as an unbiased government source that regulatory agencies can use to assist them in developing reasonable regulations. The data can be used to show that aerial applications are both extremely effective and safe.

1965

Leland Snow sells Snow Aeronautical Co. to Rockwell-Standard. The Model S-2R was developed during this time and named the Thrush.

Snow Aeronautical Co.'s S-2C

1966

The National Agricultural Aviation Association is founded to, among other things, be the "recognized public policy advocate for the agricultural aviation industry." Before this period, much of the industry was organized via regional associations, as well as operators and pilots exchanging information at "fly-ins." Some in the industry, such as a group in the Great Plains region, wanted to regulate themselves to better control the application of pesticides before the government would step in. However, 14 CFR, Part 137 was promulgated by the Federal Aviation Administration and put into effect Jan. 1, 1966, establishing new federal regulations for agricultural aircraft operations. The new rules and restrictions imposed in the original draft of the Part 137 regulations, coupled with farmland being converted to suburban neighborhoods whose inhabitants were unfamiliar with agricultural practices, plus the release of Rachel Carson's book *Silent Spring*, which was critical of pesticide use, rankled independent-minded aerial applicators to such an extent that they decided to establish a national association to monitor and influence federal policies and legislation that could impact agricultural aviators. The National Aerial Applicators Association, as NAAA was originally known, was officially founded on Nov. 28, 1966.

First NAAA President Dick Reade, 1967


NATIONAL AERIAL APPLICATORS ASSOCIATION

F. Farrell Higbee, Executive Director, 919 18th Street, N.W., Washington, D.C. 20006 Phone 202/628-4262

BULLETIN

NATIONAL AERIAL APPLICATORS ASSOCIATION HIRES EXECUTIVE DIRECTOR

F. FARRELL HIGBEE, Executive Director
National Aerial Applicators Association

First issue of NAAA newsletter with photo of NAAA Executive Director F. Farrell Higbee, 1967

NAAA's first logo

NAAA's current logo

1970

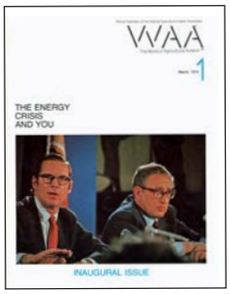
Leland Snow resigns from Rockwell when the company moves its aircraft factory from Olney, Texas, to Albany, Georgia. Back on his own, Snow devotes the next two years to designing the first Air Tractor ag plane.

1972

Leland Snow founds Air Tractor Inc. in Olney, Texas. Construction begins on the Air Tractor AT-300, which later became the AT-301.

March 1974

The *World of Agricultural Aviation* debuts as the official magazine of the National Agricultural Aviation Association. The publication, which is now named *Agricultural Aviation*, focuses on providing substantive information promoting aviation safety and environmental stewardship to the ag aviation industry and continues to publish to this day. *Agricultural Aviation* has a circulation of about 4,500 and is read by aerial application owner/operators and pilots, allied suppliers, ag aviation supporters, educators and government officials.



Mid-1970s

Turbine engines introduced. Turbine engines increased the speed of agricultural aircraft, boosting the speed of what was already the fastest way to treat crops. Turbine engine technology represented a quantum leap forward for agricultural aviation, because in addition to being more powerful and able to hold more payload, turbines were more reliable than piston powered radial engines. Turbine engines increased the cruising speed of agricultural aircraft by 20 mph or greater and allowed the hopper capacity to increase 75% from the largest piston powered aircraft.

1977

Air Tractor's first turbine model, the AT-302, is introduced.

An AT-302 Air Tractor performing a demonstration spraying flight.

1977

Rockwell sells the production rights for its agricultural aircraft to Ayres Corp.

1980s

Automatic flagman, GPS triangulation, vortex generators and pitch pump analysis are introduced. These technologies increased the accuracy of aerial applications and the safety of ag aviation crews by minimizing exposure to the agricultural products being applied. Automatic flagmen offered the first technological advance to remove the need for a human flagger in the field being treated. At the end of a pass, an ag aviator would dispense a biodegradable paper flag to mark the location of the pass. This allowed the pilot to determine where the next pass was to be located as they entered the field after the turn. GPS was a quantum leap forward in swath guidance technology. Instead of physically marking passes, GPS automatically calculates the location of the next pass and guides the ag aviator to that pass using a lightbar, which consists of a series of lights and numbers that direct the pilot to the pass with great precision. Vortex generators increase the effectiveness of the wing, flaps and ailerons. They also reduce the stall speed and improve aircraft handling at low speeds. In essence, vortex generators make the wing work better which increases safety.

1981

Operation S.A.F.E. (Self-regulating Application & Flight Efficiency) was designed by the National Agricultural Aviation Association to enhance aerial application efficacy and precision through the establishment of professional application analysis clinics to calibrate spray equipment technology on ag planes and helicopters.

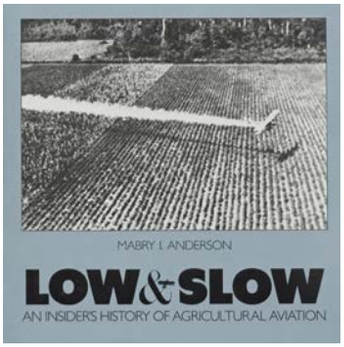
1982

NAAA's Board of Directors establishes the National Agricultural Aviation Research and Education Foundation, a nonprofit organization created to foster research, technology transfer and advanced educational opportunities among aerial applicators, allied industries, government agencies and academic institutions.

1985

The first high speed wind tunnel used to measure the droplet size from aerial applications begins operation at the USDA-ARS aerial research facility in College Station, Texas. This wind tunnel provided accurate droplet size data for aerial applications, which allowed for agricultural aircraft to be better equipped with spray equipment that properly balanced efficacy and drift mitigation. The data has since become critical for getting pesticides registered for aerial applications. Aerial applicators rely on the data for setting up their aircraft to make safe and accurate applications.

Early Operation S.A.F.E. analysis using some state-of-the-art computer technology!



1986

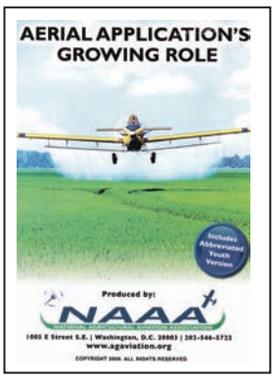
Mabry Anderson's history of the agricultural aviation industry is published in his book *Low & Slow: An Insider's History of Agricultural Aviation*. It is the first known history of the industry written and is beloved by those in the industry who have read it.

1988

AgAir Update **is converted from a newsletter of the Georgia Agricultural Aviation Association into a national newspaper published by former aerial applicator Bill Lavender. Today, *AgAir Update*, along with *Agricultural Aviation* magazine, provides industry news on safety and professionalism. *AgAir Update* is published in English, Spanish and Portuguese and has more than 4,000 subscribers worldwide.**

1990

NAAA and NAAREF release "Aerial Application's Growing Role," a videotape designed to inform the general public about the benefits of aerial application to production agriculture. In 2009 the video was remade.



1993

GPS becomes commercially available to aerial applicators. GPS provides a very accurate way to provide swath guidance that reduces overspray and results in a markedly more targeted application. It also provides a key tool needed to allow aerial applicators to begin practicing precision agriculture, allowing applied materials to be administered much more efficiently by treating only where needed, and in specific doses, based on a plant's health.

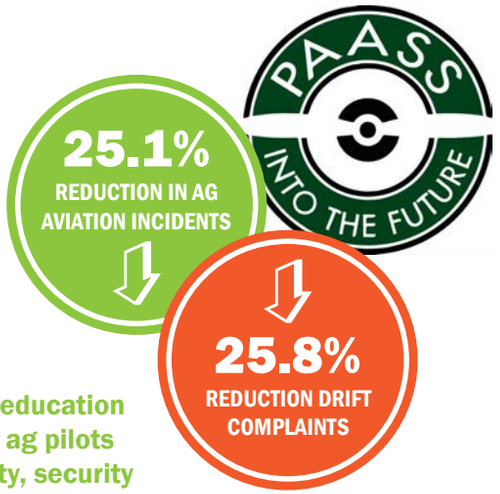
1994

A 1994 NAAA survey finds that 25% of the agricultural aviation aircraft fleet is equipped with GPS for swath marking, signifying a strong start to a revolution in avionics that will significantly enhance the industry's precision and effectiveness.

1998

NAAREF presents the PAASS Program to approximately 1,800 aerial application operators and pilots each year.

The National Agricultural Aviation Research and Education Foundation introduces the Professional Aerial Applicators' Support System (PAASS), a safety education program created to teach ag pilots the latest in aviation safety, security and environmental stewardship. The PAASS Program is offered at state and regional agricultural aviation conferences across the country each year.



PAASS
PROFESSIONAL AERIAL APPLICATORS' SUPPORT SYSTEM

- The PAASS Program has been successful in helping reduce both drift and agricultural aviation accidents. Data from two Association of American Pesticide Control Officials (AAPCO) surveys, conducted before and after the beginning of the PAASS Program, found a 25.8% reduction in the number of drift complaints.
- Agricultural aviation accident rates have decreased from an average of 9.64 incidents to an average of 7.22 incidents per 100,000 ag hours flown since the PAASS Program first hit the stage in 1998. This is a 25.1% reduction in the number of ag aviation accidents since the beginning of PAASS.

Late 1990s

The Aircraft-Integrated Meteorological Measurement System (AIMMS), a tool that can be installed on ag aircraft and used by aerial applicators to monitor in-flight weather conditions in real time, is developed. It enhances aerial applicators' ability to mitigate drift by measuring wind speed and direction, temperature and humidity in flight. Real-time weather data is transmitted to the Global Positioning System (GPS), which lines the aircraft up accordingly to account for the air movement. By checking the temperatures at different heights, AIMMS can also detect the presence of an inversion. Since off-target drift is very likely to occur in a temperature inversion, ag pilots refrain from making aerial applications in those conditions.

2001

After the Federal Aviation Administration issues a complete ground stoppage for all U.S. aircraft following the terrorist attacks of Sept. 11, 2001, NAAA succeeds in obtaining government approval to fly again, making agricultural aviation the first sector of general aviation allowed back up in the air after the tragic terror attacks against the U.S. on 9/11.

9/11/2001 Aftermath: Academic, medical and government experts conclude that due to the size, air wake and nozzle type typically used in ag aircraft, it would be an ineffective bioterrorism instrument.

Photo by Kelly Owen/Getty Images

Summer 2016 Magazine cover chronicling NAAA's response to 9/11

Stop and Go: 9/11 Ground Stop Timeline

Sept. 11, 2001
The U.S. government shuts down the airspace throughout the country after a rash of airline hijackings and the terrorist attacks in New York City and Washington, D.C.

Sept. 14, 2001
The federal government allows aerial applicators to fly again.

Sept. 16, 2001
The government grounds agricultural aircraft again in response to information the FBI received about the arrest of a suspected terrorist who possessed information about ag aircraft.

Sept. 17, 2001
Aerial applicators are allowed to resume operations again except in Enhanced Class B airspace, a 25-mile area around a dozen major metropolitan areas.

Sept. 23, 2001
Citing "serious, credible threats," the FAA grounds agricultural aircraft for the third time since 9/11.

Sept. 25, 2001
The federal government reopens the airspace to agricultural aviation.

Oct. 15, 2001
Ag operators are allowed back into the Enhanced Class B airspace.

Early-to-mid 2000s

Strobilurin fungicides, useful in controlling a broad spectrum of common plant pathogens on many different crops, are introduced to the market. Because of their ability to thwart crop diseases and increase crop yields, these fungicides soon became a game-changer for farmers and aerial applicators alike due to strobilurin fungicides' terrific results and the fact that aerial application is the preferred method of application. Why? Three reasons: its speed, better efficacy and the fact agricultural aircraft can make applications to mature crops like corn and soybeans without causing any damage to the crop.

- Today, there are 10 major strobilurin fungicides on the market, which account for 23 to 25% of the global fungicide sales. Aerial application continues to be a prime delivery method for these fungicides because of the superior results aerial application achieves. Research has shown aerial applications of strobilurin fungicides on corn can increase yields by 21%. A 21% yield increase means that 4 treated acres will produce the same yield as 5 untreated acres, reducing the need to clear more land for agriculture.

2005

After a six-year NAAA legislative advocacy campaign, Congress enacts legislation unconditionally allowing aerial application operators to be exempt from the federal excise tax on fuel used to ferry and apply crop protection products in ag aircraft. The fact that ag aircraft operate in remote areas and do not commonly use public airports or the air traffic system paved the way for the exemption.

Form 4136 (2005) Page **2**

7 Sales by Registered Ultimate Vendors of Undyed Kerosene (Other Than Aviation-Grade Kerosene and Kerosene Used in Aviation) **Registration No.** ▶

Claimant certifies that it sold the kerosene at a tax-excluded price, repaid the amount of tax to the buyer, or has obtained the written consent of the buyer to make the claim. Claimant certifies that the kerosene did not contain visible evidence of dye.

Exception. If any of the kerosene included in this claim **did** contain visible evidence of dye, attach an explanation and check here . . ▶ ☐

Caution: *Registered ultimate vendors cannot make claims for kerosene sold for use on a farm for farming purposes after September 30, 2005.*

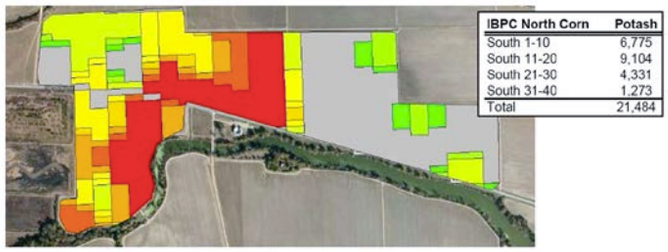
		(a) Type of use	(b) Rate	(c) Gallons	(d) Amount of credit	(e) CRN
a	Use on a farm for farming purposes before Oct. 1, 2005		$.244		$	
b	Use by a state or local government		.244/.243*			346
c	Sales from a blocked pump		.244/.243*			
d	Use in certain intercity and local buses		.17			350

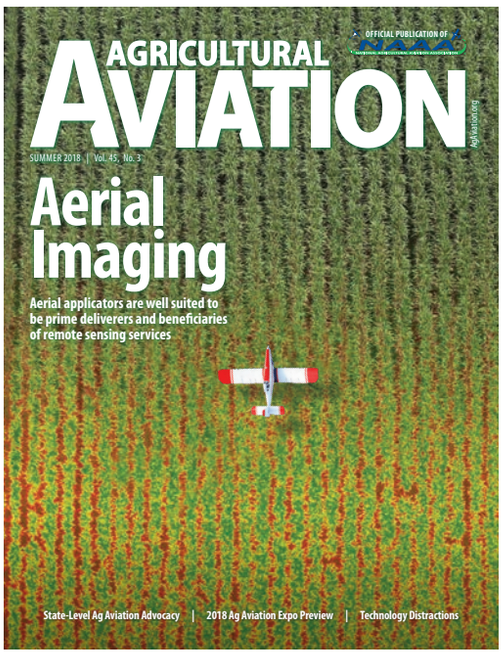
IRS form 4136

President George W. Bush, while serving as Texas governor, with an Air Tractor.

Late 2000s

Precision application is embraced by the aerial application industry. This includes remote sensing, which uses geospatial images taken by satellites, manned aircraft or drones to pinpoint, via various types of imaging, pest problems and nutrient deficiencies in the crop. Prescription maps are made from these images, which, along with GPS and flow-control plumbing/application systems, provide specific doses of pest control products or nutrients depending on the needs of individual plants in a particular field. The use of precision agricultural technologies continues to increase each year.





2010

The National Agricultural Aviation Association launches a public outreach campaign to raise awareness about the worrisome effects of wind energy development on agriculture and aviation. Meteorological evaluation towers (METs) are used to measure an area's suitability for a wind farm. These towers can be erected very quickly and often did not need to be marked, making them a major hazard for low-altitude aviators.

- From 2008 to 2018, there were 22 agricultural aviation accidents from collisions with METs, communication towers, towers supporting power lines and wind turbines, which resulted in nine fatalities. For all of general aviation, 40 tower-related accidents and incidents resulted in 36 fatalities over the same 11-year period.

Mid-to-late 2010s

The aerial application of seeds for cover crops expands. Cover crops are grasses, legumes, small grains and other low-maintenance crops planted specifically to improve soil health and biodiversity. By sowing the seeds aerially with a preharvest cover crop application, cover crops control erosion, retain and recycle soil nutrients, build organic matter to improve soil health, improve water quality and moisture availability, and break disease and insect cycles. Census of Agriculture data indicates an increase in cover crop acreage from 10.3 million acres in 2012 to 15.4 million acres in 2017. While there are several methods of seeding cover crops, aerial application is the most effective means of applying cover crops successfully.

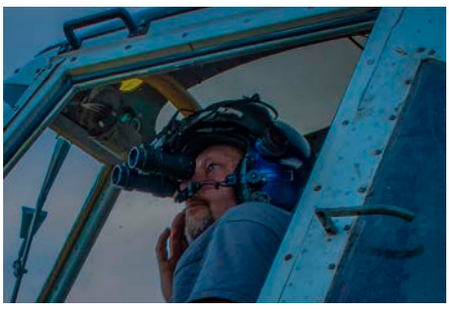
- The best time to apply many cover crops is when the harvestable cash crop is still standing. Aerial application offers the ability to spread the cover crop seed over the existing crop without any disruption to the standing crop. This means the cover crop can already be established when the cash crop is harvested allowing it more time to aerate, fertilize and establish more soil moisture.

- Using a drill to plant cover crops requires a terrestrial vehicle and for the grower to wait until their cash crop is out of the field, which might not be the best timing for establishing a healthy cover crop. This can be especially true in northern parts of the U.S. where the first frost can interfere with cover crop growth if they are seeded too late.

- Aerial application can also be used when the soil is wet and can seed many acres quickly. Timing is a critical part of successfully establishing a healthy cover crop.

Mid-to-late 2010s

Night vision goggles expand nighttime aerial applications. The 2019 NAAA Aerial Application Industry Survey shows that 7% of aerial applications are made after dark, and night vision goggles are used in 15% of those applications. The top two reasons for making nighttime aerial applications is to protect bees and protect field workers, who are not present at night.



2012

The National Agricultural Aviation Association releases its Aerial Application Industry Survey of Part 137 operators and ag pilots, which shows that operators are embracing a range of methods and technologies, such as GPS (utilized by 99% of pilots by then) and flow-control valve technology, to increase efficiencies and minimize drift. The data is used to preserve the aerial use of a crop protection product and/or prevent aerial use restrictions for a crop protection product while still ensuring environmental and occupational safety.

2013–Present

The FAA considers how best to safely integrate unmanned aircraft systems (a.k.a. drones) into the National Airspace System. Drones are a double-edged sword for the aerial application industry. On one hand, drones have become a significant safety obstacle for agricultural pilots operating in the same low-altitude airspace. On the other hand, drones could become a complementary tool that aerial applicators adopt for certain smaller spray jobs or to perform aerial imaging for land and crop monitoring purposes. At present, drones' ability to make safe and effective aerial applications has yet to be tested by the EPA. NAAA wants a safe and legal process for drones to enter the aerial application industry and has urged the EPA to begin field trials for drone spraying evaluation. Collecting UAV spray data is necessary so application instructions can be written specifically for drones on the labels of crop protection products.

- For commercial civilian drone uses to truly proliferate, safe integration is essential. Agricultural pilots worry the widespread use of drones without safe integration will result in low-altitude aviation accidents. Ag aviators commonly fly between 10 and 500 feet above ground level while monitoring many gauges in the cockpit and avoiding trees, telephone poles and power lines. Unlike larger fixed obstacles, small unmanned aircraft can be virtually invisible—and potentially lethal—to agricultural pilots, emergency medical helicopters, law enforcement and other low-flying aircraft operating in the same airspace.

- The ability to see and avoid obstructions and other aircraft is the backbone of safety for aerial applicators and all air traffic operating under visual flight rules. All aircraft, including UAVs, have a responsibility to abide by this aviation safety principle.

- NAAA has been one of the leading safety advocates for low-flying manned aircraft, advocating to the FAA and Congress that drones should be equipped with sense and avoid technology, strobe lights and tracking technology like an ADS-B Out system so that drones' flight position can be made known to manned pilots, as well as for stronger training, licensing and certification requirements for drone pilots and unmanned aircraft systems.

2013–2014

During the summer of 2013 Walt Disney Animation Studios released the movie *Planes* followed by the sequel *Planes: Fire & Rescue* in 2014. *Planes* is about Dusty Crophopper, an ag plane that spreads fertilizer by day but practices aerobatic maneuvers and dreams of being a racing aircraft. It doesn't help that he has a fear of heights. The sequel has Dusty training to get certified as a firefighting plane. He has water tanks installed and becomes a single engine air tanker firefighter. During its theatrical run, the two films combined earned almost $150 million domestically and over half a billion dollars ($535 million) worldwide. Although there are numerous instances of agricultural aviation intersecting with pop culture, the *Planes* franchise is arguably the pinnacle of the agricultural aviation industry's appearances in pop culture.

2016

The National Agricultural Aviation Association marks its 50th anniversary of representing the aerial application industry. Accident rates have declined markedly, multiple vegetative management products have been allowed to be applied by aerial application, and a less intrusive regulatory environment exists due to NAAA's policy advocacy and educational programs.

2016–2018

NAAA advocacy results in Congress enacting a federal statute requiring the FAA to develop and enforce the marking of meteorological evaluation towers (METs) between 50 and 200 feet in rural areas and to develop a database requiring these towers' geographical coordinates be logged. Communication towers in rural areas within the same height range must be either marked or have their coordinates logged into the FAA's tower database.

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EC. 576. TOWER MARKING.

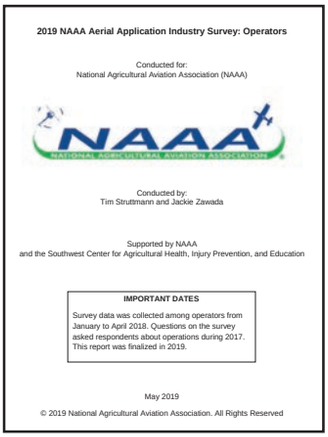
  Section 2110 of the FAA Extension, Safety, and Security Act of 2016
49 U.S.C. 44718 note) is amended to read as follows:
SEC. 2110. TOWER MARKING.

(a) Application.--
     ``(1) In general.--Except as provided by paragraph (2), not
later than 18 months after the date of enactment of the FAA
Reauthorization Act of 2018 or the date of availability of the
database developed by the Administrator pursuant to subsection
(c), whichever is later, all covered towers shall be either--
          ``(A) clearly marked consistent with applicable
        guidance in the advisory circular of the FAA issued
        December 4, 2015 (AC 70/7460-IL); or
          ``(B) included in the database described in
        subsection (c).
    ``(2) Meteorological evaluation tower.--A covered tower that
is a meteorological evaluation tower shall be subject to the
requirements of subparagraphs (A) and (B) of paragraph (1).
```

2018 FAA Reauthorization Bill

2019

NAAA releases its 2019 Aerial Application Industry Survey of Part 137 operators and pilots. The survey documents an increase in the number of aerial application operations and agricultural aviation pilots in the U.S. since 2012 and an increase in acres treated compared to the 1960s. Today there are 1,560 aerial application businesses treating 127 million acres of cropland or 28% of the commercial cropland in the U.S. There are approximately 2.3 aircraft per agricultural aviation operation, or a total of 3,588 aircraft nationwide. According to the 1962 FAA publication "Aircraft in Agriculture," there were 5,075 aircraft in the U.S. (FAA stood for Federal Aviation Agency in 1962). There were 2,077 ag aviation operators in 1962 compared to 1,560 today. In 1962, 64.8 million acres were treated by ag aircraft versus 127 million acres today. The largest ag aircraft in 1962 were the Snow S-2 and the Ag-Cat with a maximum hopper capacity (where the applied materials are stored) of about 300 gallons. Today, with turbine equipped aircraft, the average sized aircraft can hold over 500 gallons with 600, 700 and 800-gallon hopper-equipped aircraft quite common. Air Tractor, an ag aircraft manufacturer in Olney, Texas, is currently working on FAA certification of an aircraft with a hopper capacity of 1,060 gallons.


2019 NAAA Aerial Application Industry Survey: Operators

Conducted for:
National Agricultural Aviation Association (NAAA)

Conducted by:
Tim Struttmann and Jackie Zawada

Supported by NAAA
and the Southwest Center for Agricultural Health, Injury Prevention, and Education

IMPORTANT DATES

Survey data was collected among operators from January to April 2018. Questions on the survey asked respondents about operations during 2017. This report was finalized in 2019.

May 2019

2020

With the coronavirus disrupting daily life globally, NAAA—through contact with the White House, Vice President Pence's Coronavirus Task Force, the FAA, USDA and Department of Homeland Security—ensures crop input services, such as those provided by aerial applicators, are listed as essential. The Department of Homeland Security identified 16 "Essential Critical Infrastructures" that includes both the agriculture and chemical industries. The "essential" designation allows aerial application work safeguarding the nation's food supply to continue uninterrupted during stay-at-home orders from state and local governments intended to flatten the curve of the COVID-19 pandemic.

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2021

To commemorate the 100th anniversary of the agricultural aviation industry, the National Agricultural Aviation Association launched a promotional campaign to highlight the historical significance, continued importance and technological advances that cemented agricultural aviation as a vital cog in the production of a safe, affordable and abundant supply of food, fiber and bioenergy for the benefit of worldwide consumers. This included a broad, nationwide public relations campaign to educate the media, public and policymakers about the industry's past and its importance to food production in the future by launching the website AgAviation100.com with industry facts, a 100-year timeline and a documentary. NAAA also published a book, covering the comprehensive 100-year history of the industry with detailed illustrations. It also arranged highly publicized public relations events including Ag Day on the Mall with a helicopter used to make aerial applications just a few blocks from the U.S. Capitol; an ag aviation centennial airshow at EAA's AirVenture in Oshkosh, Wisconsin; and a centennial event on the official 100th anniversary on Aug. 3 at the Smithsonian Institution's National Air and Space Museum's Udvar-Hazy Center that included a donation of the Air Tractor ag aircraft in the likeness of the Disney *Planes* movies' character Dusty Crophopper. The aircraft was donated by Texas operator Rusty Lindeman who flew the Dusty likeness airplane at airshows across the U.S. to promote the film in 2013.

A CENTURY OF AGRICULTURAL AVIATION

AgAviation.org

The Future of Ag Aviation

Confronting environmental challenges from a growing population to ensure a stable and ample food supply is the next great challenge facing agriculture. Aerial applicators are well-suited to help farmers face these challenges.

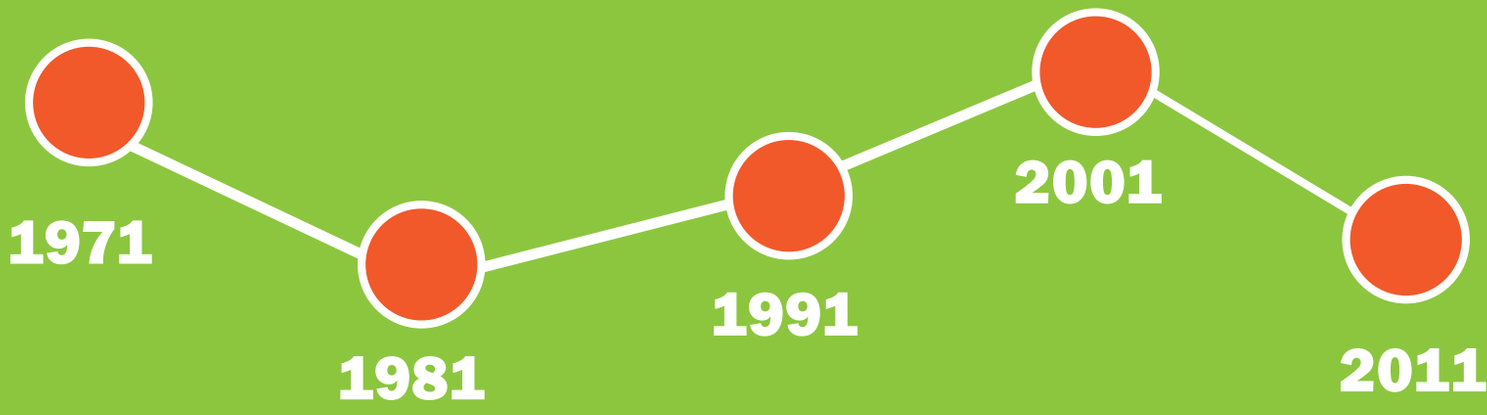
- According to the United Nations, the world population is projected to reach 9.8 billion in 2050, meaning the next three decades may see an additional 2 billion people occupying the planet. That means cities and urban areas will continue to expand and farmland use will likely continue to shrink. The growing population will also result in additional environmental challenges. More than ever, the name of the game for growers and aerial applicators is sustainability. Going forward, aerial applicators will continue to aid growers in reducing biodiversity loss and increasing the productivity and resilience of their farmland.

- Agricultural practices can help sequester carbon from the atmosphere and store it in soil where it serves as a plant nutrient. Growth in cover cropping and bioenergy production markets look promising for aerial applicators in this respect. In the case of cover crops, they increase water-holding capacity, reducing susceptibility to drought. Their roots improve soil structure by creating passages that allow for increased moisture and aeration, which reduces soil compaction. Leaves of cover crops provide shading, which can help control the rate of evaporation from the soil. Conservationists believe in the benefits of cover crops and are working with farmers to ensure that more cover crop acres get planted. Aerial applicators are uniquely qualified to help farmers seed cover crops due to the speed and precise timing of aerial application. The ability to seed large tracts of land quickly is an obvious advantage for aircraft. More importantly, aerial application expands the growing window. An aerially applied cover crop has a longer timeframe to grow, aerate and contribute natural nutrients and moisture to the soil than a cover crop drilled into the ground after harvest does.

- Hyper-precision agriculture/application, an area in which aerial applicators are involved both from taking aerial images and making variable rate applications, was a $9.5 billion industry in 2023. Aerial applicators will continue to play an important role in both taking the aerial images needed to create prescription maps, but also making precise variable rate applications, administering the exact doses of nutrients and plant protection products needed for different parts of the field to achieve better results while conserving resources.

Precision agriculture will continue to grow in importance and agricultural aviation will become even more critical as agricultural aircraft become remote sensing platforms themselves, able to scout for individual pests at the plant level. Aerial application equipment is becoming automated and able to scout, identify, prescribe solutions and make applications in real time with even greater precision and consideration of meteorological conditions and other variables influencing product movement. Automation of aerial application equipment is taking place on a smaller scale currently with uncrewed aircraft systems (UAS) or drones. This has resulted in shifting acres once treated either by terrestrial application vehicles or due to safety concerns due to close proximity to ground-affixed obstacles to now being able to treat via UAS. Continued advancements in automation for crewed aircraft will enable the pilot to focus solely on flying the aircraft, surveying for obstacles and resulting in even more improved ag aviation safety.

Precision agriculture technology enables growers to generate precise insights directly from the field, down to a single insect on a leaf. This technology will save growers time and money.



NAAA
NATIONAL AGRICULTURAL AVIATION ASSOCIATION®
The Voice of the Aerial Application Industry

1440 Duke Street | Alexandria, VA
202.546.5722 | AgAviation.org
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