Developments in

Aircraft

for

Agriculture

THE air farming machine of today and tomorrow takes shape

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Developments in

Aircraft *for* Agriculture

CONTENTS

Agricultural Aviation...

. . . its past and future

THE use of aircraft on the farm is no longer a novelty. Countless agricultural operations the world over serve to illustrate that the agricultural aircraft is now an accepted and essential part of the wide range of mechanical aids to modern farming.

Every year that passes brings a greater demand for more food due to an ever-increasing world population, and it is interesting to note that in some countries, notably the United States, crop yields are raised each year as a result of the increased use of fertilizers and insecticides applied from the air.

From small beginnings in 1919, when the U.S. Department of Agriculture dusted from the air fruit trees infested with caterpillars, aerial agriculture in the United States has expanded to such a level that over 700,000 hours are flown each year by light aircraft on agricultural duties alone. On the western coast of America, for instance, over 80 per cent of the rice crop is planted, fertilized, and weeded from the air.

The increasing use of aircraft for agricultural duties is due mainly to a number of distinct advantages they hold over ground equipment. These are :

1. The ability to apply chemicals without damage to crops.
2. Speed of coverage.
3. The ability to treat areas that are too hilly to permit ground machines to operate.
4. Aerial application can be carried out when boggy ground brings surface methods to a standstill.

Advantage number one, that of applying chemicals without damaging crops, is well illustrated by mentioning two actual applications. For instance, in order to control the pea moth maggot successfully, spraying must be carried out after the pods have formed. If ground machines are used considerable damage is done due to the straggling growth characteristics of the pea. In forestry, aircraft provide the only answer to devastating attacks by insects against millions of trees, and in Canada and the United States aerial spraying is now accepted as a normal part of routine forestry.

The second advantage, speed of coverage, shows the aircraft's ability to spray or dust some 40 times faster than a tractor. Sudden outbreaks of pests among crops can therefore be dealt with from the air before much damage is done. Over large areas of crops, such as cotton in the Sudan, treatment from the air is the only way of dealing with pests, for ground-borne methods would take far too long to be effective.

The third point—the treatment of hilly areas—again shows the aircraft's distinct advantage of being the only medium by which such terrain can be effectively treated. An example of this type of operation is topdressing in New Zealand—a revolutionary method of fertilizing hill pasture land from the air.

Some experts say that topdressing is capable of increasing New Zealand's meat and wool production by 50 per cent in ten years. Here is a case where the use of aircraft is the only practical method by which large, poor quality tracts of land can be brought back into production. The rugged and hilly territory is in any case formidable enough to exclude the use of tractors and other ground-borne methods of spreading fertilizers.

In this sphere the use of aircraft presents unlimited opportunity for the development and improvement of marginal hill pasture land such as can be found in Scotland, Wales and countless other countries.

The rapidly expanding number of aircraft employed specifically for agricultural work throughout the world already totals some 11,000 aircraft whose main range of duties includes spraying, dusting, fertilizing and seeding. The majority of these aircraft are modified ex-military types and although their basic cost is low, the replacement of parts is becoming increasingly difficult. Added to this is the problem that they were never designed to withstand continuous operation from rough airstrips well away from organised repair facilities. In addition, the corrosive action of the chemicals they are spreading causes an unnecessarily high rate of depreciation which, for any business, means a cut in profits.

Aerial spraying is acknowledged by the United Nations as an essential part of modern farming techniques. The F.A.O. badge is seen here adorning one of a number of Austers supplied to U.N.O.

Now that supplies of surplus military aircraft are almost exhausted, agricultural operators and potential operators must look elsewhere for replacements. What is required is an aircraft specially designed for the job which by reason of its greater efficiency will even justify the replacement of existing modified but usable aircraft.

The type of aircraft required

As we have previously mentioned, the surplus ex-military trainer is not an economical proposition, as apart from the constant problem of replacements, other points which must be considered have a direct bearing upon the efficiency of the aircraft as an agricultural sprayer or duster.

In most cases the basic design features of these aircraft are a handicap to the agricultural operator. Noses too high with poor visibility during prolonged low flying, unsuitable construction leading to rapid corrosion, and more important, spraying and dusting equipment that has to be adapted to match an unsuitable airframe usually results in the aircraft having comparatively poor loading and handling performance characteristics, the latter due to unavoidably large shifts in centre of gravity. The adaption of existing light planes, although providing a reasonably low cost replacement for the war surplus machine, does not remove these profit-cutting disadvantages. All these factors added together give high operating costs—the penalty of the aircraft not having been designed for the job.

What price the helicopter?

At first sight the helicopter might appear to fill the role, particularly in view of the big downwash from its rotors. It has been proved, however, that

Locusts present another problem which can only be solved successfully by using aircraft. This photograph shows a swarm of locusts covering 300 acres. It was eventually destroyed (and probably overdosed) by Auster spraying aircraft through the application of 560 gallons of 20 per cent D.N.C. chemicals.

an equally effective downwash and under-leaf spray coverage can be obtained from a fixed wing aircraft, provided that it has a *low* wing and can be flown at only a few feet above the crops or trees. There are many other disadvantages with helicopters, not the least being their high initial cost—more than five times that of equivalent fixed-wing aircraft with operating costs up to *ten times* greater than those of fixed wing aircraft capable of carrying a comparable load. The necessity for frequent overhauls and an inability to carry heavy loads economically also lies heavily against helicopters when applied to agricultural work, for big loads and simple maintenance mean much to the operator who must fly his aircraft nearly continuously throughout the day if his business is to run at a profit. Moreover, a specially-designed aircraft can operate from surprisingly small fields, strips, or even roads.

It must be simple and have low initial cost

The aircraft that is required, then, must be of simple design and easy to maintain, resistant to damage and untroubled by corrosion and petty unserviceability. Its initial cost must low be and it must be able to perform either spraying, dusting or topdressing duties at short notice from small landing areas. The only efficient aerial farming machine, therefore, is one whose whole conception, geometry and systems have been designed to this end.

The principles of
INSECT CONTROL
from the AIR

OF the thousands of species of insects responsible for huge financial losses through crop damage every year, all belong mainly to two groups. These are (*a*) those which chew, such as locusts, beetles and caterpillars, and (*b*) those that damage plants by sucking. These sharply differing physical characteristics necessitate the use of chemical killers which act in entirely different ways. For the sucking type of insect which pierces the plant to rob it of its juices a contact poison such as parathion, HETP or TEPP is normally used, and this is best applied as a spray. The insect is then killed through the action of the chemical upon its body, and further control is also effected through the destruction of its eggs in a similar manner.

The chewing insect which lives by eating plant foliage is attacked by a poison which is deposited upon the plant—again by spraying. The chemicals most effective against this group act as stomach poisons when eaten by the insect. A number of the new chemicals such as liquid D.D.T. act as both a contact and stomach poison and are therefore, becoming more widely used. The more harmless (to man) insecticides such as pyrethrum and derris are effective against chewing insects and should be used upon crops that need treatment shortly before consumption by man.

Prime considerations in the aerial application of sprays for insect control are that the spray must be applied at the right time, and coverage must be complete. Dealing with these points in order, the right time means that every insect pest is more vulnerable to chemicals at a particular part of its life cycle. Usually this is when they are young, and a typical example is the spruce budworm which is only susceptible to spraying for two weeks every year. Each year, the moth, mother of the budworm, lays as many as 250 eggs, hiding them under the needles of healthy spruce trees. The eggs hatch into tiny worms which lie dormant throughout the winter. Early in June they begin to feed on the needles, buds and flowers of the trees until they become moths—and the cycle is then repeated.

This insect devastated over 22,000 square miles of Canadian forest before the decision was taken to spray the areas affected from the air. Entomologists now keep a close check upon budworm development and when they consider the time is right, a large force of spraying aircraft is deployed, flying from dawn until dusk until the infected areas have all been treated.

A similar insect attack was controlled when several thousand acres of pine forest in central England and Scotland were saved from certain destruction by aerial spraying from two Austers. The forests were found to be infested with a moth caterpillar called the Pine Looper which feeds upon the pine leaves.

The Pine Looper or Bupalus Piniarius was causing serious trouble in the pine forests of Germany as far back as 1780, but although it belongs to the resident insect population of the British Isles it has not been a source of worry here until recent years—presumably because the conditions which favour an infestation did not exist. The Pine Looper caterpillar attacks pole stage and older crops, usually when the trees grow in sandy soil where the rainfall is low. It eats the leaves and therefore causes the pine to die—for leaves are, of course, essential to a tree's life. No pine can survive a third year's attack.

The infestation was first spotted during the spring of 1953 when the head-forester saw badgers turning over the needle litter in a search for pupae. However, aerial spraying was delayed, on the advice of experts, until the caterpillar stage was reached when it was carried out with complete success. So much then for the right time to spray, what of the problem of effective spray coverage?

This really depends upon the pilot's equipment, his skill and the employment of an accurate method of ground marking if adequate land-marks are lacking. For field work, such as crop spraying, it is usual to employ flagmen as markers for each run the spray plane makes. The flagman's job is most important for incorrect spacing of swaths will result in either a wastage of material due to overlapping, or conversely, gaps between swaths giving ineffective pest control.

The most accurate method used for positioning the aircraft during crop spraying is to employ ground markers holding flags. After the aircraft has passed over, the marker paces out the position for the next spray run.

The spraying and dusting of forest areas presents a different marker problem. Experience has shown, however, that two methods have proved successful. The first is the use of flags on tubular aluminium poles and the second—more widely used—is the employment of small hydrogen-filled balloons attached to a cord of sufficient length for the balloon to be seen by pilots just above the tree tops. These methods are two that are in favour at the moment. It is likely that they will be superseded by more accurate ways of marking in the near future as aerial spraying has become an essential part of efficient forestry. From present-day trends it is obvious that the aerial application of insecticides has a big future. The ability of aircraft to treat large areas effectively at great speed makes it possible for man to confidently tackle insect menaces such as the locust, Tsetse fly and mosquito which until recently plagued half the world with comparative immunity.

To obtain effective insect control from the air then an operator must apply the right insecticide at the right time with the right equipment. Coverage must be complete to be effective and this depends upon the efficiency of the aircraft's spray equipment, the pilot, and the ground markers.

During forest spraying the height of the trees complicate the problem of accurate swath marking. The most effective method is to use gas-filled balloons supporting flags. These are anchored to a tractor, the driver of which positions each run made by the aircraft which in this case is an Auster Autocar.

Spraying *versus* Dusting

Which is the best to use?

IT was common practice before the last war to apply insecticides from the air in dust form, but rapid developments during and after the war with sprays have led to a swing in favour of the latter. Liquid chemicals are now produced in such a concentrated form that they can be greatly diluted before use and permit very light application per acre, resulting in aircraft covering much bigger areas per flight. However, spraying's big advantage is its reduced tendency to drift as compared with dusting—sprays can be effectively applied in winds of up to 10 m.p.h. The nature of the dispersal equipment fitted to aircraft is such that a wider swath is more readily achieved with liquid sprays. Sprays also stick to crops better than dust and are less likely to be washed off by light amounts of rain. This means that insecticides applied in liquid form remain more effective for a longer period than dusts.

A reduction in dusting operations

Figures from the U.S.A. show that the time spent on dusting operations in 1954 dropped considerably and spraying increased by some 11,500 hours. This does not mean, however, that dusts will soon go out of use, for many chemicals, fungicides mostly, are more effective in dust form. The gentle floating tendency which is characteristic of most dusts gives it the advantage of greater penetration into densely growing crops.

It depends, then, upon the types of chemicals that are recommended and available whether dust or spray is used. One thing is certain, however, that the successful operator will be the one who is equipped to apply both mediums efficiently, and is able to effect a rapid changeover from one to the other.

An early type of dusting aircraft produced by the Auster Company. Note the billowing characteristics of the dust.

Aerial Spraying...

...and the specialist aircraft required

AERIAL spraying forms a major part of the many agricultural roles that aircraft are now performing with ever-increasing success throughout the world.

To do this efficiently an aircraft must incorporate many features not found in 'normal' types. As we have previously pointed out, ex-military trainers and converted aircraft are not suitable for many reasons such as inferior load capacities and unavoidably poor weight distribution, chemical attack upon the structure, high consumption of spares, and so on. Operators using these types must accept the penalty of reduced profits compared with those obtained by users of aircraft specially built for farm work.

The operational technique of a spray plane pilot in spraying fairly flat rectangular fields is to fly a grid pattern. He must fly his aircraft with the greatest accuracy to ensure complete crop coverage. He inevitably uses a rough airstrip close to the spraying area and he may make up to 150 round flights in a day. These and many other important points must be considered when designing the true agricultural spraying aircraft.

Operational conditions may vary according to the country in which spraying aircraft are flown, but three things nearly always apply, namely that airstrips are all short, are uni-directional, and have a rough surface. In addition, many strips are located at high altitudes and others are in tropical climates—both conditions affect the performance of a heavily loaded aircraft at take-off. The aim must be, therefore, to provide an aircraft with adequate performance consistent with the ability to lift economical loads.

The very low altitudes involved during spraying (when the wheels almost brush the crops) demand the adoption of many features leading to safer flying.

Of first importance is the question of visibility from the cockpit, particularly forwards. This calls for a wide windscreen free from distortion giving an unobstructed view over, if possible, a sloping nose. Visibility must also be good when the aircraft is on the ground, for a clear view over the nose when taxying will lessen the risk of accidents and help to speed up turn-round times. For pilot protection, the airframe around the cockpit should be reinforced to form a tough overturn structure. A shoulder harness, and a foam rubber pad over the instrument panel will also make for greater safety.

Provision for dumping the entire spray tank load in a few seconds is also of vital importance, particularly during take-off or during spray runs when the aircraft is at a low altitude. As with the dusting or topdressing aircraft, the disposition of the load should be such as to cause the pilot no injury in the event of an accident taking place with a full load still aboard the aircraft. Where liquids are involved it is best for the tanks to be positioned in the wings (together with the fuel tanks) well away from the engine and subsequent fire risks.

The universal use of small airstrips of the type already described automatically precludes the use of large aircraft. What is required is an aircraft capable of carrying at least half a ton with a low wing loading and high-lift wings. The power/weight ratio must be favourable to provide short ground runs and steep climbs giving adequate clearance of obstacles around the strips.

Continuous spray runs back and forth just a few feet above the ground necessitate accurate positioning of the aircraft. This can only be achieved if the flying controls give instant response and are correctly harmonised. The ailerons in particular must be sensitive, for after every spray run a steep climbing turn is made to reposition the aircraft for its next run. A reserve of power and ample stall warning will provide an additional safety margin for this manoeuvre.

Changes of trim created by the continuous emission of spray fluid and during full-power climbs, must be as slight as possible. This is an essential feature if the aircraft is to be easy to fly and demand little attention from the pilot, whose main task it must be remembered is to apply chemical sprays in as uniform and accurate a way as is possible. When 'dumping' action is taken —to jettison the load in an emergency—this too should have little effect upon the aircraft's trim—for obvious reasons.

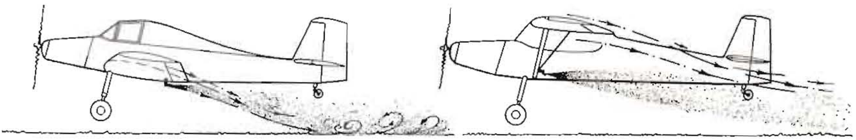
For the greater part of any spraying season aircraft employed on this work will more often than not be operating many miles from organized repair facilities. This and the rough nature of the work calls for an aircraft of very simple but sturdy construction.

Statistics show that the welded tubular steel fuselage is the cheapest to maintain over a long period, for repairs can be carried out with comparatively primitive equipment and unskilled labour.

Chemical contamination of converted aircraft is an additional operational hazard. The specially designed aircraft, however, must incorporate features which will lead to a longer airframe life. These should include : sealed component parts (wings, ailerons, tail unit, etc.) to prevent chemicals from accumulating within the airframe and corroding the structure, a cockpit which is sealed from spray chemicals and, most important, the entire structure must be protected chemically, if possible during manufacture. Treatment with standard aircraft dopes has been proved ineffective due mainly to the acid content of certain spray fluids. These also dictate the type of material from which the spray tanks should be fabricated. The new acid-resistant plastics would appear to be ideal. Not only have they a long life but their pliable nature is well suited to the construction of flexible tanks which can be easily collapsed and withdrawn from the aircraft to facilitate cleaning, or for changing over quickly to the use of other chemicals. The problem of the right tanks is not complete without mention of the position which they should occupy in the aircraft. This is determined by a number of factors, the most important being that they must be on the aircraft's centre of gravity, and easily filled, for turn-round times have to be kept to a minimum. The best position, then, would appear to be as low as possible, thereby enabling ground operators to reach the tanks without using special equipment. Only a low wing aircraft, in which the tanks can be housed in the wing bays, meets these requirements.

In searching field tests it has been found that high-wing aircraft present many other problems leading to inefficient operation.

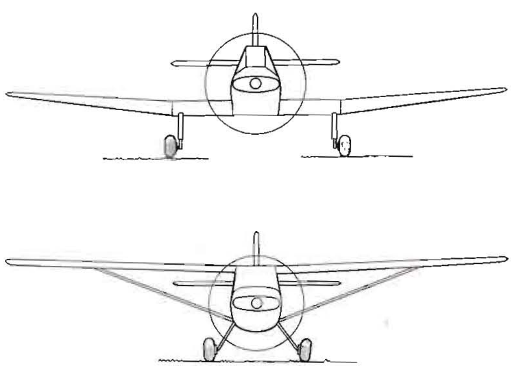
First is the question of spray boom installation. When fitted to high-wing aircraft the boom and nozzles are usually supported by a complicated structure suspended from the wing, and then cross-braced to the lift struts and undercarriage. A weight penalty is the result together with high drag characteristics. Added to this, the relatively high position of the spray nozzles means that during spraying the aircraft must be flown closer to the ground (with a lower safety margin) in order to approach the higher spray efficiency reached by low wing machines.



Left. The most turbulent and effective spray pattern comes from the low wing aircraft where the spray is carried by the downwash right into the crops.
Right. The relative position of the wing on a high wing aircraft has little effect upon the spray which eventually settles upon the crops with negligible turbulence.

In order to avoid heavy complicated spraying equipment a low-wing position is essential as the short light-weight nozzles can be fitted projecting from the lower surface of the wing. In this position every advantage is taken of the wing downwash for underleaf spray penetration. The airflow pattern from a low wing at crop height gives crop penetration similar to a helicopter's downwash. This latter point—crop penetration—is of great importance as many insects (and their eggs) cling to the undersides of crop foliage. They would otherwise escape from the effect of the spray but for the turbulent downwash from the low wing.

The rough surfaces of typical airstrips used by spraying aircraft also influence the choice of wing position. The widest possible track to the undercarriage means safer taxying and easier ground handling. A low wing position enables a track of ample width to be adopted.



The adoption of a high or low wing position greatly affects the undercarriage layout. Aircraft with a low wing can be fitted with an undercarriage of optimum track. A high wing position dictates a narrower, and less stable undercarriage.

The successful spraying aircraft, then, must be specially built for the job as its work is of an arduous and specialized nature. Very rarely in a hangar and mostly operating in the field, it must be simple, sturdy, safe-to-fly, and carry a load that will make it a profit-making proposition. Finally, and within reason, it must be versatile, when the spraying season in one area closes, it must be capable of a quick changeover to another duty such as dusting, topdressing, light freighting, supply dropping, etc. Only by using the right tools for the job can the aerial spraying contractor keep abreast of other operators in this rapidly expanding 20th century branch of farming.

Aerial Topdressing

. . . the need for a specially designed aircraft

TOPDRESSING is one of the most specialized and arduous agricultural duties now being performed by aircraft. World leader in topdressing is New Zealand where some 250 aircraft are regularly employed spreading fertilizer over sheep farming territory. Nearly all the topdressing is carried out over pasture land which is too hilly and rugged to permit ground-borne methods to be used—even tractors. If it were not for aircraft which can in any case do the job more cheaply than ground machines, much of the land would remain undeveloped.

During 1955 over 279,000 tons of fertilizer were dropped by aircraft in New Zealand. Here again, as in other agricultural roles, experience has shown that, to do the job economically and efficiently, the aircraft must be designed to the requirements of the operator.

What exactly does the operator need ? A study of his operational technique, the chemicals he spreads, and the conditions in which he operates will provide us with the specification of an aircraft to exactly suit his requirements.

The average type of landing strip is rough, short, unsurfaced and can change from dust to mud within a short space of time. The aircraft then must be ruggedly built to withstand continuous landings—as many as 200 in one day—and have a sturdy undercarriage of simple design. Large low-pressure tyres will allow it to operate from both muddy and rough strips. Under such tough conditions a most desirable feature would be to incorporate interchangeable undercarriage legs. Only one leg need then be ordered by the operator as a spare for both port and starboard positions. A wide track to the undercarriage and powerful brakes will make taxying easier and simplify the pilot's job.

The location of airstrips in the hilly country of New Zealand dictates the need for the aircraft to be capable of very short take-off runs when fully loaded. The ex-military and other converted types suffer here from high structure weights with the resultant penalty of either comparatively small payloads and an acceptable performance, or a heavier load with poor performance characteristics. The short take-off run must be followed by a steep angle of climb to clear the hills which normally surround the airstrips.

Turn-round times on the ground are kept remarkably low, in the order of half a minute. Provision must be made then for the aircraft's hopper to be filled in a matter of seconds. The more efficient and quick the loading system, the greater the daily work capacity and the wider the profit margin.

The hopper filler must be located at a convenient height from the ground and within easy reach of a ground operator. A low wing presents the advantage of a walkway on which one of the loading crew can stand in order to guide the loading trunk into position. It will be appreciated that a high wing position offers no help towards quicker loading times. It is in fact a disadvantage for it cannot be used as a walkway and must be carefully avoided with the loading equipment.

As the approved technique is to keep the engine running whilst fertilizer is being loaded, the filler neck should be positioned behind the pilot. This will minimize the possibility of dust blowing both onto the windscreen and into the cockpit. The airframe, in particular the cockpit, must be sealed against even the finest dusts. The aircraft that is not sealed will present acute maintenance problems and will have a higher consumption of spares through corrosion.

Special protective treatments during manufacture are essential to prevent airframe corrosion particularly in respect of aircraft used for dropping superphosphate. This material releases sulphuric acid when it becomes damp, which means that an aircraft picketed out for the night covered in dust from a day's operations is subjected to an acid bath when dew forms. During busy operating seasons when too much time cannot be afforded for inspections or maintenance, 'built in' protection of this sort will lead to greater safety and a lengthened airframe life.

This is typical territory over which topdressing aircraft must operate continuously. Excellent forward visibility and highly responsive ailerons are but two of the many features which must be incorporated in the aircraft which is to do this job effectively.

Many other desirable safety features must be included in the design of the 'ideal' agricultural aircraft, for continuous flying at low altitudes quite naturally involves an element of risk which can only be reduced considerably if the problem is tackled in the initial design stages of the aircraft.

The height from which superphosphate is normally dropped varies between

75 and 100 feet. Topdressing from this altitude gives a wide swath, even coverage, and provides a safety margin as the aircraft must follow the hill contours. Continuous flying under these conditions demands a high degree of concentration from topdressing pilots, the aim must be, therefore, to reduce fatigue to a minimum, for a tired pilot endangers both himself and the aircraft. His aircraft then, apart from being viceless and easy-to-fly (essential qualities), must be provided with simple, power-operated systems which will enable him to make light work of the numerous actions necessary during a complete topdressing flight. These points will be appreciated when it is remembered that a topdressing pilot who performs, for instance, 50 flights in a day must operate his flaps 200 times and the hopper doors 100 times. Any manual system for either of these operations would be both tiring and distracting. This must be avoided at all costs, for a pilot's primary job is to fly his aircraft safely and as accurately as possible to obtain a uniform deposit of chemicals over any predetermined area.

During continuous low flying an emergency may arise in which the pilot will need to jettison his load. This may be, for instance, an unexpected obstacle such as a power line or trees, etc. Provision should be made for a dumping device to be fitted enabling the entire load to be dropped almost instantaneously. Any system taking longer than five seconds should not be entertained, otherwise the opportunity to take evasive action—usually by climbing with a lightened aircraft—will be lost. The change of trim during dumping must be slight, upwards, and easily controlled.

In the interest of further safety, other features should include : suitable positioning of the hopper to afford pilots the maximum protection from crushing in the event of a crash, a strong overturn structure built around the cockpit plus a shoulder harness attached directly to the airframe, excellent visibility from the cockpit during all aircraft attitudes especially when climbing, on the approach to land, and taxying. A simple cockpit layout equipped with only the most essential instruments will also lead to safer flying.

To summarise : the aircraft that is needed must obviously be designed to a special configuration, including the most efficient dispersal equipment possible. It must be simply constructed and easily repairable, have an excellent take-off performance permitting heavy loads to be lifted continuously, and provide its pilot with every possible measure for his safety.

Its duties are too specific and sharply defined for it to be an all-round general utility machine with roles too far outside the agricultural field. The farm tractor is an excellent example of this 'specialized efficiency'. A truck or a jeep could be used instead of a tractor, but it would hardly compete economically with the latter *at its own job*.

IN the foregoing chapters we have outlined the duties and requirements of an agricultural aircraft ; from these it will appear obvious that the aircraft that is needed must be designed and not modified to meet the agricultural operator's requirements.

Until recently there was no suitable type available but now, as a result of years of market investigation, design and testing, an aircraft has been produced. It is the Auster Agricola which is in quantity production and already in service . . .

Auster Agricola

. . . designed specifically for farm duties

HAVING read this far, it may now be possible to study the new Agricola air farming machine in its proper context.

The Agricola is one of the first aircraft in the world to be designed specifically for such duties. It has been produced after careful study by Auster designers and engineers of the exact operational requirements of scores of aerial spraying and dusting units. Backed by ten years' experience with previous Auster agricultural 'planes, they have evolved an aircraft combining unmatched performance with high load capabilities and exceptional measures for pilot safety. Into no other aircraft have such elaborate crash-protection safeguards been built. The load is carried below the pilot, and the structure is stressed against possible overturning, itself improbable because of the ultrastable characteristics of the machine even on the roughest ground. The Agricola is amply powered for safety in low flight and is very manoeuvrable.

Compared with a commonly used converted training aircraft, it can spray over twice the acreage per hour at two-thirds the cost per acre. The machine costs only between £6 and £7 per hour to operate (see analysis on page 23). Consider that in this hour it can treat as much as 180 acres and the result is obvious. Taking even half this optimum figure as a fair average, the cost works out at only 2s. 2½d. per acre.

Its ability to perform aerial agricultural work cheaply with the maximum safety stems from many features unique to the Agricola. Freedom from corrosion is assured by total sealing of the structure and by thorough chemical protection of all parts. Moreover, the entire airframe, its systems and components, are built to withstand continuous 'outback' use.

Pilots find its cockpit layout pleasingly simple—and consistent with the aircraft's duties. Only the most essential instruments and equipment are fitted. Non-tiring, power-assisted hopper and flap controls, and easy spray gear actuation plus a superb field of vision lead to improved pilot efficiency—and much safer flying.

Following Auster tradition the Agricola is as versatile as possible. It is suitable for all agricultural work including spraying, dusting, fence and supplies dropping, aerial baiting and topdressing, and for freighting considerable loads as well.

The overall simplicity of the Agricola's construction lends itself to a measure of accessibility that will delight any service engineer. His ability to carry out on-the-spot inspections and maintenance will keep the aircraft flying—profitably !

Fuselage Structure

This is built from welded tubular steel and for ease of repair in the field the rear section is fabric covered. The hopper filling trunk is positioned behind the pilot ensuring that no dust is blown onto the windscreen during filling even though the engine is running. Aft of the trunk is a two-seat passenger compartment in which ground crew and equipment may be carried. It may also be used for light freighting purposes in addition to the hopper space, which can be adapted to carry heavier loads on the 'pannier' system.

Extra safety is built into the Agricola with the sealing of the rear fuselage. This prevents the ingress of dust or spray fluids which can in ordinary aircraft lead to tail heaviness and dangerous flying characteristics. Special filtered breathers are fitted to accommodate pressure changes.

No other aircraft incorporates such a simple-to-inspect system of control cables to the tail unit. There are no panels to unscrew and no fabric to cut as the cables are passed along the outside of the fuselage at the engineer's eye level !

A tough nylon covering protects them from chemical corrosion. For easy engine and cockpit servicing the entire front fuselage can be uncovered in minutes through the use of quick-release metal panels.

Cockpit

The very nature of topdressing and spraying work demands a structure around the pilot capable of withstanding high crash loads. The cockpit therefore has a tough structure designed to give pilots the maximum of protection, especially in the event of the aircraft turning over. For greater strength the pilot's seat is integral with the wing centre section structure. A robust shoulder harness affording extra protection is made of a material resistant to the corrosive effects of most powders and spray liquids.

Visibility from the cockpit is excellent. The top cowl line of the nose is sloped downward away from the windscreen providing an unimpaired forward view. Even when the aircraft is in the tail-down position the nose remains below eye level, greatly reducing the risk of taxying or low-flying accidents.

Permanent clear vision is ensured through the fitting of safety glass panels in the windscreen—to resist scratching caused when cleaning off abrasive dusts and 'phosphate. The remaining transparent panels are of simple flat 'Perspex' sheets, thus no expensive moulded canopies need be held as spares. Sliding panels give controlled ventilation in flight, and an efficient windscreen wiper provides excellent visibility in bad weather. Once the pilot's canopy is closed the cockpit is completely sealed against the ingress of any powder spilt whilst loading.

In keeping with the overall simplicity of the aircraft, the instrument panel contains only the most essential instruments—an engine speed indicator, boost gauge, sensitive altimeter, oil pressure gauge, fuel pressure gauge, oil temperature gauge, compass, ignition switches and two air speed indicators. Duplication of the last instrument is intended as an aid to safer flying—one

A.S.I. is positioned at each end of the instrument panel in which position they are easily referred to during turns either way in to land, and in reversals during low level spraying operations. The instrument panel is set as far forward and as low as possible to reduce the possibility of the pilot striking his head against it in the event of a severe crash-landing. The throttle, trim, flap, hopper and spray gear operating controls are mounted within easy reach of the pilot on his left-hand side.

Hopper and Spray Tanks

Many months before the Agricola first flew, intensive flight dropping trials were carried out with various types of hoppers fitted in development aircraft. Pilots' and observers' reports were closely studied to select the most efficient hopper system and shape.

Large daily loads of fertilizer can be dropped with this hopper which can be packed with three-quarters of a ton at each filling. Hydraulic actuation of the hopper doors avoids distraction of the pilot's attention at moments of critical concentration. Eight-inch lumps can pass through the doors which are eflortless to open and are controlled by a preset finger-tip lever close to the pilot's left hand. Hopper life is lengthened through the plastic interior lining. Hopper filling can be accomplished in seconds. A loading operator can use the low wing as a walkway and guide the loading funnel quickly into position above the eighteen-inch diameter filling trunk. In emergencies the entire load can be dumped within five seconds !

The Agricola can be supplied in three versions :

1. With hopper only for topdressing or dusting.
2. With spray tanks only, suitable for spraying.
3. Multi-purpose version with both spray tanks and hopper fitted.

The aircraft has been designed to permit a quick changeover from one role to another without the need to dismantle either installation. The hopper and spray tanks are entirely separate units permitting spraying to commence within a short time of dusting or topdressing operations ceasing, or vice versa.

The total capacity of the spray tanks is 144 Imperial gallons (173 U.S. gallons). Large underwing access panels make for easy inspection and removal. The spray tanks are of a flexible plastic material highly resistant to all known spray liquids.

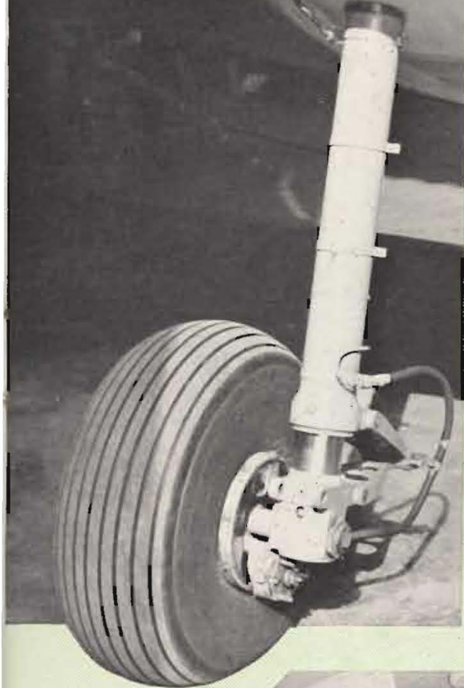
Simple, lightweight spraying equipment is fitted with high efficiency low drag spray nozzles projecting from the lower surface of the wing.

Engine and Fuel System

The choice of the 6-cylinder 240 h.p. Continental motor will be an advantage to operators of the Agricola. As a current production engine the supply of spares for the entire life of the aircraft is assured.

A high efficiency variable pitch propeller is fitted which ensures a high rate-of-climb and short take-off runs. It also increases the aircraft's maximum speed and range to very useful proportions.

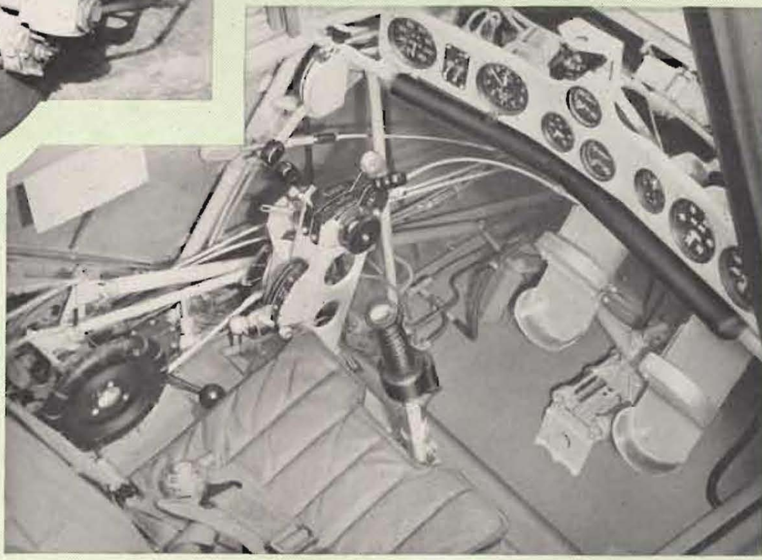
An electric starter is fitted, connected to a standard ground starter socket. As an added safety factor no battery is fitted, it is expected that power for engine starting will be taken from a ground truck. If required, however, a battery and generator can be easily installed—an approved modification is already available.

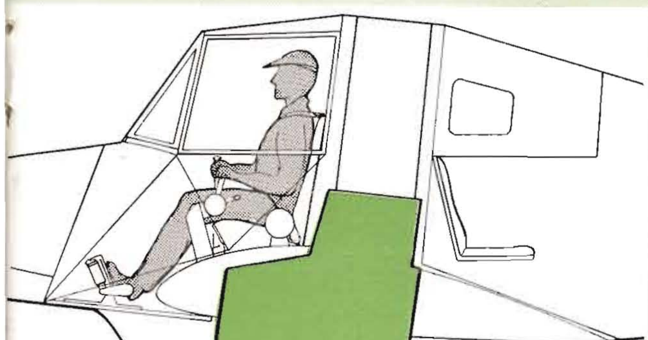


Designed for the Job

Left. Each of the sturdy undercarriage legs can be interchanged, port to starboard or vice versa. Low pressure tyres roll easily over muddy surfaces and powerful disc brakes ensure short landing runs.

Below. The Agricola's cockpit is exceptionally roomy and comfortable. For simplicity only the most essential instruments are fitted. On the pilot's left within easy reach are the engine, flap, trim and hopper controls. Adjustable rudder pedals cater for differing leg lengths.





Left.
Complete protection for the pilot from 'sandwiching' in the event of an accident is assured through the positioning of the main hopper load well below the pilot's seat. The total capacity of the Agricola's hopper is $\frac{3}{4}$ ton.

In emergencies the Agricola pilot can jettison the entire load of $\frac{3}{4}$ ton in under 5 seconds.

Engine cooling has been made entirely automatic by Auster technicians. Long before the aircraft first flew a special test bed had been built enabling extensive ground tests to be carried out on a complete power unit. An Auster-designed 'jet-cooling' system was tested and found to be very effective. No attention is needed from the pilot as exhaust gases control the flow of cooling air through large ducts. At all times cooling remains proportional to the amount of power being given by the engine. This system is particularly effective during idling on the ground (whilst loading for instance) when no ram air is available for cooling purposes.

The fuel capacity is 24 Imperial (29 U.S.) gallons, this is carried in a flexible crash-proof tank in the port wing root. When filled to capacity the Agricola has a useful range of 240 miles cruising at 115 m.p.h., and for special purposes part of the spray tank capacity could be utilised for additional fuel.

Wings and Undercarriage

Many factors were considered when the choice of wing position was made. With 17 years of high-wing experience behind them, Auster designers felt compelled to select a low wing for the specialist agricultural aircraft. The chief reasons were as follows :

Under leaf spray penetration from wing downwash.

Ease of hopper filling (operator can stand on the wing to guide the filling trunk).

An undercarriage of very wide track.

Excellent visibility during contour flying, especially when turning.
Easy filling and cleaning of spray tanks.
Quick refuelling.
Simplified installation of spray gear.
Ground cushion effect for take-off and landing.

The wing structure is all-metal with a fabric covering, for ease of repair, aft of the front spar. To combat costly corrosion, the wings and ailerons are sealed preventing contamination from chemicals, and, as in the case of the fuselage, filtered breathers are fitted to counter pressure changes with height.

The wide track (14 ft. 4 in.) undercarriage is hydraulically damped—absorption capacity is equal to that of Naval deck-landing fighters! Low-pressure tyres enable the aircraft to operate from soft ground with comparative ease.

Cost-cutting maintenance features include: a two-bolt fixing for each undercarriage leg and tail wheel, interchangeable main legs and wheels, and the provision of automobile type valves in the hydraulic damping system permitting topping up of the air pressure with a car type pump.

This view of the Auster Agricola shows the wide hopper filling trunk just behind the cockpit. The superb forward view is due in the main to the large one-piece safety glass windscreen which is completely distortion free. "Flight" photo

Auster Agricola

SPECIFICATION AND PERFORMANCE

SPECIFICATION

Power Unit . .	One 240 h.p. Continental 0-470-M-2 six-cylinder horizontally opposed air-cooled engine driving a McCauley Met-L-Matic two-blade constant speed propeller.
Fuselage . .	Welded steel tubing, fabric covered aft, metal covered around cockpit and engine.
Wings . .	Cantilever low-wing of all-metal construction, fabric covered. Wing centre section accommodates spray tanks and fuel tank.
Ailerons . .	Slotted type, metal construction, fabric covered.
Flaps . . .	Split type with Auster 'Rapid Drag Control' feature. All-metal construction.
Tail Unit . .	Cantilever, metal construction, fabric covered. Horn balanced elevator and rudder.
Landing Gear .	Fixed oleo legs with 22 inch diameter wheels.
Tail Wheel . .	Fixed oleo leg with 10 inch diameter wheel.
Hopper capacity .	1,680 lb. (overload category).
Spray Tanks capacity .	144 Imperial (173 U.S.) gallons.
Fuel System . .	One 24 Imperial (29 U.S.) gallon, crash-proof tank in port wing root.

PERFORMANCE IN STANDARD CONDITIONS

At normal category A.U.W.	3,675 lb. (1,400 lb. payload)	at 2,250 lb. (No payload)
Distance to unstick (5 knot wind) . .	185 yds.	55 yds.
Distance to clear 20 ft. (5 knot wind) .	365 yds.	135 yds.
Distance to clear 50 ft. (5 knot wind) .	440 yds.	160 yds.
Initial rate of climb . . .	610 ft/min.	1,310 ft/min.
Service ceiling	10,500 ft.	20,000 ft.
Maximum speed at 1,000 ft. . .	127 m.p.h.	136 m.p.h.
Maximum cruise at 1,000 ft. (2,400 r.p.m.) .	123 m.p.h.	132 m.p.h.
Economic cruise at 1,000 ft. (2,300/-3½ lb.) .	101 m.p.h.	115 m.p.h.
Range at economic cruise . . .	218 st. miles	240 st. miles
Stalling speed, flaps down, power off .	44 m.p.h. I.A.S.	35 m.p.h. I.A.S.
Distance to land from 50 ft. to stop (5 knot wind)	380 yds.	245 yds.
Distance to land from 20 ft. to stop (5 knot wind)	315 yds.	205 yds.
Landing run	145 yds.	90 yds.

Auster Agricola

ESTIMATE OF DIRECT OPERATING COSTS

	Topdressing	*Spraying*
Ex-works cost of aircraft	£8,500	£8,950
Assumed life of aircraft	8 years	10 years
Assumed flying hours/year	600 hours	600 hours
Assumed life of aircraft	4,800 hours	6,000 hours
Assumed engine overhaul life	600 hours	600 hours
Assumed engine overhaul cost	£400	£400
Depreciation per flying hour	£1.76	£1.48
Fuel, oil per hour at 5/- gallon (including oil)	£2.5	£2.5
Airframe maintenance/hour	£ .5	£ .5
Engine maintenance/hour at £400/600 hours (replacement) plus £200/600 hours for general and propeller maintenance	£1	£1
Aircraft insurance per hour at 15% per annum of mean written down value, £4,250	£1.06	£1.06
Total direct operating cost/hour	£6.82	£6.54
Ditto, but including pilot £3.3/hour (i.e. £2,000 per annum, including insurance at 600 hours)	£10.12	£9.84

Work capacity and economics—SPRAYING

In any problem concerning aerial spraying there are many variables. However, some of these become constants for a given combination of aircraft and equipment, which greatly simplifies calculation.

Here are some simple formulae which may be of value and which are based on the following variables :

Aircraft equipment constants :

V(F) = ferrying speed in m.p.h.
V(O) = operating speed in m.p.h.
r = reversal time in seconds
G = ground time per sortie cycle
S = mean swath width in yards
C = spray gallons per sortie (i.e. capacity)

Operation variables :

D = distance field-strip in miles
L = length of field in yards
Q = required dosage, gallons/acre
A = required spray rate gallons/min.
T = total time per sortie cycle

Work Capacity and Economics—Spraying, continued

Formulae :

It can simply be shown that :

(1) Required spray rate $A = \dfrac{Q \times S \times V(O)}{165}$ gallons/min.

(2) Sortie time cycle, $T = G \quad \dfrac{120D}{V(F)} + \dfrac{C}{A} + \dfrac{C \times V(O) \times 1 \times 22}{45\,AL}$ mins.

(3) Acres sprayed per sortie $\dfrac{C \times V(O) \times S}{165}$ acres

(4) Acres sprayed per hour $= \dfrac{60C}{TQ}$

(5) Operating cost per acre sprayed = cost per hour (£) $\times \dfrac{4TQ}{C}$ pence

Example :

Let us take at random a typical example of (say) cotton fields of average length 800 yards, situated $2\frac{1}{2}$ miles from the landing strip, and let us examine the working economics of three spraying aircraft, if two gallons are to be sprayed per acre :

(i) First aircraft, a converted 130 h.p. biplane trainer, carrying 45 gallons, spread over a mean swath width of 10 yards, V(F)=75, V(O)=60. Assume aircraft costs £2.91/hr., plus £3.3 pilot's salary and insurance.

Acres sprayed per hour = 85
Cost per acre sprayed = 17.5 pence

(ii) Second aircraft, a good general-purpose 155 h.p. 4-seat, high wing monoplane, fitted with the best available spray equipment designed for it and carrying 70 gallons.
S=12 yards, V(F)=80, V(O)=70, assumed cost/hour=£3.96, plus £3.3 pilot's salary and insurance, totalling £7.26/hour.

Acres sprayed per hour = 119
Cost per acre sprayed = 14.8 pence

(iii) Third aircraft, a specially designed high-efficiency spraying machine such as the Agricola, carrying 140 gallons. S=15 yards, V(F)=90, V(O)=80, assumed cost/hour £6.54 plus £3.3 pilot's salary and insurance, totalling £9.84.

Acres sprayed per hour = 180
Cost per acre sprayed = 13.2 pence

The costs per operating hour written into the foregoing examples are estimates embracing depreciation, maintenance, fuel, oil, insurance, spares, engine replacements, etc., and are thought to be reasonably accurate, type for type.

The money which a spraying aircraft makes for its operator is measured by its work capacity in relation to its operating costs.

It is soon obvious, therefore, that operators still relying upon 'converted' aircraft of conventional origin cannot live long in competition with those who put the high-efficiency specialist aircraft, such as the Agricola, to work for them.

Chemicals suitable for Aerial Spraying to control PESTS

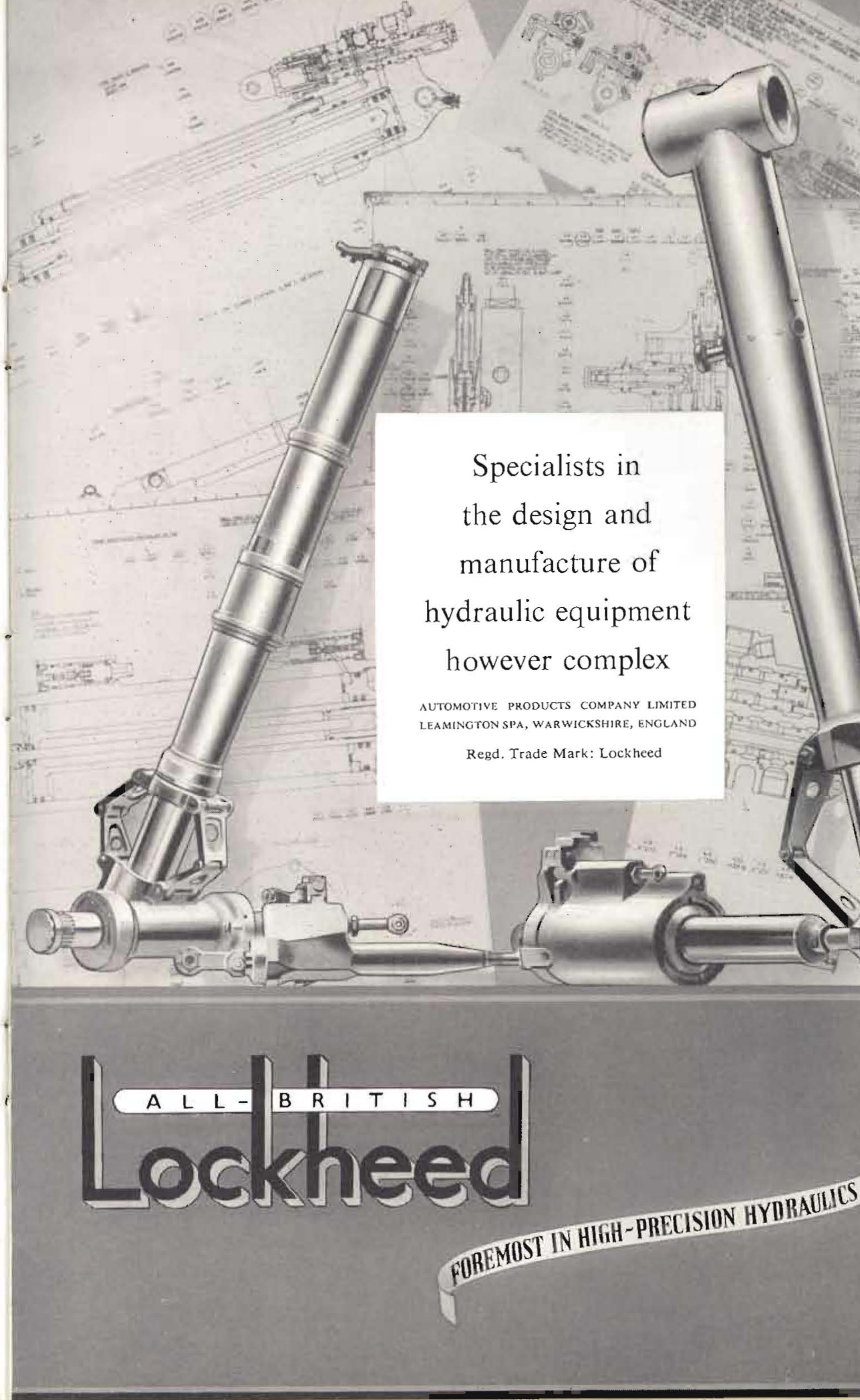
NEARLY all chemicals are suitable for aerial spraying or dusting. Their suitability depends upon (1) formulation from a purely physical point of view and (2) toxic hazard, volatility, and their drift characteristics (from a safety angle).

The list detailed below is intended to serve only as a guide to the vast range of chemicals available for the control of either insect pests or weeds. The rate and time of application are not given as they vary considerably under the different climatic and seasonal conditions.

CROP	INSECT PEST	CHEMICAL
Cotton	Cutworms, thrips, fleahoppers, boll weevil, aphids, grasshoppers, army worms, leaf worm, bollworm, stink bugs, Lygus bugs, rapid plant bug, western cotton plant bug, white lined sphinx	Toxaphene
Clover and Lucerne	Lygus, blister beetles, spittlebug nymphs, webworms, clover seed chalcid	Toxaphene
Grass and Grain	Cutworms, and army worms. General grain pests	Toxaphene
General, including pears, potatoes, onions, strawberries	Aphids (on potatoes), asparagus caterpillar, flea beetle, onion thrips, pear thrips, strawberry pests	Toxaphene
Alfalfa	Alfalfa weevil, webworms, blister beetles, Lygus	Toxaphene
General	Pea weevil, clover weevil and caterpillars and most chewing insects	D.D.T.
Cabbages, carrots and mangolds	Beetles, mangold fly	Dieldrex 15 Supadiel
Clover, lucerne, cabbages, peas and beans	Cabbage caterpillars, flea beetles (on cabbage crops), clover weevil (on forage crops), lucerne weevil. Pea and bean weevil	Arkotine or Dieldrex 15 or Supadiel
Seed crops	Pollen beetle, mustard beetle, turnip seed midge	Arkotine or Sillortox
Soil and general pests	General pests including wireworms	Aldrex 30 or Toxadrin
Cotton	Cotton Jassid	D.D.T. in oil
General	Mosquitoes	D.D.T.
Pine Forests	Pine looper moth	Sillortox (D.D.T. emulsion)
Potatoes	Fungus diseases	Blitox (copper fungicide)
General	Locusts	D.N.O.C. Mark 4

Chemicals suitable for Aerial Spraying to control WEEDS

USES	CHEMICAL
Weed control in asparagus . . .	2,4-D
Weed control in cereals . . .	M.C.P.A. selective herbicide
Weed control in grassland . . .	M.C.P.A. selective herbicide
Weed control in grassland . . .	2, 4-D amine selective herbicide
Weed control in flax	M.C.P.A. or 2,4-D
Weed control in sugar beet . . .	T.C.A.
Weed control in beans . . .	D.N.B.P.
Weed control in spinach . . .	C.I.P.C.
Weed control in potatoes . . .	D.N.B.P.
Weed control in strawberries . . .	2,4-D
For the destruction of woody weeds including gorse, brambles and scrub . . .	2,4,5-T
For weed control in grassland, especially for tough weeds in unfavourable conditions . .	2,4-D ester selective herbicide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Auster Agricola

One of the first aircraft to be designed specifically for agricultural duties, the Agricola combines exceptional performance and capacity with a degree of safety never before achieved. This versatile aircraft effectively performs a wide range of duties with remarkably low operating costs, and is available with hopper for top dressing or dusting, with spray tanks, or fitted with both.

"Flight" photograph

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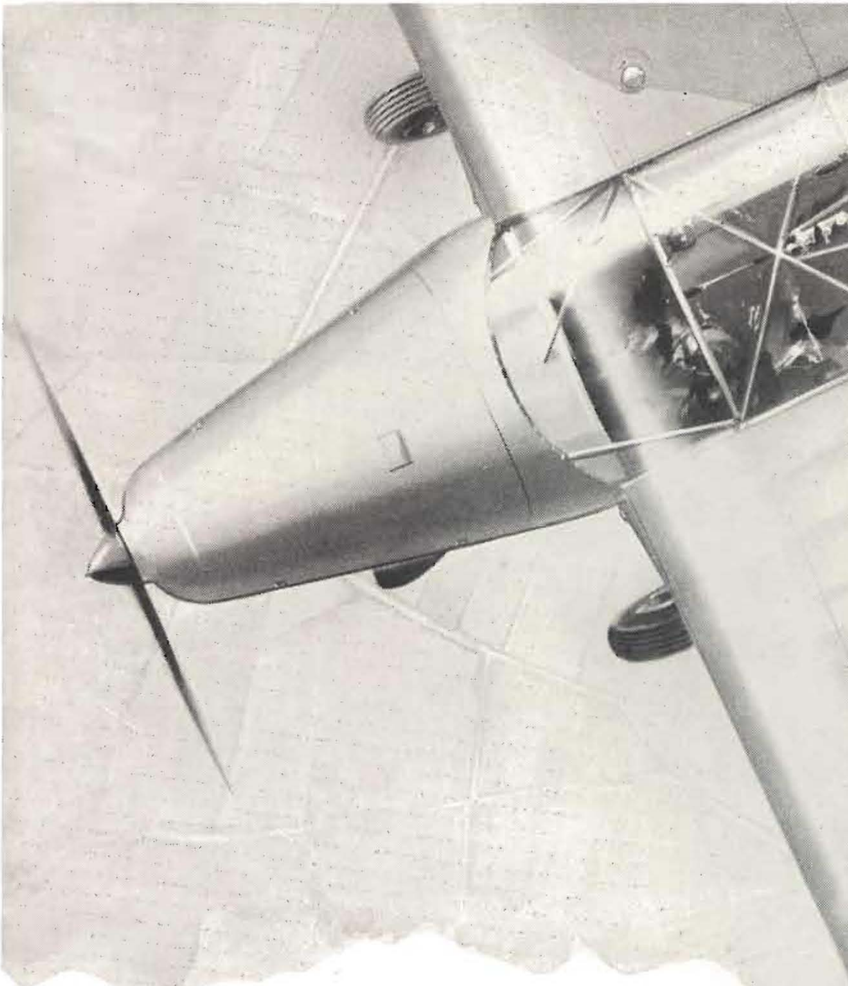

Auster specify Goodyear for the B.8

Goodyear are proud to have their equipment chosen as standard on the Auster Type B.8 "Agricola" — wheels, brakes, tyres and hydraulic brake control components.

SPECIAL FEATURES ARE:

Extra Low Pressure Tyres for operation from unprepared surfaces associated with the aircraft's role of crop spraying and dusting.

Special Parking Valve designed to meet extreme tropical operating conditions.

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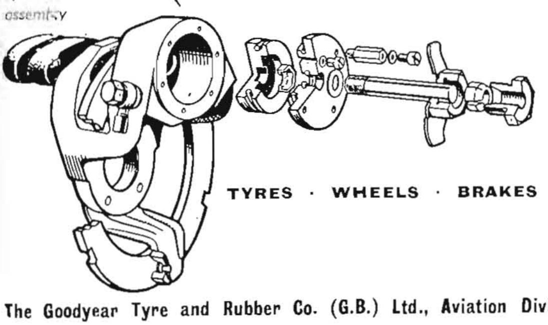
Cut-away of brake assembly



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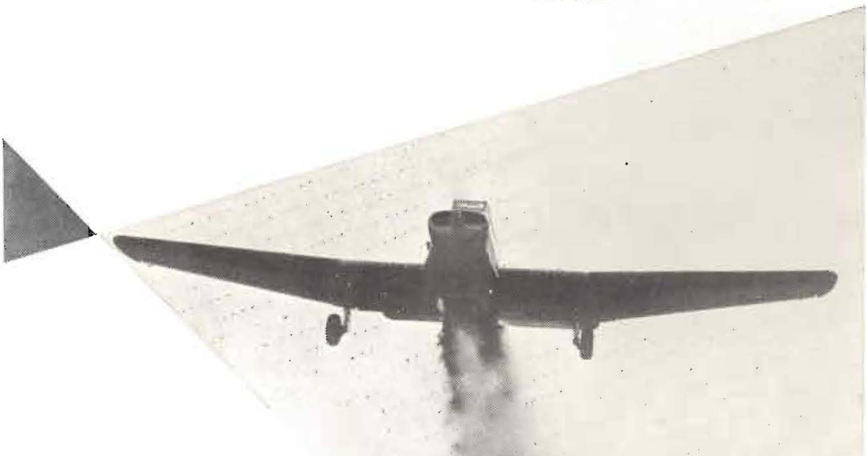

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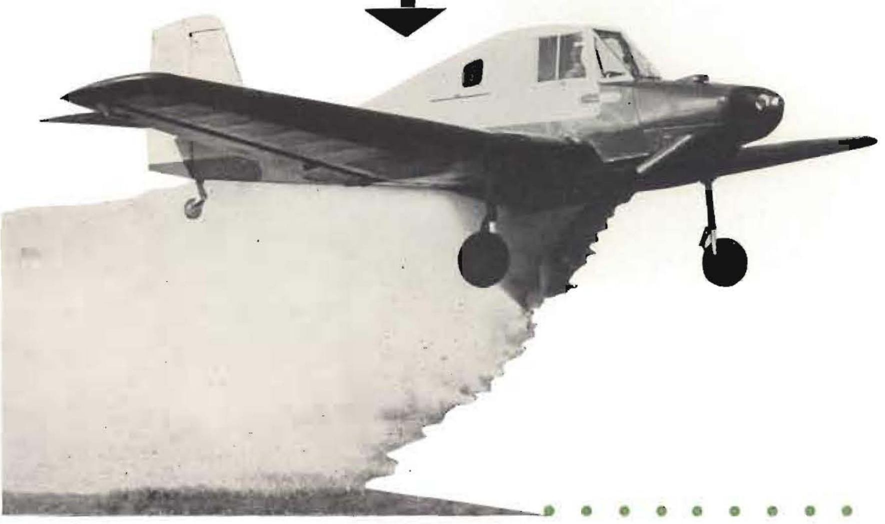

★ THE Agricola is capable of spreading more chemicals—at lower cost per hour than any other aircraft of similar power. This is due to the aircraft having been designed specially for agricultural duties.
The Dusting/Topdressing version has a hopper capacity of $\frac{3}{4}$ ton and can be loaded in seconds through the wide necked filling trunk. In its spraying version the Agricola can carry 144 imp. gallons of spray fluid, and by virtue of its low wing has crop penetration characteristics similar to those of a helicopter. The Agricola has a full normal category C. of A. and is in quantity production.

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