Development of Aerial Seeding for the Regeneration of Tasmanian Eucalypt Forests

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Abstract

Aerial sowing of eucalypt seed as a technique for reforestation after logging has had a prolonged developmental process. Extensive modifications have been made to seed dispersal equipment designs. The accuracy of seed output and pattern of distribution now obtained from the equipment is considered satisfactory, in view of the many variables affecting distribution and growth of seedlings.

Introduction

The concept of aerial seeding a logging coupe to create a new forest became an operational reality in the late 1960s. The technique of aerial seeding after logging and burning was initially developed for the wetter Southern Forests and the Australian Newsprint Mills Concession area. It is now the standard procedure for reforestation of clearfelled coupes.

This paper describes the development of aerial sowing equipment and the techniques of aerial sowing in Tasmanian eucalypt forests. Information on the technique and equipment in the 1960s was minimal and the Forestry Commission adopted a pioneering role in aerial seeding developments.

Early procedures

In the early days, the aerodynamic characteristics of light seed introduced into a wind stream created by an aircraft flying at 50-60 knots were untested. Increasing the size and mass of the seed by pelleting with clay material bound by a gum arabic sticker produced a heavier pellet less susceptible to drift and gave a better coverage of the seed on the ground. The bulking-up increased the quantity of material sown by a factor of about four. Ideally, each particle contained one seed, but multiple seeds were common.

To ensure visibility of the seed on the ground, a yellow vegetable dye was added, and to counteract the possibility of insect and fungal damage, small amounts of insecticide and fungicide were added to some of the earlier mixes. Mixing of this seed batch in a baffleless cement mixer was very messy, with yellow dust covering men and machines.

In the initial years, the application rate was 1 lb of pelletised seed to the acre. In hindsight, this application rate was far too heavy to achieve optimum site occupancy.

Low-wing Piper Pawnees were the main aircraft used. No specialised dispersal equipment was used, with the flow rate of seed being controlled by the opening width of the hopper door. The key tool was a one-eighth inch drill bit used to set the spacing on the hopper door. At this opening width, the hopper discharged the approximate rate although blockages were quite common. At one time, a V-shaped comb was tried to enable a finer adjustment to the hopper mechanism. A high-winged Cessna with two wing pods containing the seed was also used but with no real benefit.

Photo 1. The Transavia PL-12 Airtruck, the standard aircraft used for aerial operations in Tasmania.

Intermediate developments

Silvicultural research trials indicated that regeneration could be readily achieved without the need for costly and time-consuming pelleting of seed. The standard rate of application was reduced to about 0.5 kg of raw seed per hectare. Less frequent reloading of the aircraft also improved cost efficiency of operations. The main change in procedures was to restrict operations to a lower prevailing windspeed. Further developments to conserve the amount of seed used and improve spread patterns have resulted in substantial changes to practices and equipment used.

The Transavia PL-12 Airtruck (Photo 1) is now the standard fixed-wing agricultural aircraft in Tasmania. The early equipment (Photo 2) consisted of a double hopper with dual exits which allowed the seed to flow into the mouth of an aerodynamically-inefficient spreader which was heavy and bulky. This spreader was originally designed for farm application of superphosphate, where large quantities per hectare were applied, and precise control of application rate and distribution pattern were not considered so important. Air flowed past the aircraft through the mouth of the spreader, and was diverted by flanges within the spreader to produce the final swathe for the seed.

Rigid hopper inserts into which seed was directed from flexible chutes were then tried. Flow-rate control was based on a manually adjusted sliding flap at the base of each hopper. This was subsequently modified to a revolving turret with aperture holes of various sizes, together with a venturi feeding into the mouth of the spreader (Photo 3).

Calibration of equipment posed significant problems. Selected rates derived from ground adjustments were seriously inaccurate once the aircraft was in the air. The increased seeding rate between static ground and inflight trials was due to the induced slip-stream effect. Although a good design in theory, the gravity flow characteristics of the equipment made it very prone to uneven flow rates. These were particularly noticeable when a pilot, flying

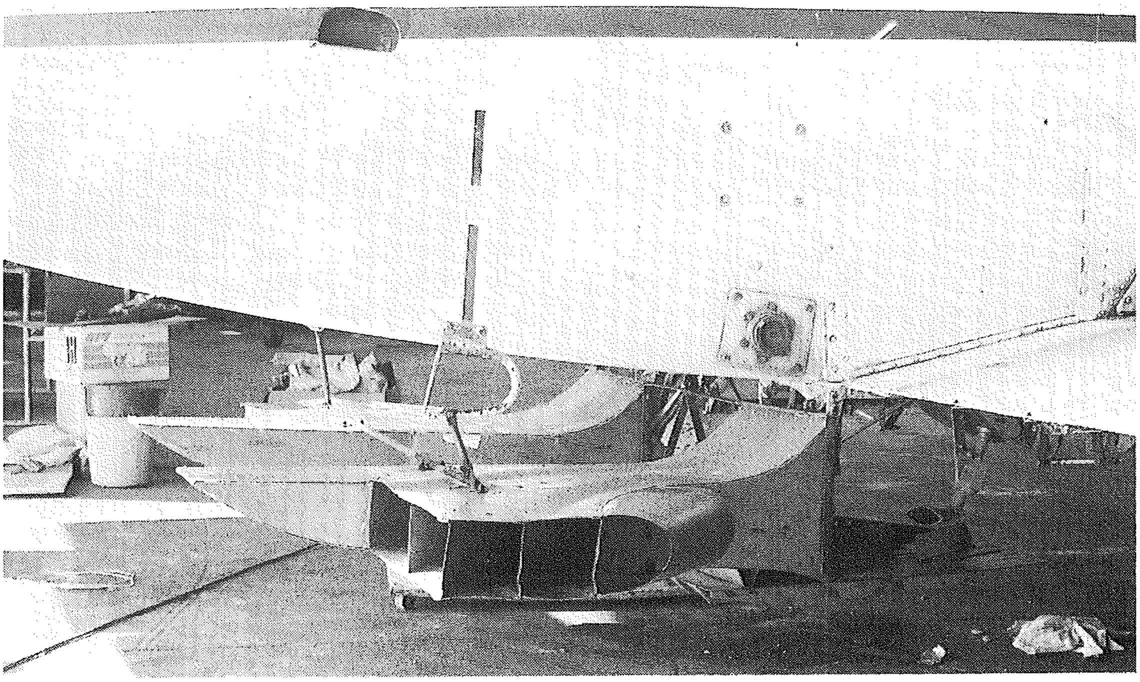

Photo 2. Transland spreader used to give width to the seed swathe.

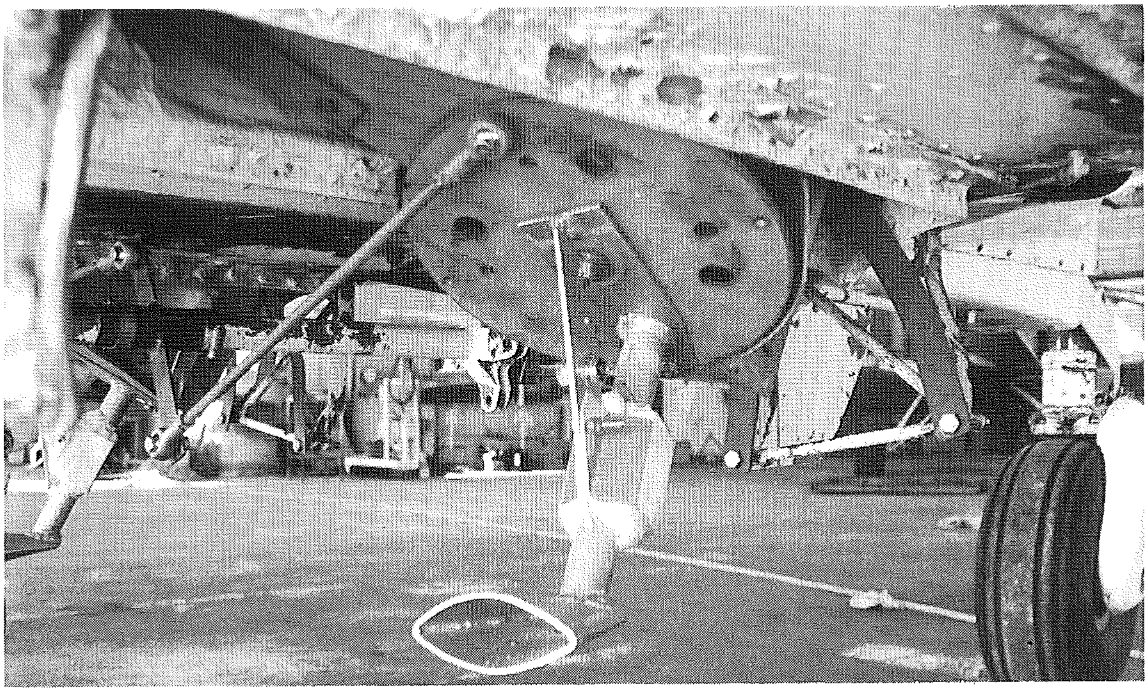

Photo 3. Gravity seed flow turret and venturi.

parallel to the ground, would fly up ridges and down slopes, subjecting the seed to positive and negative gravity forces.

The Brohm auger and slinger

The latest development, the Brohm auger and slinger, has received high praise from field staff. This is a major modification of a screw auger system developed originally in Canada. A mechanical auger draws seed from a hopper and discharges it into a revolving slinger below the aircraft (Photo 4). This system maintains a constant rate of seed output, the only variation to the sowing rate being that due to variation in aircraft ground speed.

Modification to aircraft structures and the attaching of accessories to aircraft are strictly controlled by the aviation authorities. The services of certified aeronautical consultants were used to ensure the desired modifications were feasible and acceptable to the authorities.

Evaluation trials were held at the University of Tasmania's farm at Cambridge. Analysis of the seed fall showed an even spread pattern over the 20 m swathe without the large peaks and troughs of earlier patterns.

Since the purchase of the Canadian auger, the equipment has been extensively modified to include an electronic speed control unit which enables an operator to pre-set and make infinite adjustments to the sowing rates.

The slinger, essential to give the even swathe to the seed, has been modified to reduce the start-up drag on the electrical motors. Early trials resulted in circuit breakers which popped at the most inconvenient times and which required replacement by much heavier fuses. The present design for the fixed-wing aircraft is about as far as developments can proceed while keeping within the realm of cost efficiencies. However, an hour meter will be incorporated in the electrical circuit of the slinger to provide a check on the actual operating time of the equipment.

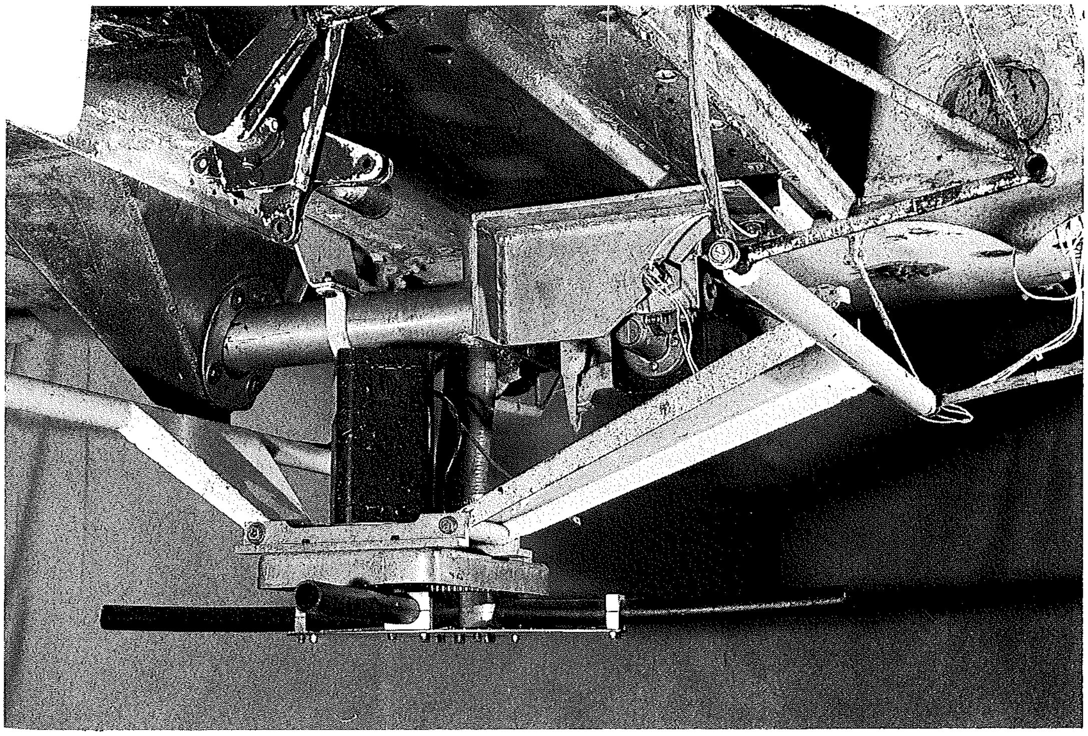

Photo 4. Brohm seed auger installed on the PL-12 Airtruck.

The heliseeder

About five years ago, at approximately the same time as the Brohm auger was being evaluated, a seeding unit suitable for a helicopter was leased from the Alberta Forest Service, Canada, for trials. The leasing arrangement included a trained operator from that organisation. These trials were successful and the Forestry Commission subsequently purchased a unit.

The heliseeding unit is quite complex, but consists of three basic components: a seed hopper, a seed metering device and an externally mounted slinger. The hopper and seed meter fit in the rear passenger compartment of a Bell 206 helicopter once the seats are removed (Photo 5). The slinger bolts onto the external cargo hoist attachment points underneath the helicopter. The wiring and inlet pipe for the slinger pass through a hole in the helicopter floor.

Helicopters have a monocoque stressed-skin honeycomb construction and no ribs to provide strengthening support, so any holes in the skin will interfere with the structural integrity of the body. Fortunately, the Bell Helicopter company in America had an approved modification design for the hole (Photo 6) and trials were able to proceed.

The seeding operation and activation of the seeder are under the control of the pilot. No observers are carried on board during actual seeding flights. It is important therefore that the pilot is adequately briefed on the requirements of the task, including the location of all boundaries.

A refinement of the heliseeding system has been the development of a hopper which will accept the Brohm seed auger as used in the fixed-wing aircraft. This new system is much cheaper than buying a new heliseeder unit and allows some compatibility of equipment components between fixed-wing and rotary-wing aircraft.

Photo 5. Heliseeder equipment installed in Bell 206 helicopter.

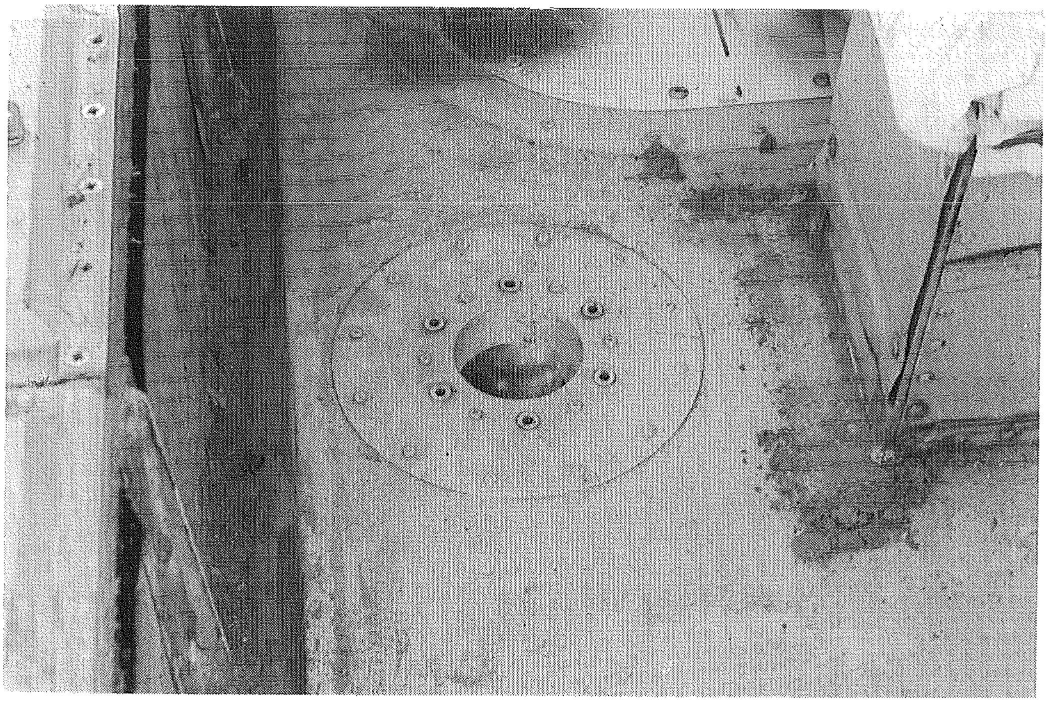

Photo 6. A hole in the floor allows the external slinger to be attached to the seeding unit inside the helicopter.

Fixed-wing versus rotary-wing aircraft

Fixed-wing aircraft have been used on seeding operations since the Forestry Commission started aerial sowing in the late 1960s. The advent of helicopter seeding has given some greater flexibility to the operation but at an additional cost. Photos 7 and 8 show the two types of aircraft in operation.

There are very few harvesting coupes which cannot be flown by a fixed-wing aircraft. Closed valleys with no escape fly-out routes, such as the Martha Creek cable logging coupes in the Mersey Valley, can only be sown by helicopter and even then with some difficulty, particularly when trying to maintain a consistent airspeed over the coupe.

Table 1 gives the areas flown for regeneration for the last few years and shows the trend towards using both helicopter and fixed-wing aircraft, the balance depending on circumstances.

The helicopter has some advantages over fixed-wing aircraft for seeding operations. There is no need for an airstrip. The helicopter can alight at each coupe to have the hopper filled with the specific seed recipe for the coupe to be sown. Where necessary, the seed mix can be changed within the coupe to cover altitudinal or aspect changes that have given rise to different species. The seeding co-ordinator can travel with the aircraft to each site and be on hand to resolve any problems. There is also no need to return to an airstrip to re-load and this keeps down ferry time. The major disadvantage is the higher cost of helicopter hire. However, with good flight control and shorter turn round at the end of each run, the helicopter theoretically spends more productive sowing time over the coupe than a fixed-wing aircraft. Nevertheless, considerable difference in costs of ferrying between coupes and forest districts exists between helicopters and fixed-wing aircraft as the latter have superior flight speed and lower hourly cost.

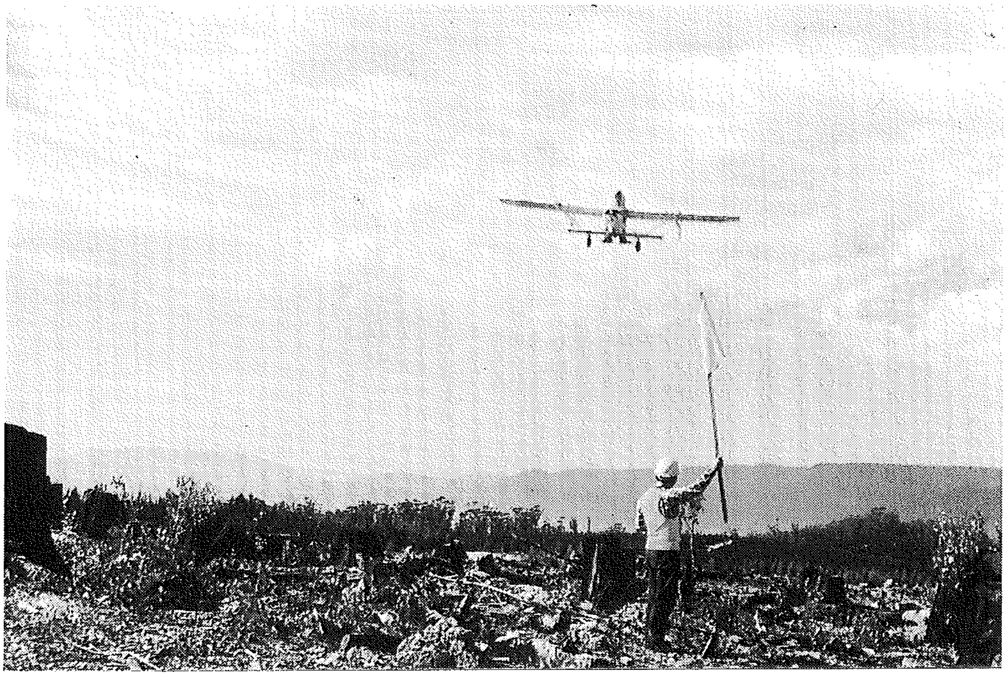

Photo 7. Fixed-wing aerial seeding.

Photo 8. Heliseeding.

Table 1. Area of land sown by aerial seeding. (Area sown for timber companies is not included.)

Year	Region	Fixed-wing aircraft	Helicopter	Total area (ha)
1987	NW	895	0	895
	NE	3088	0	3088
	SE	152	0	152
Total		**4135**	**0**	**4135**
1988	NW	1197	0	1197
	NE	714	0	714
	SE	165	336	501
Total		**2076**	**336**	**2412**
1989	NW	1745	0	1745
	NE	679	786	1465
	SE	1443	108	1551
Total		**3867**	**894**	**4761**
1991	NW	1646	0	1646
	NE	777	195	972
	SE	526	399	925
Total		**2949**	**594**	**3543**
1991	NW	1397	480	1877
	NE	503	277	780
	SE	633	54	687
Total		**2533**	**811**	**3344**
5-Year Total		**15560**	**2635**	**18195**

Discussion

Like any operation using highly technical and costly equipment, the more pre-planning undertaken, the more easily the operation proceeds. This is particularly so when a central co-ordinator monitors the aircraft movements around the State.

Aerial operations in general, and sowing in particular, are very weather dependent. Sowing requires a great deal of co-ordination, and field staff must take advantage of suitable weather when it arises. Seeding follows high intensity burning and the time delay between the two operations should be kept to a minimum, within operational limitations.

Uniform coverage of seed over the coupe is based on a series of parallel flight paths 20 m apart. The position of the flight path to be sown is indicated by flag wavers at predetermined positions along flag lines. These flag lines are marked out on the ground soon after the coupe has been burnt. Seeding rates are directly linked with ground speed, which in turn relate to air speed when prevailing winds are taken into consideration. Depending on the prevailing wind conditions, offsets may need to be made to the flying to compensate for wind drift of the seed. Correct placement of the aircraft over the coupe and attention to the effect of seed drift due to wind can have a much bigger effect on the outcome of regeneration than any unevenness in distribution across the swathe. The use of electronic flight marking equipment that no longer requires flag wavers is currently being investigated.

One factor in the operations that has become evident since the introduction of helicopter seeding, is the importance of the manner in which the aircraft is flown. Fixed-wing seeding is done by pilots with agricultural licences. These pilots understand what is required and work the aircraft hard, doing low flying agricultural work for their daily living. The helicopter pilots used by the Forestry Commission, however, are commercial charter pilots, only doing this specialised seeding work for a short period each year and do not have the same degree of experience. The tight torque turns possible with helicopters are not always suitable when aerial seeding. Time is needed for flag wavers to reposition themselves, and in difficult country, the pilot may need time to orient the helicopter for the most suitable approach for the next run. Consequently, the theoretical saving of time with a helicopter is being lost because of the slower turn round at the end of each run.

Time spent using the helicopter to collect bags of seed from another location, picking up flag wavers from the end of runs and a lack of tight control over time quickly accumulate costs. It is important to use helicopter flying time efficiently because of the high operating costs.

Future work

Future work on aerial seeding will concentrate on streamlining operations to increase the cost effectiveness of the technique. Although aircraft, and helicopters in particular, are expensive, by far the highest cost associated with artificial regeneration is the cost of seed. It is worth spending some extra money on the sowing operation to ensure that the seed is used to best effect.

Acknowledgements

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