Sticky Seed Traps—A Useful Tool for Monitoring Seed Distribution During Aerial Sowing

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Abstract

The design, function and operational testing of sticky seed traps are described. They promise to be a cheap, convenient and efficient tool for monitoring eucalypt seedfall during aerial sowing. Field tests indicated that a relatively even distribution of seed was achieved by routine sowing with a helicopter-mounted seeder. There is some indication that the traps may under-estimate overall sowing rate but they are reliable in portraying distribution patterns.

Introduction

The monitoring of seedfall, whether natural or artificial, is an important aid to understanding the outcome of forest regeneration processes. Only when the timing, amount and distribution of seedfall are known can relative seedling establishment rates be determined.

The assessment of seed distribution during artificial sowing can provide a valuable check on the effectiveness of the equipment and procedures used. It may also allow the prompt re-sowing of areas which do not receive enough seed. This is preferable to waiting until gaps are shown up by regeneration surveys done one or two years later, by which time re-sowing may no longer be effective due to weed competition and/or loss of seedbed, and more costly remedial treatments may be needed.

In the early years of aerial sowing of eucalypts in Tasmania, a coating was applied to the seed particles (Cremer 1966; Hodgson and McGhee 1992). The resultant large pellets were dyed bright yellow so that the number enclosed by a fixed-area hoop thrown on the ground could be counted easily to assess distribution. However, seed coating was discontinued in about 1980 and, because untreated seed is very difficult to detect on the ground, that technique is no longer used.

Funnel-type catchers of metal or woven fabric which direct seedfall from a known area into a container for counting or weighing have often been used for research purposes (e.g. Cunningham 1960; McCormick *et al.* 1990). However, because current sowing rates are sometimes less than 0.5 kg/ha (0.05 g/m^2), quite large catchers and a sensitive balance are required to derive a reasonably precise measure of seed weight which is not unduly influenced by very small amounts of extraneous matter. Metal catchers of this type with an area of 4 m^2 were used in the initial testing of helicopter-mounted sowing equipment in 1987 (Hodgson and McGhee 1992). However, they are unsuitable for monitoring operational field sowings because they are too cumbersome to transport and set up in large quantities, especially on difficult terrain.

If seed particles are counted rather than weighed then a reasonably precise assessment of seed distribution can be derived from relatively small traps without the need for sensitive equipment. Egg cartons have sometimes been used to monitor sowings (R. Heathcote, Australian Newsprint Mills, pers. comm. 1993) but they catch only a few particles on average and are too small to

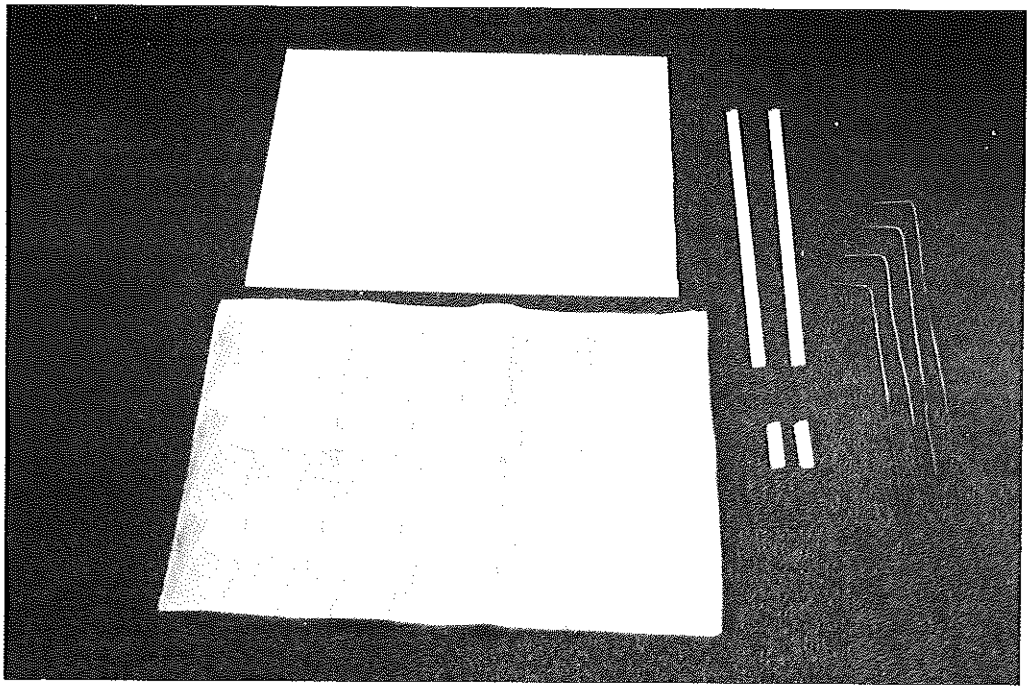

Photo 1. Basic components for a seed trap: a mounting board, self-adhesive vinyl book covering, PVC capping and pegs.

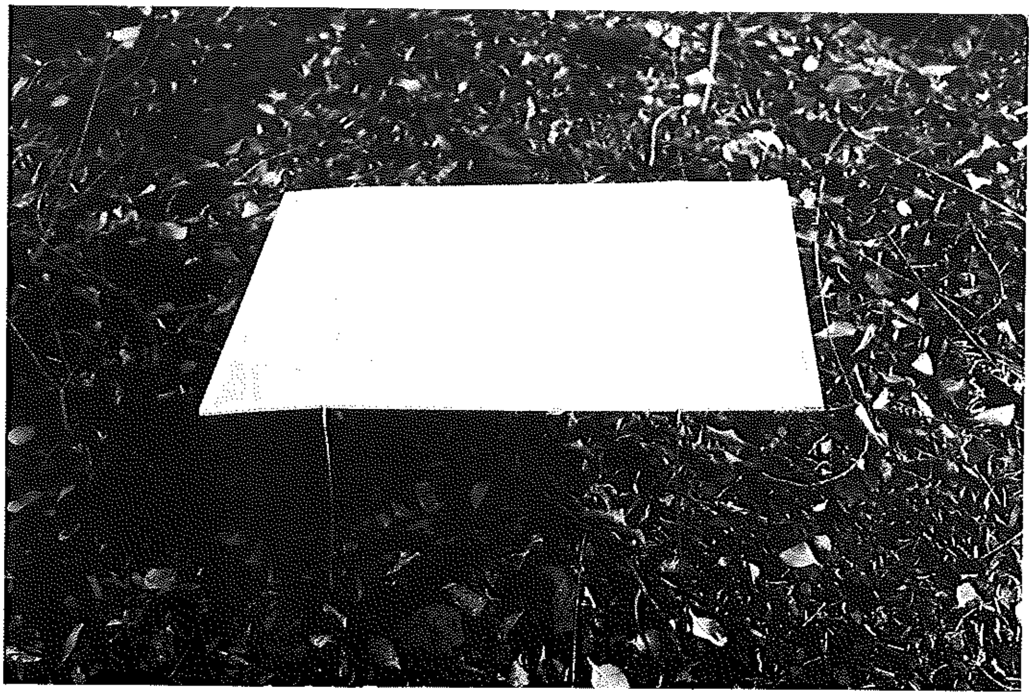

Photo 2. The assembled seed trap.

give anything but indicative results. Empty catchers do not necessarily represent a significant gap in the seed distribution.

The present paper describes the design and operational testing of sticky seed traps used to monitor aerial sowings. The technique is a modification of one used in Victoria (McCormick *et al.* 1990). It allows an immediate visual estimate of seed distribution to be made in the field or, if preferred, an accurate particle count following trap retrieval.

Design and use of the traps

Each trap has four basic components (Photo 1).

- A mounting board of lightweight fluted-core plastic sheet, approximately 61 cm x 46 cm. Eight pieces can be cut from an 183 cm x 122 cm sheet.
- A 62.5 cm x 45 cm sheet of clear, self-adhesive vinyl book-covering. Twenty-four sheets can be cut from a 15 m x 45 cm roll. In this case, Nylex 'Con-Tact' was used.
- Two 45-cm lengths of PVC capping as used for finishing the edges of sheet material. They must be a firm fit on the mounting boards.
- Four pegs made from 3.15 mm galvanised wire with the top 5 cm bent at right angles. Cutting the pegs to a range of lengths facilitates installation on uneven ground.

The initial cost of materials is about $3.00 per trap. The mounting boards can probably be used 5–10 times before becoming unserviceable. Only the adhesive vinyl has to be replaced each time at a cost of a little under $1 per trap. Hence the material cost for each use is of the order of $1.20–$1.30 per trap.

In pre-assembly, the backing is separated along one end of the vinyl sheet to facilitate peeling back, and the capping is used to attach the sheet, backing up, to the mounting board. A worker can carry 20–25 of these traps under one arm, with the pegs in a back pack. Total weight per trap is about 380 g.

The traps are numbered and installed on site. The pegs are positioned to support the board in a near horizontal plane by inserting their turned-over tops into its fluted edges (Photo 2). Just prior to sowing the backing is peeled back (Photo 3), folded under the board and clipped in place to ensure that it does not flap and cover the exposed sticky surface or throw dirt on it.

After sowing (Photo 4), the traps are inspected and particle numbers may be counted or estimated at this stage if desired. On-site evaluation can be facilitated by doing a particle count in advance on an accurately weighed sample of the seed to be used so that the required number of particles per trap can be calculated. The backing is then smoothed over the sticky surface to cover the seed particles and the trap is retrieved.

Photo 3. Preparing the seed trap for use.

Depending on the terrain and trap layout, a worker might set up 10–20 traps per hour. Peeling the backing and final trap recovery are quicker operations and in most cases can probably be done by the ground crew overseeing the sowing.

On return to base, the vinyl sheets are removed from the boards. If an accurate count is required, the sheets may be turned clear side up for counting of the seed and chaff particles through the vinyl, with a hand lens being used where necessary to ensure that any extraneous matter is excluded (Photo 5). If desired, the folded over ends may be trimmed off to provide a flat sheet, 0.25 m^2 in area (i.e. 45 cm x 55.5 cm), and to facilitate storage for future reference.

If an estimate of actual sowing rate is required rather than just an evaluation of how evenly the seed was distributed, the known number of particles/kg may be used to convert particles/trap to kg/ha.

Photo 4. Aerial seeding, with the traps in position.

Testing the traps

Preliminary tests

Initial trials were carried out with *Eucalyptus obliqua* seed to determine how well the adhesive vinyl would retain falling seed. A long length of pipe was used to direct a known number of seed particles, selected at random, from a high roof onto a sticky trap. Generally less than 10% of particles were observed to bounce off on impact. Although the velocity of these particles was unknown, Cremer (1977) showed that the terminal velocity of seed of Tasmanian eucalypts is in the order of only 10–20 kph. It was therefore concluded that losses due to bounce-off during aerial sowing were unlikely to substantially bias the seed-trap results.

Field trials

An operational trial was undertaken in the north-eastern highlands during the 1993 autumn sowing season. The coupe (SA 137A) was to be sown with a mixture comprising 75% *E. delegatensis*, 15% *E. regnans* and 10% *E. dalrympleana*, reflecting the original species composition of the stand. The sowing equipment comprised a Squirrel helicopter fitted with a modified Alberta heli-seeder incorporating a positive-feed metering mechanism and a four-arm horizontal slinger rotating at a constant 1000 rpm (see Forestry Commission, Tasmania 1991).

The traps were laid out but deteriorating weather prevented the coupe being sown as scheduled. The traps were retrieved without the adhesive surface being uncovered but the backing paper on many was thoroughly saturated. The traps were dried out in a warm office before being set out again two weeks later. Two rows containing 43 traps were laid out at about 50° from the flight lines (Figure 1). The traps were about 30 m apart and flight lines were 20 m apart. No attempt was made to match up the trap spacings with the flight lines, so all positions across the swathes, including the overlap zones, should have been equally represented.

On the day of the trial, the weather was drizzly but eased long enough for the helicopter-sowing operation to be completed before steady light rain resumed. While preparing the traps some difficulties were experienced in peeling back the damp paper backing without tearing it. Many of the traps also had water pooling on the sticky surface before retrieval. On return to base, the traps were dried out and assessed as previously described.

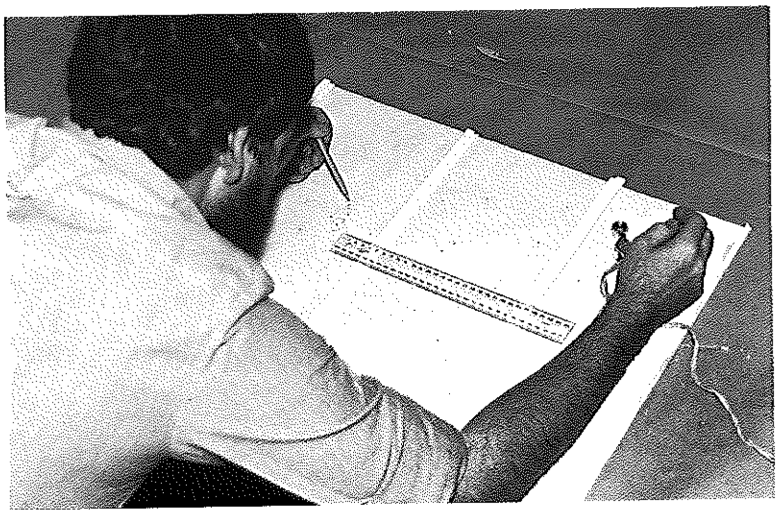

Photo 5. Counting seeds on the surface of the traps.

Assessment of seed distribution

The particle counts from the traps were used to study the seed distribution pattern. A conversion factor derived from five accurately weighed 200-particle subsamples was used to convert particles/trap to kg/ha for the sowing mix. The results were then compared with the figure derived from the total weight sown and the nominal coupe area.

Results and discussion

Seed distribution

Particle counts from the seed traps are illustrated in Figures 2 and 3. Given the relatively small size of the traps, the catches are considered very even. Both lines retained an average of 30 particles per trap, or 1.2 million particles/ha, with more than 70% of all traps receiving within ± 50% of this figure. According to the most recent germination tests, the sowing mix used would have produced about 79 000 laboratory germinations/kg, which equates to one germinant for every 21 particles, or 57 000 germinants/ha.

An indication of the likely implications for future stocking can be derived by translating the 0.25 m^2 particle counts to 4 m^2 equivalents, this being the quadrat size used for defining stockings in regeneration surveys. Even if field germination is only 10% of laboratory germination, then 86% of 4 m^2 quadrats would have received sufficient seed to stock them initially, representing a very high success rate. This figure is likely to underestimate the stocking rate if larger quadrats had actually been used because the larger quadrats are likely to even out highly localised variations, making low (and high) particle numbers less likely than on the

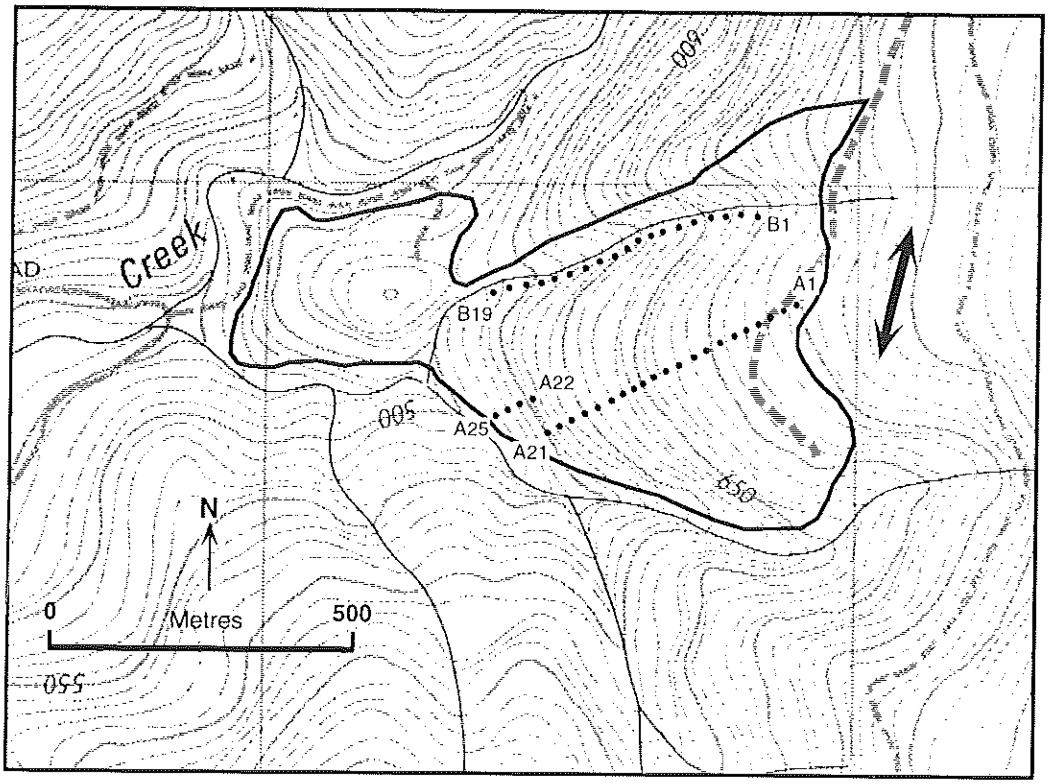

Figure 1. Position of the two rows of traps in the coupe. (The heavy arrow shows the direction of the helicopter flight path.)

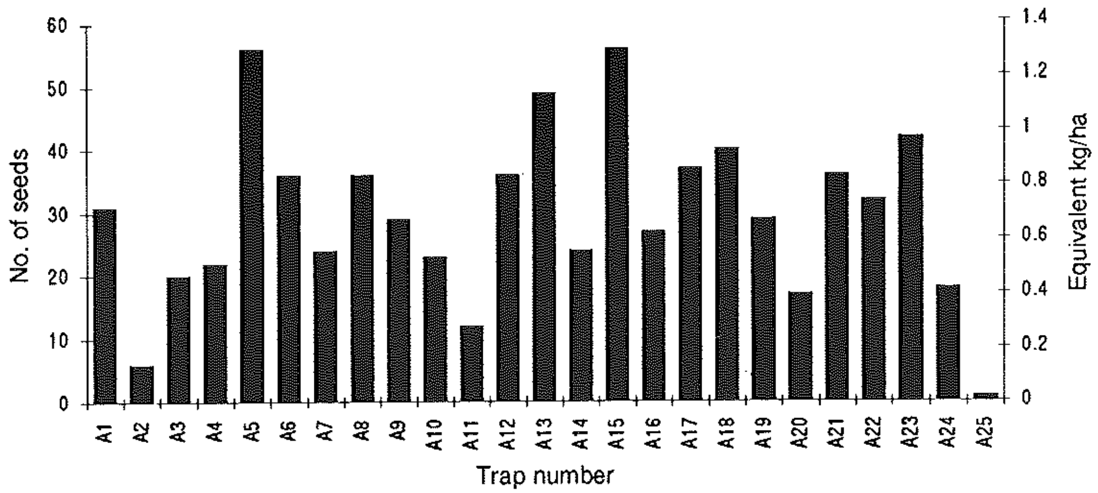

Figure 2. The number of particles per trap for line A.

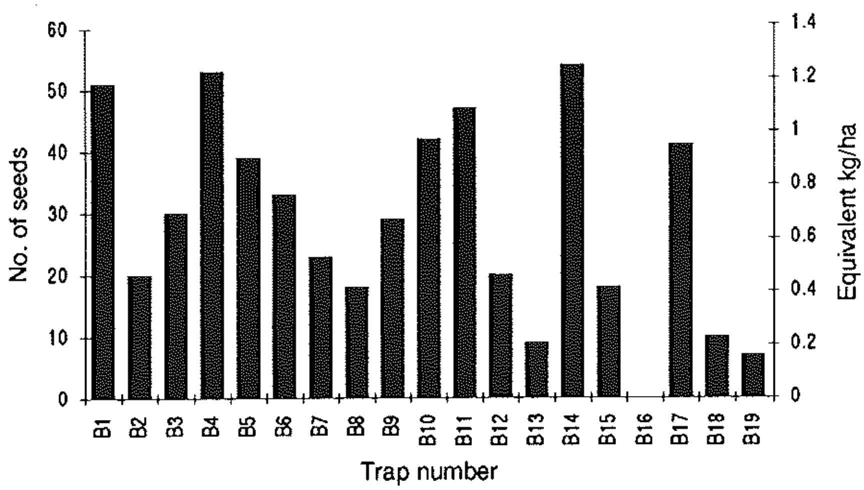

Figure 3. The number of particles per trap for line B. (Data missing for B16.)

smaller seed traps. The overall conclusion is that there should be no significant gaps in stocking within the sampled area due to poor seed distribution.

These results illustrate the efficiency of the sowing equipment. They also demonstrate the skill of the pilot who, guided by flag-wavers on the ground, must generally have maintained very good control of his line spacing while flying low over the steep and broken terrain.

Most of the traps producing low counts (i.e. Nos A24, A25, B18 and B19) were at the lower tip of the main slope. By this stage the aircraft hopper was running out of seed. This, rather than any deficiencies in the equipment or flying, may have caused the low counts. The breeze was too light and in the wrong direction for seed drift to have been responsible for the low numbers (i.e. 7 kph average from the north). The hopper was re-loaded to sow the knoll to the west. There is evidence from traps B13–B15 that mis-alignment of the aircraft at this point may have given one trap a double dose of seed while leaving its neighbours short, but overall the results were considered very even, given such difficult terrain.

Sowing rates

The sowing rate derived from the average of 30 particles per trap and the conversion factor of 0.119 g per 200 particles was 0.71 ± 0.06 kg/ha*. The sowing rate derived from the weight of seed used and the nominal area sown was 0.99 kg/ha. A number of factors may have contributed to the discrepancy between the figures for sowing rate.

1. The rate derived from seed usage may be misleading due to inaccuracies in the area figure, to the inclusion of some 'free flying' sections which may not have received the same rate as the controlled area sampled, or to some seed actually landing outside the coupe boundaries, especially at the beginning and end of each run.
2. The arrangement of traps in two long lines may not have given a good representative sample. However, because both lines gave the same mean and the overall confidence limits were fairly narrow (± 13%, $P = 0.05$), this was not likely to be a major factor.
3. Imprecision in the conversion factor may have contributed. However, since the confidence limits in this case were ± 8% ($P = 0.05$), this alone could not account for the discrepancy.
4. Some particles which would have been counted in determining the conversion factor may have been rejected as extraneous material in the trap counts. This seems unlikely because any doubtful particles on the traps were examined with a hand lens to ensure that consistent standards were applied.
5. A proportion of particles may have bounced off the traps and been lost.

Factors (1) and (5) seem likely to have been the most important in this case, but it is proposed that a more rigorous trial be undertaken in an attempt to resolve these uncertainties. While these factors may have influenced the absolute values derived from each trap, the relative values should not have been affected. Thus the distribution pattern portrayed should be an accurate one.

Trap functionality

Although the effective life of the adhesive surface when exposed to the elements may be too short for long-term seedfall studies (McCormick *et al.* 1990), sticky traps are very convenient for monitoring seed distribution during aerial sowing. They are more easily made, cheaper, lighter and less bulky than funnel-type traps, allowing a worker to comfortably carry more than 6 m^2 of sampling area under one arm. This trial also showed that they could be retrieved in damp conditions which would have caused seed in funnel-type traps to cling to the sides of the funnel rather than draining into the container for recovery.

One trap which was left on site with the backing in place after the first aborted trial remained functional when the backing was peeled away for the final sowing 16 days later, after many wetting and drying cycles. This suggests that the traps could be put in place well before sowing if desired. However, subsequent work with cheaper vinyl than the Nylex 'Con-Tact' used here has shown that not all products are equal in this regard. In some cases, the backing is less robust and in others the adhesive tends to peel away with the backing when it is damp. Minimial exposure to moisture is therefore recommended unless the vinyl to be used has been thoroughly tested beforehand.

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* The mean weight of 200 particles was 0.119 ± 0.009 g giving 1 681 000 particles/kg.

As each catcher is 0.25 m^2, each particle represents 40 000 divided by 1 681 000, i.e. 0.0238 kg/ha.

The mean sowing rate for each row is therefore 30 x 0.0238 = 0.71 kg/ha.

Conclusions

At a cost of about $1.20–$1.30 per use, the sticky seed traps are a cheap, convenient and efficient means of monitoring seed distribution during aerial sowing. The distribution pattern they revealed during an operational sowing was relatively even in spite of the difficult topography at the site. They produced an apparent under-estimate of the overall sowing rate but factors other than problems with the traps themselves may have contributed to this result. A more rigorous trial is required to resolve this point. However, their main purpose is in monitoring the distribution of the seed and this should not be affected by any tendency to underestimate actual sowing rate.

Acknowledgements

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