AERIAL PASTURE IMPROVEMENT IN NEW SOUTH WALES*

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1. SUMMARY

In New South Wales approximately one-fifth of all fertiliser spread on pastures in 1956-57 was applied by air. Prior to 1951 less than 1,000 tons were spread yearly; by 1957 the figure exceeded 45,000 tons annually.

In this study the scope for aerial topdressing, the costs of applying it and the results which can be expected, are discussed. An attempt has been made to assess the profitability of aerial pasture improvement under varying economic and farm conditions.

A mail questionnaire was sent to 406 farmers thought to be using the technique and replies were received from 197. In addition the writers visited 40 of the properties whose owners had at least three years experience with aerial pasture improvement.

At present unevenness and steepness of terrain are the main reasons for using aerial topdressing. According to the mail questionnaire 73 per cent of the area topdressed from the air in 1956 and 1957 was too hilly or rough to be improved by ground methods. Other reasons for using the technique are the speed with which fertiliser can be spread and the evenness of the spreading. In addition it covers gullies and rough patches inevitably neglected by ground methods, obviates costly clearing and may reduce the need to buy expensive cultivation machinery.

The potential area for aerial topdressing in New South Wales is probably about 13-15 million acres. Of this 10 to 11½ million acres consists of steep country and the remainder are areas which, for reasons of convenience already mentioned, lend themselves to aerial techniques, although they could be treated by ground methods.

When developing country by aerial topdressing the landholder has to perform certain tasks to co-operate effectively with the aerial contractor. He must provide a landing strip which is usually done at very small cost. (68 per cent of the survey farmers spent less than £20 on the construction of an airstrip.) He must purchase the fertiliser and have it readily available on the strip in a bin, shed or heap for quick loading on to the aircraft. Finally he must brief the pilot, either by accompanying him on an initial

flight and providing marked maps or using men as markers. The use of markers is costly and opinion is divided as to whether it is worthwhile. In New Zealand where farmers and pilots are more experienced, markers are usually not used.

The costs of aerial pasture improvement can be divided into the direct costs of aerial topdressing and the costs associated with carrying extra sheep. Direct costs include the purchase and storage of fertiliser and seed, payment to the aerial contractor and the wages of men handling fertiliser and marking as well as the construction of a landing strip if required. Excluding the cost of seed, annual direct costs normally amount to 20s. 0d. to 25s. 0d. an acre given the normal annual application of 1 cwt of superphosphate to the acre. Bulk handling, for which more facilities are likely to be available soon, can cut fertiliser costs considerably. The saving is likely to be between 30s. 0d. and 40s. 0d. per ton of fertiliser. Bulk handling does involve storage at the airstrip but even if the most expensive type of storage is erected, the saving would pay for a bulk fertiliser shed in less than three years.

The costs associated with running more sheep include the purchase of additional stock, the provision of additional fencing and water supplies, the extension of wool sheds and yards and the wages for the increased labour force which may be necessary. The capital cost for materials and construction can vary widely but a typical figure incurred by the farmers visited was 25s. 0d. per extra sheep carried.

In the last eighteen months competitive conditions in the agricultural aviation industry have led to substantial reductions in spreading charges; at present a typical contract price is £5 per ton. Further reductions may result from aerial operators making additional economies by the use of more suitable or larger planes. Additionally, the realisation that fertiliser can be profitably spread during the spring period when contractors offer reduced rates could lead to the fuller use of existing aircraft and consequent reductions in costs.

The benefits obtained from pasture improvement manifest themselves in many directions. Of these financially the most important is the increase in the number of stock which can be carried. Those graziers who had a minimum of four years experience in aerial pasture improvement estimated that carrying capacity was raised from an average of 1 dry sheep to the acre to 2.1 dry sheep over a period of four years. (Their fertiliser applications averaged .95 cwt per acre per annum.) It is likely that substantial increases can be achieved in succeeding years but information on such responses was only available from a small number of farmers. An examination of farmers' production figures showed that the estimates they gave were substantially in agreement with increases in sheep numbers and wool production obtained. There is evidence of greater increases in carrying capacities in those areas where the average annual rainfall exceeds 30 ins., while responses tend to be smaller in the 20 in. to 25 in. rainfall belt.

Considerable increases in wool cut per sheep is another feature of pasture improvement. Furthermore, it has led to better sheep health with consequent economic benefits in the form of a longer productive life, fewer deaths and the sale of surplus animals in fat rather than in store condition.

To examine the profitability of topdressing with aeroplanes the costs incurred and returns obtained are given for a typical situation. If the landholder using aerial topdressing can handle the extra sheep without employing any additional labour, the discounted long term return on the capital he invests will be 19 per cent—at a wool price of 5s. 0d. net (*i.e.*, after deducting 5d. a lb. marketing charges). Although this is an attractive rate of return it should be stressed that in the initial years of this pasture improvement programme costs will be considerable. During the first four financial years the costs of buying fertiliser and seed, spreading it, obtaining extra sheep and making the necessary structural improvements will exceed additional returns by approximately £5 per acre.

While an attempt has been made to estimate costs and returns under reasonably typical conditions, the assumptions used are probably conservative. This is true especially because the increase in sheep numbers used (*i.e.*, 1.1 dry sheep per acre) was based on the graziers' estimates of responses over a four year period. Further increases can usually be obtained in succeeding years with continuous topdressing. (If the average increase obtained over a period longer than four years by a small number of graziers is used for estimating the profitability, the rate of return increases to 24 per cent.)

An examination was also made of the situation in which a grazier has to increase his permanent farm labour force to handle the extra sheep following pasture improvement. Under these conditions the profitability of aerial pasture improvement is reduced to $13\frac{1}{2}$ per cent (or $18\frac{1}{2}$ per cent using the less conservative figures on changes in carrying capacity). Again these calculations were based on the relatively low wool prices of 5s. 0d. net per lb. The effect of different wool prices is examined in the article.

The aerial application of fertiliser and seed to pastures is only one—though probably the most spectacular—method which graziers can use to improve their properties. Where ground equipment can be employed it will usually be cheaper to use more orthodox methods of improvement. It is hoped to examine the relative profitability of the two techniques at a later stage. The information given here shows that aerial pasture improvement is a worthwhile proposition at least for those graziers who cannot improve their pastures by the more traditional methods.

2. INTRODUCTION

In New South Wales the development of aerial methods of improving pasture has been very rapid in the last three years. According to the latest figures available, approximately one-fifth of the amount of fertiliser spread on pastures in New South Wales is applied from the air. In this article the scope for the further development of aerial pasture improvement in this State is outlined, and the costs of using this technique and the results which can be expected are discussed. An attempt is also made to assess the profitability of aerial pasture improvement.

The information used here was obtained from a variety of sources. In the spring of 1957 a mail questionnaire was forwarded to 406 farmers and graziers who were thought to have used aircraft for pasture improvement.

One hundred and ninety-seven landholders returned their questionnaires.[1] In addition, the writers visited more than 40 properties where the landholders had at least three years experience with aerial topdressing. Valuable information was also gathered from discussions with pilots, aerial agricultural operators, officials of fertiliser firms and others connected with this industry.

(a) The Growth of Agricultural Aviation

Experimental use of aircraft for agricultural work in this country was fostered by the RAAF before World War II. During the war years, Australian entomologists gained extensive experience in the use of aircraft for insect control. In 1944 and 1945 mosquitoes were sprayed and controlled by air in the South-West Pacific as an anti-malaria measure. Similar techniques were used in 1946 at the request of the Victorian Department of Agriculture to control the Rutherglen bug (*Nyzius vinitor* Berg.) and swarms of the Australian Plague Locust (*Chortoicetes terminfera* Walk). In 1947 East-West Airlines Ltd. of Tamworth set up an agricultural division, mainly to carry out aerial dusting of linseed crops. In October 1949 a proprietary company, Airgriculture Control Ltd., was formed to take over the equipment, staff, records, etc., of the Pest Control Division of East-West Airlines. Although this company was not financially successful, it played a very important role in developing suitable techniques for local conditions and publicising the industry amongst the rural community. After this company was liquidated in 1952, two other aerial agricultural companies were formed and in 1953 another operator started aerial spreading and insect control. Since 1953 eleven additional firms have entered this field in New South Wales, but the three original companies still account for more than 80 per cent of the total volume of business. (A list of all firms engaged in the industry at the time of writing is given in Appendix II.)

The earliest known topdressing and sowing of pasture by air in Australia was done privately in 1945 and 1946. A 110 acre paddock on Mr. A. S. Nivison's property, "Mirani", Walcha, was topdressed aerially with superphosphate in 1945 and sown from the air with four pounds of sub-clover seed one year later.

It is not possible to ascertain how much fertiliser was distributed by air in the early post-war years but it is unlikely to have exceeded 200 tons annually. An attempt has been made to estimate the tonnages distributed

[1] An additional 28 replies were received without the questionnaire being filled in. In most cases these were farmers who had not in fact used aircraft or had only done so in the preceding year and were not prepared to venture an opinion regarding some of the questions asked. A further six replies were received after tabulation of results was completed.

An attempt was made to visit a sample of graziers who did not reply to the questionnaire. Unfortunately lack of resources made is necessary to abandon this attempt after the authors had tried to contact ten graziers who had not replied. Of these two had left the properties they had been improving aerially, three had not in fact used aeroplanes, two had died, one had used aerial topdressing on established improved pastures and therefore not thought it worthwhile to reply.

The graziers who did reply used 41 per cent of the total amount of superphosphate spread by air in 1956 in New South Wales.

between 1949 and 1956 and the relevant figures are given in Table I. These estimates are based on information made available by some aerial operators and from the mail survey of graziers.

TABLE I

*Estimated Tonnage of Fertiliser Spread by Aircraft in New South Wales**

Calendar Year	Tonnage
1949	100
1950	250
1951	700
1952	2,500
1953	4,000
1954	11,000
1955	16,000
1956	25,000

* This includes superphosphate and gypsum, but the former accounts for more than 90 per cent. of the total.

Since 1956 the Department of Civil Aviation has collected statistics of operations from firms in the industry. The information collected so far is shown in Table II.

TABLE II

*Aerial Pasture Improvement in New South Wales**

Year	Area treated with:				Superphosphate (weight used)	Seed (weight used)
	Superphosphate alone	Superphosphate and seed	Seed alone	Total		
	acres	acres	acres	acres	tons	lb.
1955-56 ..	253,624	66,040†	4,175	323,839	19,063	68,682
1956-57 ..	733,577	123,856‡	39,742	897,175	45,329	149,048

* Excludes topdressing with gypsum unless seed is spread at the same time.
† Including 1,500 acres of gypsum and seed.
‡ Including 5,230 acres of gypsum and seed.

(b) Reasons for Using Aerial Pasture Improvement

Aerial pasture improvement can be undertaken under a variety of conditions and for widely different reasons. A classification based on the reasons given by the survey farmers is shown below.

TOPOGRAPHY

At present the most important reason for using aircraft for spreading fertiliser and/or seed on pastures is to develop country too hilly or rough for ground methods of pasture improvement. According to the mail survey 73 per cent of the area aerially topdressed in 1956 and 1957 was too steep to be treated otherwise.

Steep and rugged country which is treated from the air can be either topdressed only or it can be seeded as well. Where an adequate amount of subterranean or white clover and other legumes is present in the unimproved pasture sward, topdressing alone may be sufficient. This would be the case where a substantial proportion of the holding has already been improved by the sowing of improved pastures on the more level areas in earlier years and stock have spread the seeds over the balance of the land. In other cases such as in the basalt country of the New England Tablelands white clover has become naturalised in the pasture sward. On native pastures, however, better results are usually obtained from sowing seed (especially legumes) with the fertiliser and thus establishing new and better species in the sward. A small minority of graziers have continued to topdress native grasses even though their attempts to establish clovers or other legumes have failed so far. An improvement in production per acre and in palatability has been experienced under such conditions, but it is uncertain whether this improvement is sufficient to cover the costs incurred.

Speed, Timeliness and Convenience

The speed with which fertiliser can be broadcast by aircraft—ranging from 20 to over 100 tons a day depending on the aircraft used—is a major factor in persuading many owners of highly improved properties to switch to aerial topdressing. When the tonnage of superphosphate to be put out annually reaches 70-80 tons (or approximately 1,500 acres at 1 cwt per acre) the time taken to distribute this quantity by the commonly used fertiliser broadcaster will probably exceed two months for one man if allowance is made for breakdowns and interruptions because of other urgent work. Although contractors are available who will quote prices for ground spreading which are below charges for aerial topdressing, many graziers have found aerial spreading preferable because (*a*) the spread is more even than with any ground implement (other than a direct drop, which is a very slow and expensive method), and (*b*) the whole area of a paddock or a property can be done by air whilst ground methods inevitably leave gullies, creek banks and rough patches without fertiliser. The unimproved areas then become of little value to the landowner as stock will always concentrate on fertilised pasture and ignore unimproved patches.

The Cost of Clearing

Another important reason for pasture improvement by aircraft is the cost of clearing necessary before ground methods can be used. Of the 315,339 acres aerially treated by 188 farmers who returned their mail questionnaires only 24.5 per cent (77,265 acres) were completely cleared. The remaining country could not have been cultivated without further expenditure on clearing—apart from the possible danger of soil erosion after cultivation.

The Cost of Machinery

Other reasons sometimes advanced for the use of aircraft instead of more conventional means of improvement are that it eliminates the need to purchase expensive cultivation machinery and the need to spell the land

in the year of surface sowing. (However, to evaluate the relative merits of aerial and conventionally sown pastures, other factors have to be taken into account.)

(c) The Scope for Aerial Pasture Improvement

While there is no doubt that the rate of adoption of aerial pasture improvement will depend considerably on seasonal and economic conditions, some idea of the potential for this technique may be of interest.

In the winter of 1957, the New South Wales Department of Agriculture —in co-operation with local fertiliser companies—conducted a survey of 545 farms designed to obtain information on a number of aspects of pasture improvement and fertiliser use. In the course of this survey information on present and potential land use was obtained.[2]

The survey area included all shires where topdressing of pastures is likely to be beneficial,[3] except for some of the coastal shires, where serious unsolved problems of pasture establishment exist. As defined, the survey area accounted for 86 per cent of superphosphate used in the State in 1956-57; 78 per cent of the State's sown pastures[4] and 59 per cent of all sheep and lambs shorn.

Of a total of almost 60 million acres in farms in the survey area almost 51 million acres are regarded by landholders as suitable for some type of pasture improvement. At present only 8.5 million acres are in the category

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[2] The total number of farmers in the sample was 567; but 22 farmers could not be contacted and no replacements were used.

[3] A list of all shires included in the survey area is given below:—

Hunter and Manning: Muswellbrook,* Patrick Plains,* Upper Hunter.*
South Coast: Mittagong, Wingecarribee, Wollondilly.
Northern Tableland: Dumaresq,* Guyra,* Macintyre (part),* Severn,* Tenterfield,* Uralla,* Walcha.*
Central Tableland: Abercrombie, Blaxland, Canobolas, Coolah, Crookwell, Cudgegong, Gulgong (part), Lyndhurst, Merriwa, Oberon, Rylstone, Turon, Waugoola, Wellington (part).
Southern Tableland: Bibbenluke, Goodradigbee, Gunning, Monaro, Mulwaree, Snowy River, Yarrowlumla.
North-Western Slope: Barraba,* Bingara,* Cockburn,* Liverpool Plains,* MacIntyre (part), Mandowa,* Murrurundi,* Nundle,* Peel,* Tamarang.*
Central-Western Slope: Boree, Gilgandra,* Goobang, Gulgong (part),* Jemalong, Molong, Talbragar, Timbrebongie, Wellington (part).
South-Western Slope: Bland, Boorowa, Burrangong, Demondrille, Gundagai, Holbrook, Hume, Illabo, Jindalee, Kyeamba, Mitchell, Narraburra, Tumbarumba, Tumut, Weddin.
North-Central Plain: Coonabarabran.*
Central Plain: Lachlan.
Riverina: Berrigan, Carrathool, Conargo, Coolamon, Corowa, Culcairn, Jerilderie, Leeton, Lockhart, Urana, Wade, Yanko.

(Shires marked with an asterisk are included in the "North" portion of the survey area; the dividing line was taken as the line of equal freight charges between Port Kembla and Newcastle. The balance of the shires was in the "South".)

[4] If paspalum could be excluded from the Statistician's category of "sown pastures" this percentage would be considerably greater.

of "improved pastures" (*i.e.*, sown and self-sown)[5] and approximately 5.5 million acres are under crop and fallow in a normal year. In other words the total area suitable for pasture improvement which is not yet improved or cropped is (according to landholders) approximately 37 million acres—or more than four times the area at present under improved pastures. Of these 37 million acres 11.3 million acres can only be treated by air and a further 8.4 million acres will require additional clearing if they are to be improved by means of cultivation.

TABLE III

*Estimated Pasture Improvement Potential in New South Wales**

(excluding most of the Coastal and the Western Divisions)

Measure	North	South	Total
	'000 acres	'000 acres	'000 acres
Total Area in Farms	18,400	41,433	59,834
Area suitable for—			
(a) Sown Pastures (by cultivation)	5,610	30,866	36,476
Portion of this area not cleared for cultivation	(3,547)	(4,863)	(8,410)
(b) Surface Topdressing but not for (a) ..	700	2,469	3,169
(c) Aerial Topdressing (but not for (a) or (b))	5,560	5,736	11,296
Total area suitable for some type of pasture improvement	11,870	39,071	50,941
Area under sown grasses as at 31st March, 1957 (including lucerne for grazing)	1,113	6,197	7,310
Area self-sown (usually established by top-dressing)	5	1,203	1,208
Total Area of Improved Pastures	1,118	7,400	8,518

* According to the sample survey on which this table is based the estimated total area in farms covered by the survey was 61.27 million acres. According to the Statistician the area is only 59.83 million acres. A 2.4 per cent. downward adjustment was made in all survey estimates presented in Table III.

A partial confirmation of the size of the area suitable only for aerial topdressing is provided by a classification of land slope types prepared by the New South Wales Premier's Department which shows that—in the survey area as defined—there are 12,555,000 acres classified as "rugged and mountainous" (*i.e.*, a gradient in excess of one in four). Some of the area within this classification is perhaps too steep for grazing animals and thus not worthy of improvement; in addition some portion of this land would be in State Forests, Reserves, etc.

These figures suggest that the potential area for aerial pasture improvement is very large indeed. More than ten times the area topdressed aerially in 1956-57 could be improved by this means but not conventionally. As mentioned earlier, the speed, convenience and savings on clearing costs are other features of aerial topdressing which have persuaded graziers to

[5] The area under self-sown improved pasture was obtained from the survey. The Statistician has not so far attempted to collect information regarding this particular type of pasture improvement which is becoming fairly important in some southern areas.

adopt this method on areas where surface methods could have been used. It would seem quite possible, therefore, that the potential area for aerial pasture improvement in New South Wales is in the vicinity of 13 to 15 million acres—10 to 11½ million acres of steep country and the balance in areas which lend themselves to aerial improvement even though they could be improved by ground cultivation and spreading equipment.

3. THE PROCESS OF AERIAL PASTURE IMPROVEMENT

If a grazier desires the aerial spreading of fertiliser and/or seed on some of his pasture paddocks, what arrangements will he have to make? What are his costs likely to be? These two questions will be discussed in this and the next section.

Normally a grazier contacts one or more aerial spreading firms (or the firms' local agents) and obtains a quotation for the work. At this stage no exact date is set but an approximate time—say late March or early April—is agreed upon. About two weeks before the contractor arrives he gives the grazier a definite date and this is confirmed a few days before flying operations on the holding are due to begin.

If the operator has not used the strip before, or if he is using a new type of aircraft, he will inspect the strip and suggest any alterations needed.

The contractors employ different methods of working; some have supplies of fuel sent to the strip, others carry their fuel with them. Some require accommodation from the grazier, others use caravans or tents or stay at a local hotel and fly out each morning.

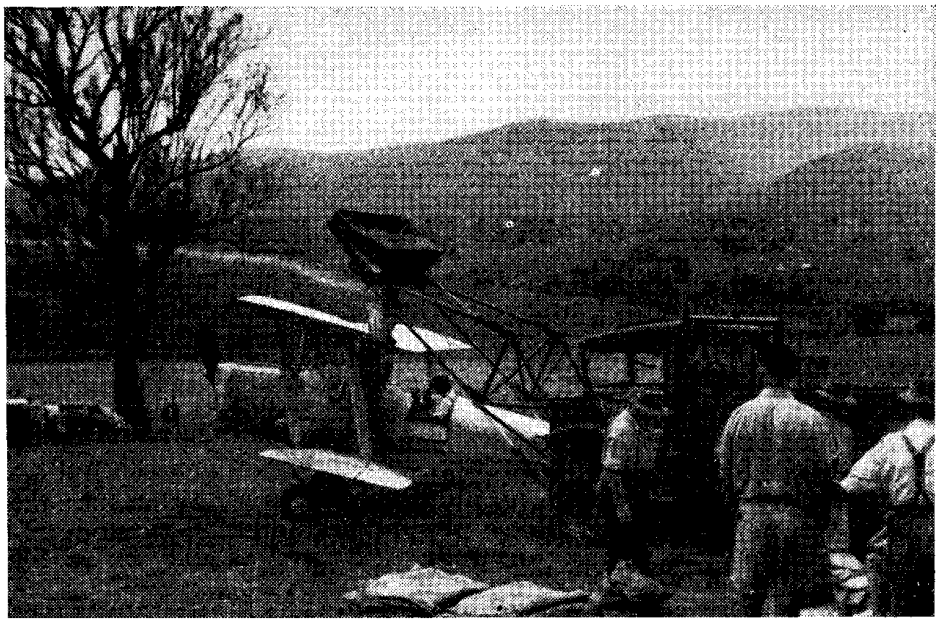
Usually operators start their work soon after daybreak because strong winds during the middle of the day can often temporarily halt operations. Most planes can spread their loads in ten to thirty seconds and each round trip takes between two and eight minutes, depending on the distance from the airstrip to the paddocks to be topdressed and the type of aircraft used. This requires adequate labour on the strip to maintain turn around without delay, especially if more than one plane is used.

Apart from the question of payment to the aerial contractor, what other obligation or responsibility does the landholder incur? This can be discussed under three headings—(1) the preparation of the landing strip; (2) the provision of fertiliser and/or seed on the strip in such a form that it can be loaded into the aircraft; and (3) instructing the pilot where he is to spread the fertiliser and seed.

(a) The Preparation of the Landing Strip

It is advisable to discuss the preparation of an airstrip with an aerial operator and to examine farmers' strips in the district which have proved satisfactory. Basically, operators require a level area 500-600 yards long and 200 feet wide for small or medium sized planes.[6] The site should be level enough to be able to drive a car over it comfortably at 30-35 m.p.h.

[6] Details of the Department of Civil Aviation's regulations giving the minimum specifications of farm airstrips for different types of planes and for different altitudes are shown in Appendix III.



Loading of Tiger Moth DH 82 from ground dump of bagged superphosphate
Each bag has to be emptied into the truck-mounted hopper. An improved technique is shown in the following photograph. Note trail of fertiliser from spreading aircraft behind the tree.

(Photo.—N.S.W. Department of Agriculture.)

The strip need not be flat; in fact some operators prefer a strip with a slight slope which will slow down the aircraft on landing. Of great importance is the nature of the country at the end of the strip. An ideal end is one where the land falls away rapidly, so that no trees or hills have to be flown over immediately after take-off. On most properties there are one or more paddocks—perhaps an old cultivation paddock—which lend themselves to conversion to a landing strip at very little expense.

(b) The Handling of Fertiliser

The grazier has to purchase the fertiliser and have it available at the strip in a bin, shed or heap, so that it can be loaded by the operator's equipment into the hopper of the aircraft.

Bulk handling of fertiliser is likely to become the normal method of handling within the next few years, but as over 95 per cent of all fertiliser spread this season was still bagged the landholder's responsibilities under the old system will be described first.

Bagged fertiliser has to be ordered and transported to the property well before the spreading contractor is due to arrive.[7] It is the landholder's responsibility to transport the fertiliser from his storage site to the strip but

[7] Some of the landholders contacted have managed to arrange the arrival of railtrucks of fertiliser to coincide with aerial spreading. However, such an arrangement is a hazardous one as the slightest hitch either at the fertiliser works, the railways or by the carrier will lead to costly delays for the aerial operator.

it is preferable to erect a simple form of storage on the strip. He must employ sufficient labour to open bags of fertiliser quickly enough to enable the planes to be loaded (with the contractor's own loading equipment) in a minimum time. This involves filling the hopper of the contractor's front-end loader.

To open and unload bags at the rate of 50 tons a day (*i.e.* the daily work capacity of about three Tiger Moths or one Cessna) requires at least three men. If the grazier cannot supply this labour directly he can sometimes make arrangements with the local agent of the aerial contractor or of the fertiliser company to hire the necessary men.

With bulk handling the landholder's job is completed when the fertiliser is stored in an accessible form on the strip. The contractor then loads the planes with his own labour and equipment. Bulk handling, therefore, saves a considerable amount of labour during the loading of the aircraft, but it requires some type of storage arrangement at the strip and the provision of bulk handling equipment at the railway siding where the fertiliser is unloaded.

A description of the different types of storages used on strips may be of interest. The most elaborate and the costliest method of storage is to build a storage shed on the strip. Such a shed should be 16 ft. high at the eaves to allow tip trucks to empty their trays. A shed of 100 tons capacity needs to be about 20 ft. x 36 ft. x 16 ft.—allowing for the fertiliser to reach a height of approximately 5 ft.

Front-end loader picking up fertiliser from simply constructed farm bulk dump

Front-end loaders are now commonly used as they reduce the work considerably. Where the fertiliser is not in bulk the bags are emptied into a pile on the ground. Note the cheap materials used in constructing the bin which seem quite adequate for the task (10 *ft.* x 10 *ft.* x 1 *ft. will store three tons of fertiliser*)

(*Photo.—Australian Fertilisers Ltd.*)

A simpler storage can be provided by a temporary bin constructed with boards and steel fencing posts which is covered with tarpaulins or polythene sheeting and a net to hold the plastic cover in place. At present one aerial operator is experimenting with the cheapest type of storage of all—a conical heap of superphosphate on the strip which is hosed with water after it is dumped. This forms a fairly thin crust which prevents any superphosphate blowing away, or any deterioration in the fertiliser for many months under the shell of water-saturated superphosphate; such a shell has successfully withstood several inches of rain. At the moment it seems likely that this presents a cheap and promising solution to the storage problem.

(c) Guidance of the Pilot

The pilots are instructed by the landholder which areas of the property are to be fertilised or seeded. Maps are generally used for this purpose or the grazier may fly in the aircraft and point out the paddocks. One grazier put four white sheets on the ground at the corners of the area to be done—with his wife's apparent concurrence. In some cases definite natural features define the area to be treated. Once the pilot knows the "lie of the land" he may use natural features and compass bearings to work out his position for each pass or flight.

A more expensive but not always more accurate system is the use of men as markers. If two are used the pilot flies from one to the other and they move a certain distance—depending on the type of aeroplane and rate of application—after each pass. If only one marker is used the pilot flies overhead using a compass bearing or a distant aiming point and lines up on the marker with the same bearing for the return flight. Again the marker moves an appropriate distance between passes.

During the writers' field interviews, 50 graziers were asked whether they used markers. Twenty-six considered markers an unnecessary expense, whilst 24 used one or more markers. Six of these 24 graziers had tried doing without markers but were dissatisfied with the result. Opinion on this question is obviously very evenly divided. Markers are used to a much lesser extent in the southern and central part of the State. The writers' view is that in many cases it should be possible to avoid using markers. This is, of course, desirable from the point of view of costs, which are not restricted to markers' wages during the actual flying time, but may be increased as a result of bad weather, plane mishaps and other causes.

Since so many graziers have been able to dispense with markers using pilots experienced in topdressing work and properly briefed, it seems likely that some graziers incur unnecessary expenses by their use. Furthermore, in New Zealand, where farmers and aerial operators have had considerably more experience than in Australia, markers are not used.[8] One disadvantage

[8] cf. "Aerial Topdressing of Pastures—Development in New Zealand" by R. A. Sherwin—*Quarterly Review of Agricultural Economics*, Vol. VIII, No. 2 (April, 1955) p. 73.

of not using markers is that the landholder will find it more convenient to use the same pilots every year which makes him somewhat more dependent on one spreading contractor.

It may also be questioned whether even spreading is so important. Unevenness tends to cancel out over the years but more importantly experimental results in a number of areas suggest that total response from established pastures (in terms of feed production per acre) is not markedly affected by some unevenness. In the year when seed is sown it is essential to have an even spread.

4. THE COST OF AERIAL PASTURE IMPROVEMENT

The costs of aerial topdressing can be classified into two groups. Firstly, direct costs resulting from the actual spreading of fertiliser and/or seed; such expenses include the purchase of fertiliser and the cost of its storage, payment to the aerial contractor, payment of wages to men handling fertiliser, the wages of markers—if any, the cost of seed and expenses incurred in the construction of landing strips. Secondly, there are the costs of running more sheep. Among these costs are the purchase of additional stock (or the withholding of the natural increase in the breeding flock from normal sale); the provision of additional water supplies when necessary; the extension of other facilities such as wool sheds, yards, etc.; the cost of any additional labour; and lastly, any further subdivision.

Costs which landholders have incurred in the past for some of these items are given below.

(a) Direct Costs of Aerial Pasture Improvement

FERTILISER

The most important single direct cost in most forms of aerial pasture improvement will be that of fertiliser. At present superphosphate sells for £13 17s. 6d. per ton in bags and £12 17s. 0d. in bulk on rail trucks f.o.r. Port Kembla or Newcastle (Since this article has gone to press the price has been reduced by 25s. 0d. a ton.) Gypsum is sold for £4 per ton in bulk or £7 10s. 0d. in bags f.o.r. Ivanhoe. To these prices must be added rail freight to the nearest town and the cost of road transport to the property. The cost of rail freight will normally vary between £2 and £2 6s. 0d. per ton (this is for 200 and 300 miles, respectively) over most of the areas in New South Wales where aerial pasture improvement is used.

PAYMENT TO AERIAL CONTRACTORS

The average contract price for aerial spreading in 1957 for the 175 graziers who completed this section of the mail questionnaire was £6 2s. 9d. a ton. As shown in Table IV, costs varied from less than £5 to over £7 per ton but 83 per cent of the landholders paid between £5 10s. 0d. and £7 per ton.

TABLE IV

Contract Price Paid by Graziers for Aerial Spreading in 1957

(Per ton)

Price per ton	Number of Landholders
£5 or less	9
£5 1s. 0d. to £5 10s. 0d.	17
£5 11s. 0d. to £6	64
£6 1s. 0d. to £6 10s. 0d.	21
£6 11s. 0d. to £7	61
Above £7	3
Total	175

The contract cost of aerial topdressing will depend partly on the operator who is selected (there was a considerable variation in the price charged in 1957), the type of aeroplane used, the distance from the landing strip to the various paddocks, and the tonnage actually spread by each landholder. On the average, graziers who spread less than 50 tons paid £6 4s. 0d. while those spreading over 200 tons paid £5 18s. 0d.

The price charged by operators has, until now, been the subject of bargaining between the individual landholder and the aerial contractor. Some companies charge a definite price, others charge a certain basic price which is altered upwards or downwards depending on the tonnage which is actually spread per day, thus giving an incentive to the landholder to construct convenient strips and to have the aircraft refilled as quickly as possible. During the last twelve months here has been a substantial increase in the number of firms doing this type of work and prices have become increasingly competitive. While the average price in 1957 was slightly above £6 per ton, it seems likely that a similar survey this year would reveal a price about 15s. 0d. lower. There are reports of spreading contractors charging as little as £4 to £4 10s. 0d. per ton on some large properties and prices in the vicinity of £5 to £5 5s. 0d. would be fairly common now.

THE COST OF LANDING STRIPS

Most of the landholders contacted managed to build a landing strip quite cheaply. Of the 192 farmers who supplied information regarding their costs 68 per cent spent £20 or less (see Table V).

TABLE V

The Cost of Constructing a Farm Landing Strip

Cost of Landing Strip*	Number of Farms
Nil to £20	131
£21 to £50	23
£51 to £100	11
£101 to £200	18
£201 and over	9
Total	192

* This cost includes all cash contract costs plus the cost of labour (valued at £4 a day).

Fertiliser Handling, Storage and Markers

The next item to be considered is the cost of labour for handling fertiliser and marking.[9] With labour taken at £4 a day the average cost of fertiliser handling, marking, etc., by 171 survey farmers was 13s. 3d. a ton (or .166 man/days per ton). As might be expected there was a considerable variation in costs per ton spread; the average seems to be unduly influenced by a small number of farmers whose costs were abnormally high —perhaps, because of double handling, the distance of airstrips from the homestead or the use of too many men at loading points. As shown in Table VI, 64 per cent of the landholders managed to keep their costs below 10s. 0d. per ton.

TABLE VI

*Fertiliser Handling Costs**

(Shillings per ton)

Price Range	Number of Farmers
5s. 0d. or less	54
5s. 1d. to 10s. 0d.	55
10s. 1d. to 15s. 0d.	30
15s. 1d. to 20s. 0d.	10
Over 20s. 0d.	22
Total	171

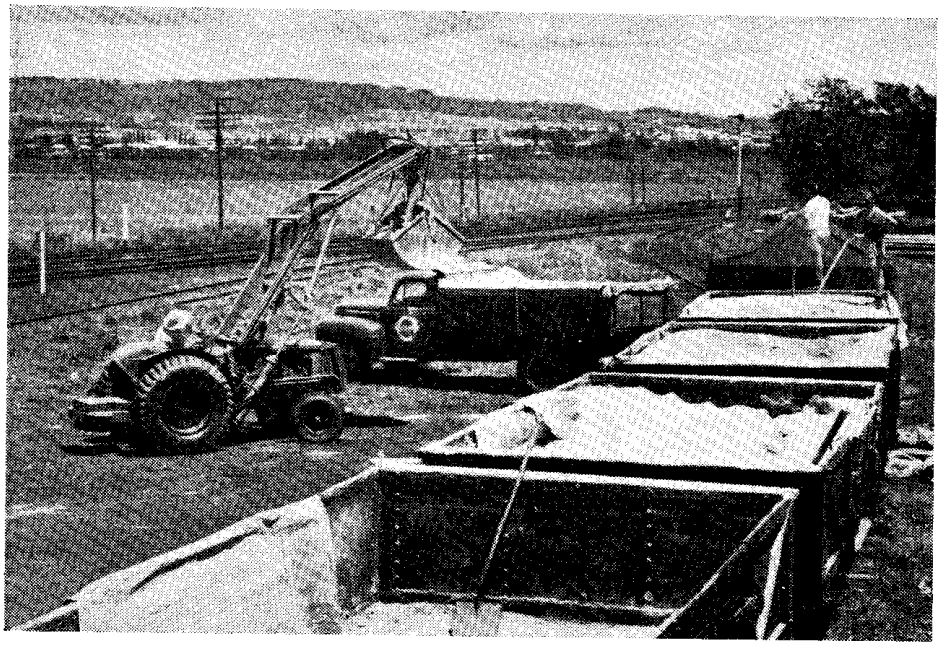
* Labour valued at £4 a day.

One factor influencing the cost of handling is the quantity of fertiliser spread. Farmers who used 20 tons or less spent, an average of 21s. 6d. per ton on handling and markers; this declined to 12s. 10d. for the next group (21-50 tons). The lowest average handling cost was registered by 17 farmers in the 76-100 ton group (8s. 8d.); after that there was a slight increase in expenses.

As mentioned earlier it is believed that practically the whole of these costs of fertiliser handling and markers can be eliminated by the use of bulk handling and by experienced pilots.

Appendix II gives a comparison of typical costs of bagged and bulk fertiliser. In the case discussed in the appendix the cost of superphosphate landed on the airstrip (ready for the contractor's equipment) is £18 6s. 6d. per ton for bagged superphosphate and £16 14s. 0d. per ton for bulk.

[9] The cost of markers is included in this section because in the mail questionnaire landholders were asked, "How much labour did you supply for handling fertiliser, marking, etc.? ..... men for ..... days." Thus it is not possible to distinguish between the respective costs incurred on fertiliser handling and on markers.



Bulk handling of fertiliser from rail truck to carrier's bulk truck

The bulk handling of superphosphate will save landholders about 30*s.* 0*d. per ton; with gypsum the saving is about* 80*s.* 0*d. per ton. The loader shown will handle about* 15 *tons/hour at a charge of* 6*s.* 0*d. per ton.*

(*Photo.—Country Life.*)

SEED

The cost of this item will depend on the variety sown, the rate per acre and the price of seed which varies markedly from season to season. Seeding is usually only carried out in the first one or two years of aerial pasture improvement. On the average the initial cost will rarely exceed 10s. 0d. per acre. In later years of aerial pasture improvement—*i.e.*, when there has been a satisfactory establishment of clovers and an attempt is being made to sow grasses aerially—the cost may become substantially greater. Rates of application and species used are given in Table VII.

TABLE VII

Rates of Application of Seed on Aerially Sown Pasture

(144 graziers)

Type of Seed	Rates of Application (lb. per acre)							
	½ or less	1	1½	2	3	4 or more	Not given	Total
	Number of Cases*							
Subterranean Clover ..	3	20	..	56	23	17	..	119
White Clover	20	25	..	4	..	..	..	49
Red Clover	..	3	..	1	..	..	..	4
Perennial Ryegrass ..	2	..	..	7	2	11	2	24
Wimmera Ryegrass ..	..	2	..	2	..	1	2	7
Cocksfoot	1	1	1	2	..	..	2	7
Total	26	51	1	72	25	29	6	210

* As many graziers sowed a mixture the total number does not correspond with the number of graziers answering this question.

(b) The Costs of Carrying More Sheep

These costs are usually a very important item in the total cost of pasture improvement, but it is difficult to obtain information about them. This is partly because such costs will vary greatly between properties and partly because in some cases costs such as the erection of dams and buildings may be minimised by the use of the property's own labour force during off-peak work periods. On some properties water supplies, fencing, yards, wool sheds, etc., may be adequate to run three or four times the number of stock currently carried, on others no increase in stock numbers can take place unless more facilities are provided.

An attempt was made in the follow-up survey to ascertain what additional capital investment was made by the survey farmers *as a necessary consequence* of the increase in stock numbers. Such a concept is, of course, a rather vague one. For instance, if a paddock is subdivided, an additional dam put down and the farmer at the same time increases his sheep numbers by 10 per cent, is it correct to say that the additional expenditure is necessary for the increase in the sheep population or is this investment made largely to enable the country to be better used and to provide more security against seasonal adversities? It is difficult to answer such questions; in the follow-up survey it was decided to rely on the survey farmers' judgment for estimates of the portion of their expenditure which was directly attributable to the increased stock population.

In Table VIII, information given by 31 of the survey farmers is grouped according to the increased capital investment required for each additional sheep run. Of the 31 graziers, 11 spent less than £1 per additional sheep and a further 11 spent between £1 and £2 per additional sheep. It would seem, therefore, that expenditure of between 10s. 0d. to 30s. 0d. per additional sheep on extra water facilities, sheds, buildings and fences would be reasonably typical. (The median expenditure was 25s. 0d. per sheep.)[10]

TABLE VIII

Additional Capital Investment as a Result of Increased Stock Numbers

Increased Capital Investment per Additional Sheep Run	Number of Graziers
Nil	2
1d. to 20s. 0d.	11
20s. 1d. to 40s. 0d.	11
40s. 1d. to 100s. 0d.	6
Over 100s. 0d.	1
Total	31

[10] It is possible that some of the extra capital investment ultimately required has not yet been incurred. No allowance has been made for this. However, as will be shown later, the expenditure in the initial years of aerial pasture improvement is of crucial importance. Extra expenditure in later years—when income from increased production is obtained—is likely to prove a much smaller financial burden.

LABOUR

The change in the labour requirements after at least three years of aerial pasture improvement on 40 farms visited is shown below:—

1 grazier used less labour ("wages have gone up too much") ;

24 graziers used no more permanent labour ;

3 graziers used no more permanent labour on the farm but shifted one or more men from pasture and developmental work to stock work ;

2 graziers used no more permanent labour but more casual labour ;

5 graziers used one additional permanent man ;

4 graziers used two additional permanent men ;

1 grazier used "more" labour without specifying the number of men.

WATER

Forty-two of the survey farmers visited gave information about investment in water facilities ; eighteen had not spent any money on additional dams, etc., since their stock numbers had increased. Additional expenditure on water ranged from less than £100 to £22,000. An (arithmetical) "average" expenditure on water under such conditions is of little value. Table IX gives the additional investment in water facilities by 38 survey farmers.[11]

TABLE IX

Additional Investment in Watering Facilities

	Number of Farmers
Nil	18
£1 to £250	5
£251 to £500	1
£501 to £750	5
£751 to £1,000	4
£1,001 to £2,000	2
Over £2,000	3
Total	38

BUILDINGS

Twelve of the farmers visited did not require any extra buildings and 28 did. The most important types of building construction were: new or enlarged wool sheds, yards and additional cottages for permanent labour. Typical expenditures seemed to be in the vicinity of £1,000.

FENCING

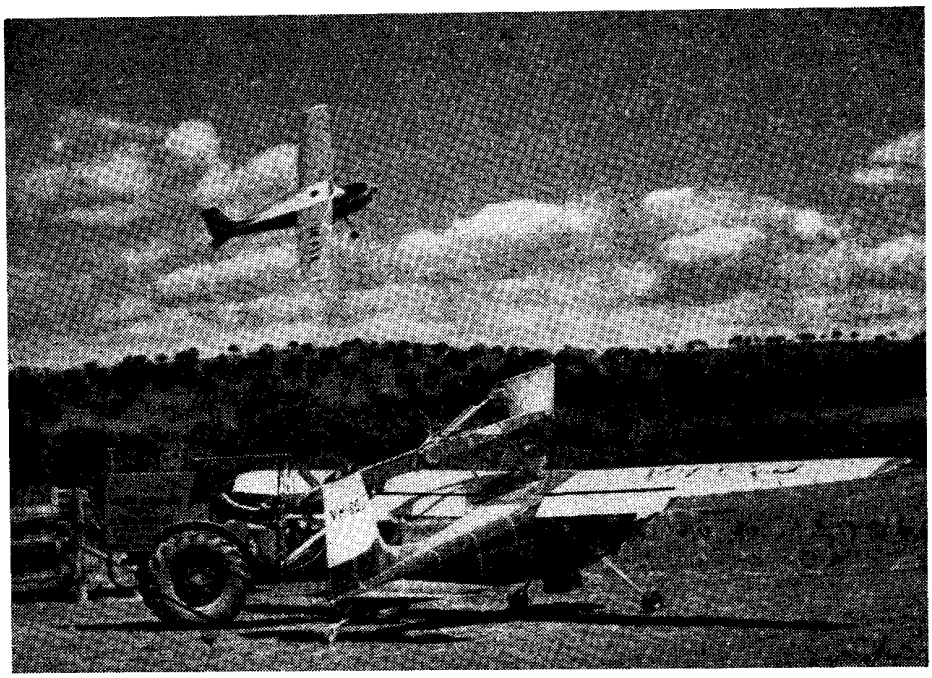
Twenty-five of 39 survey farmers had gone in for additional subdivisional fencing, typical expenditures being £1,000 to £1,700 (or three to five miles).

[11] On an additional four farms dams and bores were constructed with the operators' equipment and costs could not be estimated.

(c) The Possibilities of Cost Reduction

Apart from bulk handling the main possibilities for cost reductions are in the use of planes better suited to this type of work and the greater utilisation of aircraft at present in the industry.

Until recently most spreading was done by light aircraft—especially the Tiger Moth (DH 82) which has a maximum load of four to five cwt. With the purchase of medium sized aircraft which can carry between eight cwt. and one ton (such as the Cessna, the Fletcher and the Beaver) costs are reduced considerably. It is noteworthy that the few operators who are still relying on light planes only, are finding it difficult to cut their charges.



General view of Cessna aircraft, and loading operation

(Photo.—Country Life.)

One of the biggest spreading contractors has recently purchased an aircraft capable of carrying a load of six tons and expects to be able to offer landholders substantial savings when it is in operation. The savings to the landholder may not be only in terms of actual charges by the aerial operator but may take the form of a saving on road freight to the property. Aircraft of this size will probably operate only from aerodromes near country towns where bulk fertiliser depots can be erected.

In the near future a new Australian-made aircraft specially designed for this work may enable further economies to be made. One advantage of local manufacture is that better repair and servicing facilities should be available. This could reduce repair and insurance costs—two important items in the cost of operating agricultural aircraft.

A second major change which offers scope for a reduction in costs is the greater utilisation of existing aircraft. This would involve a lengthening of the topdressing season. Currently, 80 per cent of all fertiliser spread

aerially is spread between November and June. For the remainder of the year aircraft are comparatively idle as there is insufficient other agricultural work for them. To overcome this problem two spreading companies are reducing their off-season price by 10s. 0d. to 15s. 0d. a ton. The fertiliser manufacturers are also introducing off-season rebates of 5s. 0d. and 10s. 0d. per ton during the second half of the calendar year. This, coupled with the general realisation that fertiliser can be put on profitably during any period of the year, may enable spreading services to utilise their aircraft more fully and thus obtain substantial economies.

5. THE RESPONSES FROM AERIAL PASTURE IMPROVEMENT

An attempt is made below to show the likely response that comes from aerial pasture improvement. However, it must be stressed that this response is extremely difficult to assess. Difficulties in estimating response are encountered for several reasons.

Firstly, there are a great many directions in which it can show its influence. Pasture improvement can lead to:

(*a*) Increased stocking rate per acre;

(*b*) Increased wool yield per sheep carried;

(*c*) Ability to run breeding sheep on country formerly too poor for that purpose;

(*d*) Better health and nutrition reflected in fewer deaths, improved lambing percentages, a longer productive life and the sale of culled and surplus animals in fat rather than in store condition.

For some of these factors it is difficult to obtain quantitative estimates.

Secondly, there is the problem of deciding whether increases in production are due to the use of this new technique or the result of other factors such as seasonal fluctuations, rabbit eradication and other developmental programmes.

Thirdly, how reliable are the judgments of response made by graziers who have used aerial spreading services? Can they be substantiated by factual data?

(a) Increased Stocking Rate per Acre

In the mail questionnaire each grazier was asked to estimate stock carrying capacity per acre prior to aerial topdressing and the response—in terms of the increase in carrying capacity—during the first four years of aerial pasture improvement. Specifically he was asked to do this in the form of estimating sheep per acre and specifying the type and the breed of sheep for each year considered.

In a number of cases where only cattle were run the operator failed to supply any data.

Where both sheep and cattle were carried on a property generally no allowance appeared to have been made for the changes in cattle numbers although in a few cases this was done. In as far as this was not done the response would be under estimated.

The graziers' estimates of the original carrying capacity of unimproved pastures and of responses for the first four years of aerial topdressing are given in Table X.[12] Merino wether equivalents were used as the basis of calculation—a Merino ewe being considered equivalent to 1.5 wethers and a Corriedale ewe as equal to 2 wethers.

Graziers who had aerially topdressed for four years or more estimated that carrying capacity increased by 50 per cent in the first two years and by more than 100 per cent in four years. Graziers who had used aerial topdressing for only one or two years indicated even greater percentage responses.[13]

TABLE X

Estimated Response to Aerial Topdressing

(134 graziers)

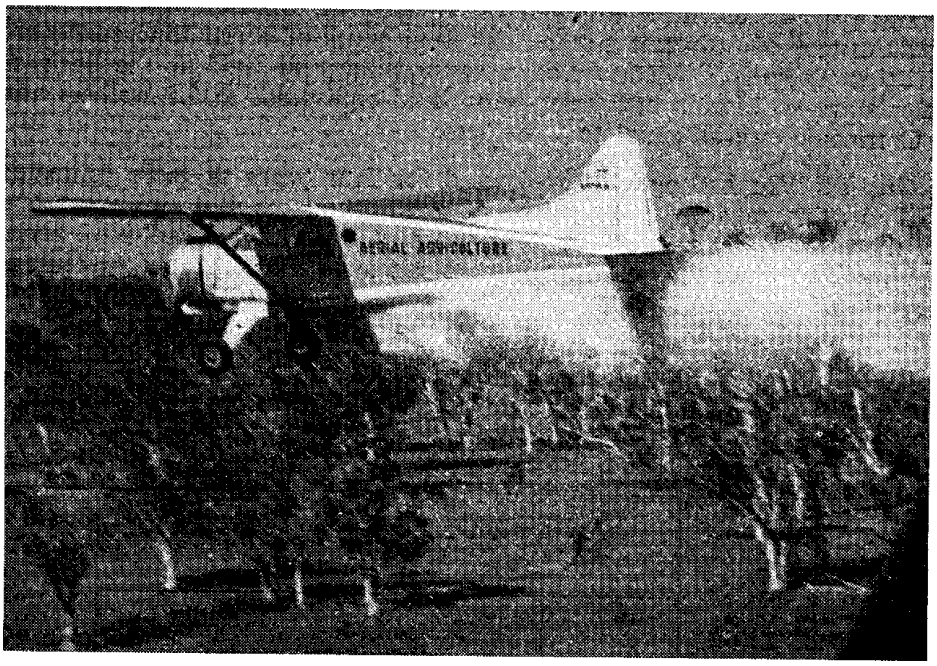
Group	No. of Years Aerial Top-dressing Used	Average Estimated Carrying Capacity (per acre)						No. of Graziers
		Prior to Aerial Top-dressing	Years after commencement of aerial topdressing					
			1st	2nd	3rd	4th	Ultimate Expected Level	
I ..	4 or more	1·0	1·2	1·5	1·8	2·1	3·0*	37
II ..	3	0·9	1·2	1·7	1·8	..	..	21
III ..	2	1·1	1·5	1·8	..	..	..	25
IV ..	1	1·0	1·4	..	..	..	..	27
V ..	0	1·1	..	..	..	..	..	24

* 27 answers only.

A figure for the expected ultimate carrying capacity was obtained only from Group I farmers. This figure is a combination of what has been achieved in some cases, plus anticipated achievement in the light of past results in others. In view of this, it is somewhat uncertain, and undue significance cannot be attached to it. Whilst a fourfold increase can perhaps be expected after a number of years in some reliable and good rainfall areas, in others it would not be wise to anticipate much more than a doubling of carrying capacity. But many experienced graziers considered that it takes five years before the main effect is obtained. It should be noted that some graziers with more than six years experience in this field have quadrupled the stock numbers on their property.

[12] Certain minor adjustments have been made to answers given by graziers. These are discussed below.

[13] This difference is statistically significant at the 5 per cent level. It was probably due to the excellent season experienced in 1956 which gave a big boost to pasture being established for the first time and also to pasture established in the previous year which was consolidating an initial year of growth.



Beaver aircraft spreading over country well suited for aerial topdressing

(*Photo.—Farmer & Settler.*)

(b) Changes in Wool Cut per Sheep

Each grazier was asked if he could supply details such as changes in wool yield or cut per head which would provide evidence of any other benefits of aerial improvement.

The most commonly mentioned result other than increase in carrying capacity was that of wool production per head, the general opinion being that there was an immediate rise in wool cut per sheep, even though there was little change in stocking rates.

Some of the results are shown in Table XI.

TABLE XI

Estimated Increases in Wool Cut per Sheep

Increase in cut per sheep	Number of Graziers
" More wool " (unspecified)	19
½ lb.	1
1 lb.	8
1½ lb.	3
2 lb.	8
3 lb.	10
4 lb.	3
Total	52

In some cases the increase was shown in terms of wool per acre which was compounded of both higher yields and additional stock, *i.e.*, in two cases it was considered wool per acre had increased by $2\frac{1}{2}$ and 3 times respectively after four years. In four cases the figures were given (*i.e.*, 7 lb. to 12 lb., 7 lb. to 14 lb., 8 lb. to 22 lb., 10 lb. to 24 lb. of wool per acre).

One Northern Tableland grazier who was able to supply his 15-year average of stock and wool prior to aerial improvement provided these figures:

	15 year average	1953	1954	1955	1956	1957
Wool (lb.)[14]	22,269	23,108	23,032	25,637	27,912	30,023
Sheep[14]	2,985	3,045	3,061	3,181	3,299	3,494
Wool per head (lb.) ..	7·4	7·6	7·5	8·1	8·5	8·6

In 1953—when this landholder started to use aerial topdressing—only 14 per cent of his total area was topdressed from the air. By 1957 this had risen to 61 per cent so that the response is not the result of the whole or even the major portion of the property being topdressed for three or four years. Lastly, 1957 was characterised by extremely adverse seasonal conditions in this area which led to substantial declines in production on surrounding properties.

Many other graziers also supplied changes in wool production for their properties, sometimes without supplying details of the change in sheep numbers. These data were in general agreement with the estimates given earlier. Two other specific cases are of general interest. In one of these instances, just west of the Southern Tablelands, the data was available for two separate areas.

The stock carried were Corriedales. On a basis of 100 acres, the original stocking rate was 50 mixed sexes and ages and in each succeeding year the number increased to 89, 107, 145 and 150.

In the other area the numbers carried rose from 22 to 40, 78, 99 and finally 110 sheep per 100 acres. These results were on partly cleared granite soils. It was considered that about 70 per cent of this improvement was due to aerial topdressing and sowing subterranean clover.

Another instance was in the eastern part of the Yass district. In this case a rough hilly paddock of 680 acres which could not possibly have been improved by ground methods gave the following results: before improvement, 700 Merino wethers were carried and, in succeeding years, the number rose to 700, 700, 1,100, 1,400 and 1,600 in turn. (The last figure is for the dry season up to March, 1958.)

[14] Wool production and sheep numbers have been multiplied by a common factor to preserve the anonymity of the landholder.

Whilst these examples may not be typical they were duplicated by other respondents. That such detailed examples closely follow other estimates provides some confirmation of the general reliability of the data.

(c) Other Benefits of Aerial Improvement

Besides the change in carrying capacity and wool production, a number of other benefits were mentioned as a result of aerial topdressing. Of 89 responding, 32 mentioned benefits other than increases in cut per head and carrying capacity. These comments are given in Table XII.

TABLE XII

Other Benefits of Aerial Topdressing

(32 graziers)

Benefit mentioned	Number of Graziers
Sheep in better health, condition	13
Good feed, despite drought	8
Reduces losses	3*
Reduces drenching	3
Better lambs	3
Better lambing	2
New breed	1

* Two graziers mentioned reductions by 70 and 90 per cent. respectively.

The better health and condition of the sheep was the outstanding commentary here. Emphasis was sometimes placed on the maintenance of flock numbers despite the dry season. In some cases significant reductions in losses were claimed. An examination of stock numbers quoted in income tax returns substantiated this. However, in some areas these would have been offset by increased cattle deaths due to bloat.

Information obtained from the farmers visited suggests that the comparatively small proportion of graziers mentioning other benefits in the mail survey was probably due to the vague nature of the question which read: "Can you supply any other figures which would illustrate the benefits of aerial sowing, for instance, changes in stock numbers, in wool cut or total yield, etc.?"

Graziers visited were asked whether aerial pasture improvement had affected their stock policy in any way. Only eight of 50 replied that there had been no change; 11 referred to the better health of their sheep and that it enabled them to fatten their surplus or cast-for-age stock. Another 19 mentioned that they could breed more safely or better than before or that they were able to change over to fat lamb production and five referred to improved lambing percentages. Seventeen graziers mentioned that they had good feed available despite the drought, thus eliminating the need for forced stock sales.[15]

[15] In reply to a question on the effect of aerial topdressing on the incidence of stock disease, eight graziers maintained there had been no change, nine replied, "less worm trouble" while four thought their worm problems had increased. Ten referred to more difficulties with bloat and three to foot abscess. Five graziers said that aerial topdressing had reduced diseases generally by raising the nutritional level of their stock and five denied having any disease problem at any time.

(d) The Reliability of the Estimates Obtained

In a mail questionnaire, little detail other than the above could be obtained. However, each grazier was asked whether he considered that the results he gave were solely due to the aerial operations or whether they were partly due to other factors such as rabbit control, clearing, other pasture improvement, etc.

Except in one or two instances where rabbits were regarded as of primary importance, these other factors were felt to be a contributary, but not the dominant cause of the increase in productivity. This is shown by the nature of the answers, *i.e.*, "due to a combination of ringbarking, rabbit control, other ploughed pastures, but mostly due to aerial topdressing"; "Timber rung five years ago and rabbits were completely eradicated same time, but paddock did not appear to move and stock did not do well until super was applied" (in this case there was an interval of two years between ringbarking and topdressing; after three cwt. of superphosphate the paddock was carrying just over double the stock despite the dry season); "These changes are aerial topdressing only; no clearing has been done and rabbits been out 20 years" (in this case stock numbers had doubled on treated area and wool increased from 60 to 112 bales, although only two-thirds of property treated); "Partly due to run of good seasons but I would say at least 50 per cent of improvement due to super" (here wool clip changed from 20,000 to 35,000 lb. and cut from 7 to between 11-12 lb. per head after use of less than 3 cwt. of superphosphate over the whole property. Only 200 acres sown to clover but its seed had been spread over most of the property by sheep); "I think due to topdressing".

Where the grazier gave emphasis to other factors an adjustment was made to the estimates given in Table X—on the assumption that the grazier might not have separated the effects of aerial improvement on his stock numbers from the other factors mentioned. This was, inevitably, subjective in view of the limited number who allocated the proportion of the increase to different types of improvements. Generally, aerial improvement was given the credit for 75 per cent of the change where one other cause of increasing production was mentioned and 66 per cent where several points were given.

Where no comment had been made about the effect of other factors, it was assumed that the total increase in carrying capacity was due to aerial means. When the questionnaire was carefully completed, as it seems to have been in the vast majority of cases, this is a reasonable assumption. But in the case of "slap-dash" answers, this may not be true. Due to the large numbers who made no comment, there was practically no difference between adjusted and unadjusted data, *i.e.*, the difference in response over four years was about 0.1 dry sheep per acre.

Another problem requiring discussion is whether there is any way of checking the reliability of the graziers' estimates. Some graziers did volunteer to give production figures for the whole of their properties and in some cases graziers were asked for their income tax returns when visited. Of ten cases where a close check was possible, it was found that one had underestimated the rise in stocking, seven had been very close in their estimate and two had apparently overestimated the number of stock

carried.[16] Whilst the number of possible comparisons is very limited the fact that the stock figures and the grazier's estimate are so close suggests that the graziers contacted have provided reasonably reliable estimates.

A further check was obtained from the properties visited. Here the stock numbers before and after topdressing were usually available. These agreed, in 90 per cent of cases, very closely with the estimated carrying capacity.

Perhaps, the summing up could most fairly be that, in a limited number of cases, it was possible to check the estimates of changed carrying capacity with changes in stock carried, and that generally there was a good agreement though instances of under, as well as over, estimation were found. In view of this, the consolidated data are regarded as a reasonably good estimate of the likely response to aerial topdressing.

(e) Factors Affecting Response from Aerial Pasture Improvement

The main factors affecting the response from aerial pasture improvement seem to be: soil type; rainfall; altitude; pasture management; and rate of fertiliser application. These factors are now considered in turn.

Soil Type, Clearing and Ground Clover

It has not been possible to separate responses according to soil type. Furthermore, no very definite conclusions could be drawn from the experiences of graziers contacted. As would be expected the impression was formed that responses were better on the better soils; establishment seemed to be uniformly good on basalt soils—especially red basalt. Most aerial seeding was done on partly cleared ground although some successful establishments were obtained under green timber. In the Northern Tableland is was considered that establishment was more difficult under stringy bark than box or peppermint.

There was general agreement that establishment tended to be poor on bare ground and that the best response was obtained when the ground cover was approximately $\frac{1}{2}$ to 2 ins. Some graziers considered that the protection offered by fallen timber and stumps aided establishment—especially of grasses. The very great importance of climatic conditions after seeding was also stressed.

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[16] The word "apparent" is used because the grazier was asked to estimate what the pasture would carry and he might not have stocked so heavily. For instance, due to worries about the introduction of foot rot and other sheep diseases some graziers increased their stock numbers by breeding rather than by buying. Under such conditions there may be some delay before the benefits of pasture improvement can be fully utilised.

A second reason for these discrepancies could be that tax data provide numbers only, and especially in the case of cattle, large errors can arise in the course of conversion to dry sheep units.

RAINFALL

The only farms for which annual rainfall records were obtained were those which were visited. For this reason, it was only possible to relate the response to rainfall in this limited number of cases. The results are shown in Table XIII. The figures in this table provide a quantitative estimate of the relationship between average annual rainfall and response from aerial pasture improvement. In view of this data it would seem that the increase in carrying capacity shown in Table X could be regarded as typical for the 25 ins. to 30 ins. rainfall zone.

TABLE XIII

The Effect of Rainfall on the Response from Aerial Pasture Improvement

Rainfall Group	Average Annual Rainfall	Average Estimated Carrying Capacity (Dry Merino Sheep Equivalents 100 acres)				No. of Graziers
		Before Aerial Top-dressing	In the fourth year of topdressing programme	Increase from Year 0 to Year 4		
				Absolute	Per-centage	
	inches				per cent	
Less than 25 in. ..	24·0	89	171	82	92	8
25 in. to 30 in. ..	28·5	105	214	109	104	11
More than 30 in. ..	33·5	98	265	167	170	8

ALTITUDE

The elevation of the area aerially treated was known only for those farmers who were visited. The 28 farms for which figures were available were divided into three groups with an elevation of less than 2,000 ft., 2,001 to 3,000 ft., and greater than 3,000 ft. As can be seen in Table XIV the responses obtained are much better on properties above 2,000 ft. than at lower levels. It is considered that this effect is largely due to rainfall. The farmers in the higher elevation groups were those in 25· ins. and higher rainfall groups. For this reason, it is considered that elevation probably has little direct effect on the results obtained, especially as the average response for the greater than 3,000 ft. group was not significantly different from the 2,000 to 3,000 ft. group. It may be that at a higher elevation frosts retard the growth and affect the germination of broadcast seed thus resulting in a slower establishment and consequently less increase in the carrying capacity of the land.

TABLE XIV

The Effect of Altitude on the Response from Aerial Pasture Improvement

Altitude	Average Estimated Carrying Capacity (Dry Merino Sheep Equivalents per 100 acres)				No. of Graziers
	Before Aerial Top-dressing	In the fourth year of topdressing programme	Increase from Year 0 to Year 4		
			Absolute	Percentage	
Less than 2,000 feet ..	101	177	76	75	7
2,001 to 3,000 feet ..	98	247	149	152	8
Over 3,000 feet ..	97	235	138	143	10

PASTURE MANAGEMENT

The graziers who were visited were asked how they treated their aerially sown pasture in the first year after seeding. There were 44 respondents to this question. In relating the increase in stock carried to pasture management it was found that the six respondents who did not stock in the first year obtained a rise of 280 per cent after four years compared with their original stocking rate, whilst six who decreased their stock over the whole year obtained an increase of 150 per cent; eight who reduced the stock numbers at flowering and seeding time only increased the carrying capacity by 100 per cent and those 23 who stocked at the same rate as previously did not quite double their carrying capacity. (The solitary farmer who stocked more heavily in the first year obtained no increase in the stock carried after four years.) Unfortunately there are insufficient numbers to test these results for significance, but the outstanding increase obtained by the six who did not stock in the first year suggests that spelling the top-dressed paddock may be a very worthwhile proposition.

RATE OF FERTILISER APPLICATION

The records of all graziers who began aerial topdressing in 1954 or earlier were examined to test the relationship between the rate of application of fertiliser and the increase in stock carrying capacity. The graziers used many varied systems in their fertiliser applications. Some apply 2 cwt. every second year, others 4 cwt. in the first two years and 1 cwt. every second year thereafter. Others, again, apply 1 cwt. to a different proportion of their property each year. For these reasons it is difficult to classify the respondents according to fertiliser applications. Three examinations of the data were carried out and while the results obtained were in some respects unsatisfactory they showed clearly that the 25 per cent of farmers with the lowest rate of application obtained markedly smaller increases in carrying capacity.

It is not possible with the limited number of observations available to determine what interrelations, if any, existed between rate of fertiliser application, rainfall, elevation and pasture management. But these factors either singly or taken together do appear to influence the results obtained from the aerial improvement of pasture.

(f) A Comparison with Traditional Methods of Improvement

In the mail questionnaire the graziers were asked to compare the time taken to establish an improved pasture by air and by means of seed bed preparation. Although only 69 graziers answered this question they gave an extremely wide range of replies. Of these, six believed that aerial establishment was as quick as proper seed bed preparation. This was clearly a minority view. The general opinion was that it took two to three years longer (25 graziers) but some thought it took four to five years longer. An additional 33 graziers indicated it took longer without specifying any time; sometimes this could be inferred from their statements that they preferred a prepared seed bed.

Information was also obtained as to success or failure in establishment of pasture by aerial sowing. Of 125 farmers, 50 per cent had success, 34 per cent had failures and 16 per cent considered the results fair. The large proportion of failures was partly due to the fact that 71 per cent of the graziers reporting failures had tried aerial seeding for the first time during the drought of 1957.

When all reported failures were considered, drought was the predominant factor to which failure was attributed. Other factors mentioned were poor soil, lack of ground cover at time of seeding, poor or no inoculation of clover and inadequate rates of seeding.

From the earlier pasture improvement survey mentioned in the Introduction, it was possible to obtain estimates of the effects of seed bed preparation on changes in carrying capacity in three shires on the New England Tablelands. Twenty-four graziers estimated that, on the average, carrying capacity increased by 2.2 dry Merino sheep per acre over a period of four years when a pasture was prepared by means of thorough cultivation. In comparison, 13 graziers from the same shires estimated an increase of 1.3 dry Merino sheep per acre after four years of aerial topdressing. The estimates for the two different methods are given in Table XV, which also brings out another difference between the two methods. With seed bed preparation there is a considerable increase in carrying capacity in the first year of improvement and the greatest change occurs in the second year. After the third year the increase reported was only fractional. On the other hand with aerial improvement the increase in the first year was negligible, it was greatest in the third year and there was still a considerable increase in the fourth year.[17]

[17] Such a comparison can only suggest tentative conclusions as no data is available on the comparability of soils, etc., for the two groups of graziers.

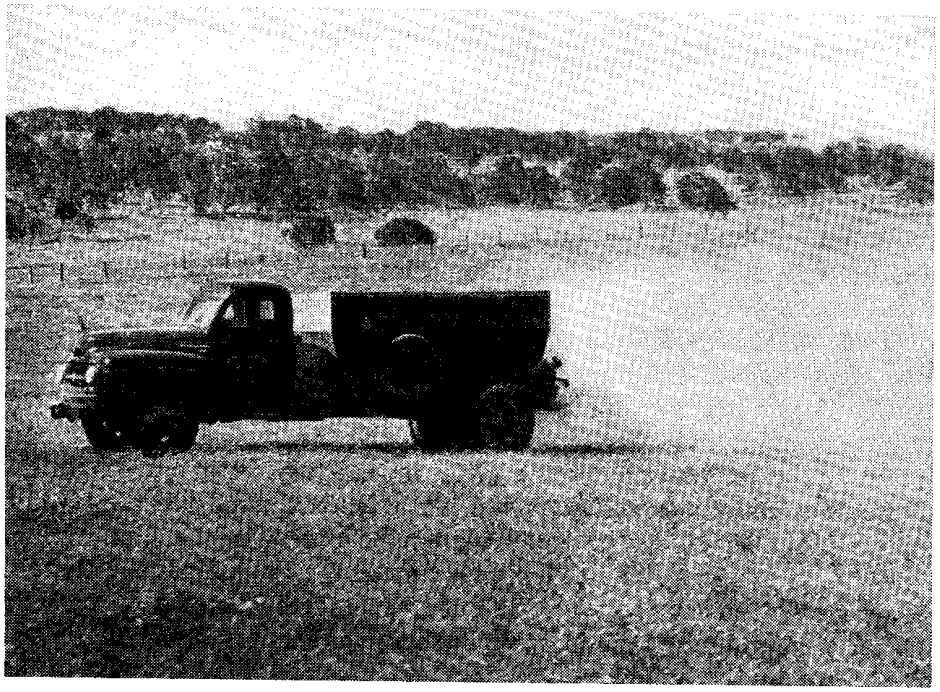
TABLE XV

Graziers' Estimates of Changes in Carrying Capacity—Aerial and Prepared Seed Bed Methods

(Shires of Guyra, Dumaresq, and Walcha)

Method of Improvement	No. of Graziers	Estimated Carrying Capacity of Pastures (Dry Merino Sheep Equivalents per acre)				
		Prior to Improvement	Year 1	Year 2	Year 3	Year 4
Aerial	13	1·0	1·1	1·4	1·9	2·3
Prepared Seed Bed..	24	·9	1·5	2·7	3·1	3·1

In the present survey the graziers were asked to compare the expected ultimate carrying capacity of seed bed and aerially sown improved pasture. Of 32 respondents, 22 considered that it would be the same, and 10 thought that the carrying capacity was not so good on aerially improved pasture. As few farmers have sown grasses aerially it can only be expected that the carrying capacity of aerially improved pasture would not equal a well established and balanced ground sown pasture.



The competitor. A fertiliser broadcaster mounted on a bulk truck

Spreading charges by this means will usually be considerably lower, but it can only be used on fairly even cleared country and gives a most uneven spread, which many landholders dislike.

(*Photo.—Farmer & Settler.*)

In the follow-up survey the graziers were asked whether they considered that there was any difference in drought resistance between pastures aerially sown or sown by prepared seed bed methods. Many farmers considered that the aerially sown pasture was superior because the native species withstood the drought conditions better. However, when the actual rate of stocking on the two types of pasture was compared it was usually found that there were no discernible differences.

6. HOW PROFITABLE IS AERIAL PASTURE IMPROVEMENT?

Two problems arise when one attempts to assess the profitability of aerial pasture improvement. The first practical difficulty is the very wide range of conditions—both physical and economic—which have to be taken into account. The course followed here is that costs and returns in what is regarded as a reasonably typical situation are given, with a full explanation of all the assumptions involved. The effect of varying some assumptions such as wool prices and wool cuts per head is estimated.

The second type of problem concerns the criterion of profitability to be used. Normally, the rate of return on capital invested is used to measure profitability. In the case of pasture improvement, it is difficult to estimate the percentage rate of return, because the additional costs are incurred over a period of years so that it is not entirely accurate to obtain a single value representing the capital invested. Furthermore, the expansion of income arising from the use of this technique takes some years to reach a stable maximum level—if such a maximum is ever reached. This makes it difficult to calculate the percentage return on capital.[18] The procedure here will be to use a number of measures indicative of the profitability of aerial pasture improvement under different conditions.

(a) A Typical Case

In the discussion of the typical case selected—the aerial improvement of 1,000 acres of good granite country in the Tablelands—the assumptions made are that:—

(i) the cost of buying clover seed and applying it (or mixing it with the fertiliser) is 10s. 0d. per acre in the first financial year;

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[18] The percentage return on capital is given by the following equation:—

$$\frac{x_1}{1+r} + \frac{x_2}{(1+r)^2} + \frac{x_3}{(1+r)^3} + \cdots + \frac{x_n}{(1+r)^n} = \frac{y_1}{1+r} + \frac{y_2}{(1+r)^2} + \frac{y_3}{(1+r)^3} + \cdots + \frac{y_n}{(1+r)^n}$$

where x = the additional expenses incurred (as a result of aerial topdressing), y = the additional income obtained (as a result of aerial topdressing), the subscripts denoting each of the separate years (i.e., x_3 = the expenses incurred in the third year of the development programme) and r = the rate of return on capital. In this equation all x's and y's are known and it is to be solved for r. The equation is one to the power of n and therefore will have n solutions. The solution of economic interest is the minimum $r>0$ which solves the equation. The authors have only been able to find a numerical method of solving this equation. In all interest calculations n was taken to be 50 years. The series are rapidly approaching a limit so that an increase beyond 50 years will have little effect on the value of r.

(ii) a bulk shed at the airstrip (capacity 50 tons) costs £150 and the preparation of a strip £25;

(iii) topdressing is done at the rate of 1 cwt. of superphosphate per acre annually; with fertiliser costing £16 14s. 0d. per ton landed on the airstrip ready for use by the aerial contractor;

(iv) aerial contracting charges (including the use of markers, if any) are £5 5s. 0d. per ton;

(v) shearing costs are £21 per 100 sheep and the cost of phenothiazine and other chemicals is £5 per 100 sheep;

(vi) the price of two-year-old Merino wethers off shears is £3 17s. 6d. and that of two-year-old Merino ewes off shears £4 5s. 0d. when the average Merino wool price (net of marketing charges) is 5s. 0d. per lb.; the price of rams was taken to be £35 each.[19]

The assumptions made so far are of comparatively minor importance in the sense that prices and costs of various items listed are known within reasonably narrow limits and also that the changes in their prices are unlikely to have a major effect on the profitability of aerial pasture improvement. However, four assumptions which had to be made in constructing this budget will need to be discussed in more detail to show that they can be regarded as reasonably typical of the conditions under which these budgets are expected to apply. These relate to:—

(1) the increase in carrying capacity resulting from aerial pasture improvement;

(2) the labour required by the grazier to look after the extra stock carried as a result of pasture improvement;

(3) the wool prices used; and

(4) the wool cut per sheep.

Carrying Capacity

The expected increase in carrying capacity used in the budget is 110 dry sheep for 100 acres, being the average given in Table X by graziers who have used aerial topdressing for four years or more. As shown in the preceding section this increase is likely to underestimate the response in areas where average rainfall exceeds 30 inches a year and to overestimate the response where average rainfall falls below 25 inches a year. However, it should be stressed that this assumption is conservative as no increase in carrying capacity takes place in any succeeding year. Our data on the increase which could be expected after that period is too meagre to base definite conclusions on such further increases but it is unlikely that no further response occurs after the first four years. The effect of varying this assumption is shown below.

[19] According to information obtained from wool brokers and others there is a "normal" relationship between sheep and wool prices so that under normal seasonal conditions two-year-old Merino wethers are worth the equivalent of one and a half times their annual wool clip. This relationship was used in determining the cost of sheep for these budgets. It is realised that at the time of writing—largely because of bad seasonal conditions—sheep prices are considerably lower than the levels assumed here.

Labour

The assumption made in the first budget is that the additional sheep carried do not require an increase in the amount of labour used on the farm. As shown in section 4, 28 of the 40 graziers visited did not increase their farm labour force after the use of aerial topdressing and the resulting increase in stock numbers. It is believed that this assumption is a reasonable one in the case of many farms with a small labour force—say one or two men—where a small increase in sheep numbers can normally be made without changing the amount of labour used.[20] In the case of properties with a larger labour force it is often possible to reallocate the duties of the workers to permit an increase in stock numbers without increasing the number of permanent employees. This is another assumption which is varied in the subsequent discussion.

The Price of Wool

The assumption made is that the average return per lb. of greasy wool, after deducting the cost of marketing (*i.e.*, insurance, commission, warehousing, road and rail freight, etc.), is 5s. 0d. per lb. This net price would correspond with the average auction price of 5s. 3d. to 5s. 6d. per lb. The size of the deductions for marketing charges depends on the distance of the grazier's property from the rail head, the distance of the rail head from the auction centre and the proportion of wool which is sent for bulk classing. The average price graziers realised from the sale of Merino wool from Tableland districts in 1955-56 and 1957-58, is estimated to have been between 5s. 6d. and 5s. 9d. But 5s. 0d. net is probably 5 to 10 per cent higher than current wool prices (this is written in May 1958 when prices are at their lowest level since 1949. In 1956-57 the average price obtained in this area was about 7s. 6d. per lb. It is obviously important to examine the effect of differing wool prices on the profitability of aerial pasture improvement and this is done in a later section.

Wool Yield

The assumption with regard to average wool cuts per sheep were as follows: 10½ lb. for wethers; 9 lb. for ewes; 6½ lb. for weaners; and 15 lb. for rams, giving an average for the composite flock of 9.1 lb. (lambs are not shorn). This may appear to be an optimistic assumption as the average wool cut for the entire Tablelands for the ten years ending 1956-57 has been 8.6 lb. per head. However, this figure is influenced by many farms running non-Merino flocks where wool cuts would be somewhat lower. In addition the regional average includes a large proportion of sheep run on unimproved pastures. The sheep on the farms visited averaged 9.4 lb. per head for 1956-57 and 1957-58 (*i.e.* one excellent and one very dry season). The effect of making different assumptions about average wool cuts per sheep is given in a succeeding section.

[20] In the budget the assumption of 1,000 acres for aerial pasture improvement is made solely for purposes of illustration—the figure chosen could equally well have been 100 acres—and all costs and incomes divided by 10 (with the exception of the cost of erecting a storage shed and the cost of constructing an air strip. These would not diminish proportionately as the acreage topdressed diminishes but both are very minor items in terms of total cost).

Furthermore, it was assumed that the country to be improved was originally running one dry sheep to the acre and that pasture improvement would lead initially to an increased wool cut of 1 lb. per head and in the second and succeeding years to an increase of 2 lb. per head from these sheep (this assumption is based on the information given in Table XI). Deaths were assumed to average 5 per cent per annum. Ewes and wethers were sold as cast-for-age sheep at six and five years respectively. Culling of weaners was allowed for at 10 per cent.

Profitability in Budget I

Year 1.—Table XVII gives the annual receipts and expenses associated with topdressing 1,000 acres by air under the conditions outlined. In the first year, total costs amount to £1,772 including almost £1,100 for superphosphate and the aerial contractor's charges; an additional £500 is spent on buying and applying seed. These costs are listed here in terms of financial years ending in June. The budget shows no increase in income in the first financial year.

Year 2.—In the second year costs amount to £1,847 of which almost £1,100 are the cost of superphosphate and the charges payable to the aerial contractor. The only other major item is the purchase of 150 additional Merino ewes and three rams. It is assumed that these ewes are purchased off shears in the spring of the second financial year so that the increased wool production from them will not be recorded until the third financial year. However, there is an increase in wool production from sheep previously carried on the unimproved country (of 1 lb. per head). The additional income resulting from aerial pasture improvement in the second year is therefore £250 so that the net cost of aerial pasture improvement amounts to almost £1,600.

Years 3 *and* 4.—In the third year additional expenses amount to £1,886, the major items again being the cost of buying and spreading superphosphate and the purchase of additional sheep. Additional income is £833 leaving a net cost of aerial pasture improvement slightly exceeding £1,000. In the fourth year additional costs are almost £2,000 but extra income now is a major offsetting item. The additional income attributable to aerial pasture improvement in the fourth year amounts to £1,300, leaving a net cost of around £650 due to aerial pasture improvement.

Subsequent Years.—From the fifth year onwards the increase in income will more than offset the additional costs incurred. In the fifth year the net balance in favour of aerial pasture improvement is small, amounting to less than £100 but this rises to almost £1,300 in the sixth year. After that there is a gradual rise until year ten when a stable long term position is reached. The increased net income from aerial pasture improvement then amounts to almost £1,800 annually.

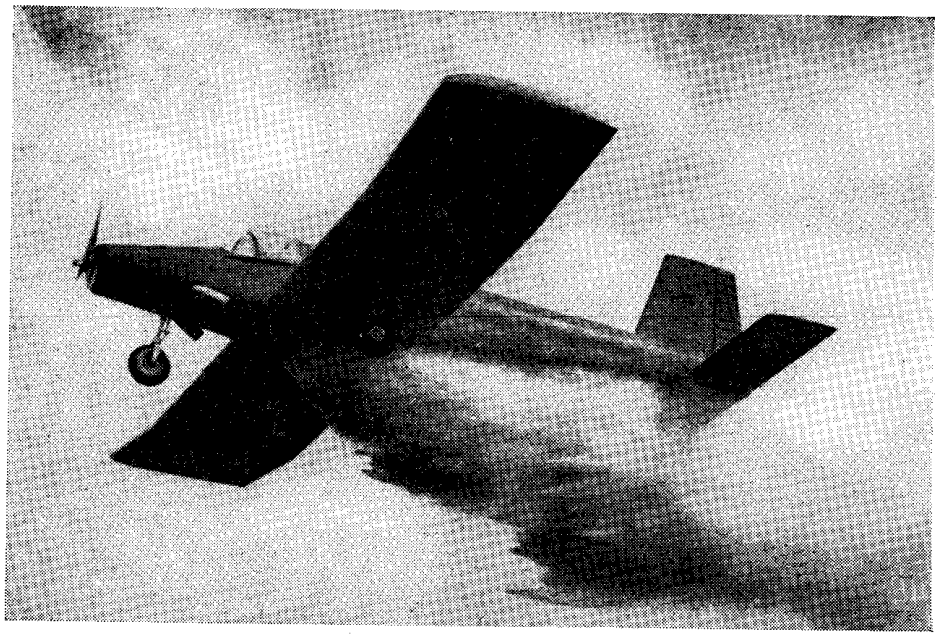
TABLE XVII

Budget I: Estimate of Receipts and Expenses of Aerial Pasture Improvement on 1,000 acres.

(No additional labour employed)

Financial Year	Change in Expenditure							Change in Income				Net Financial Result		
	Seed and Incidentals	Super-phosphate* at 1 cwt. per acre	Extra Sheep†	Shearing and Chemicals ‡	Aerial Contract Charges§	Capital Costs (Fences, etc.) of Running Extra Sheep‖	Total	Wool from Extra Sheep¶	Extra Wool from Original Flock**	Sale of Culls and c.f.a. Sheep††	Total	Net Cost; Expenses Less Receipts	Cumulative Cost (5% Interest added)‡‡	Excess of Annual Receipts over Expenses
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	£	£	£	£	£	£	£	£	£	£	£	£	£	£
1	675§§	835	..	..	262·5	..	1,772·5	..	..	..	..	1,772·5	1,772·5	..
2	..	835	742·5	7·5	262·5	..	1,847·5	..	250	..	250·0	1,597·5	3,458·6	..
3	..	835	742·5	4·6	262·5	..	1,886·0	333	500	..	833·0	1,053·0	4,684·6	..
4	..	835	689·0	107·0	262·5	75·0	1,968·5	813	500	12·5	1,325·5	643·0	5,561·8	..
5	..	835	387·5	180·0	262·5	237·5	1,902·5	1,470	500	25·0	1,995·0	..	5,747·4‖‖	92·5
6	..	835	70·0	253·0	262·5	287·5	1,708·0	2,240	500	254·0	2,994·0	..	4,748·7	1,286·0
7	..	835	105·0	266·0	262·5	250·0	1,718·5	2,401	500	281·0	3,182·0	..	3,522·6	1,463·5
8	..	835	70·0	266·0	262·5	275·0	1,708·5	2,401	500	326·0	3,227·0	..	2,179·2	1,519·5
9	..	835	70·0	266·0	262·5	187·5	1,621·0	2,401	500	338·0	3,239·0	..	670·6	1,617·5
10 and later ..	..	835	82·0	266·0	262·5	..	1,445·5	2,401	500	338·0	3,239·0	..	..	1,793·5

* £16 14s. 0d. per ton.
† Cost of ewes £4 5s. 0d., wethers £3 17s. 6d., rams £35 each.
‡ Shearing at £21 per 100 sheep, chemicals for drenching, etc., £5 per 100 sheep.
§ £5 5s. 0d. per ton.
‖ £1 5s. 0d. per additional sheep carried; of this 10s. 0d. in the 2nd year after increase in sheep numbers and 15s. 0d. in the 3rd year.
¶ Cuts per head—Wethers 10·5 lb., ewes 9 lb., weaners 6·5 lb. Wool valued at 5s. 0d. per lb.
** 1 lb. per acre (*i.e.*, per sheep) in 2nd year and 2 lb. in the 3rd and each succeeding year.
†† Culls sold at £1 5s. 0d. each, cast-for-age sheep at £1 15s. 0d. each.
‡‡ Balance of overdraft at end of each financial year—interest added at 5 per cent. No interest added in 1st year as most expenditure is incurred 2 to 4 months before the end of the financial year.
§§ Includes £500 for seed, £150 for erection of a bulk fertiliser shed, £25 for airstrip construction.
‖‖ The cumulative cost increases in year 5 because the excess of receipts over costs does not pay the interest charge on the overdraft.



Fletcher FU 24 in a fertiliser dumping test
Rapid release of the load is essential for safety in emergencies
(*Photo.—Air Farm Associates Pty. Ltd.*)

A Summing Up

The financial implications of aerial pasture improvement under these conditions can therefore be summed up as follows: In the first four years the programme will cost a landholder more than the return which he will receive from it. The net additional cost on one thousand acres over this initial period amounts to £5,066.[21]

This additional income rises from £100 in year five by gradual stages to £1,800 in year ten and succeeding years. Another way of stating the financial implications of this budget is to say that over the first five years of the programme, under the specified conditions, costs will exceed benefits by £5,000. During the next five years income will exceed the cost of the development by £7,700. Alternatively the financial results might be discussed in terms of the percentage return on the capital invested by means of the calculations outlined previously (footnote [18]). *The discounted long run percentage return on capital (and the fuller use of farm labour) was estimated by these means to be* 19 *per cent.*

[21] If this expenditure is financed by means of an overdraft with interest at the rate of 5 per cent, the maximum level of bank accommodation required would be reached in the fifth year at an amount of almost £5,750. The annual level of an overdraft which is used to finance aerial pasture improvement and which is repaid by means of the increased income is given in column 14 of Table XVII.

Even if the money is not borrowed some return has to be allowed on it.

Of the extra capital required £2,174 will be spent on sheep—finance for the acquisition of this asset is usually available freely. It is also more easily convertible into cash than the other capital charges which have to be met.

TABLE XVIII

Budget I: Changes in Sheep Numbers on 1,000 Acres during Aerial Pasture Improvement Programme

Financial Year	Extra Sheep Shorn*				Wool† Cut from Extra Sheep	Extra Sheep Bought‡			Extra Sheep Run§						Extra Sheep Sold‖	
	Ewes	Wethers	Weaners	Rams		Ewes	Wethers	Rams	Ewes	Wethers	Weaners	Lambs	Rams	Total	Culls	Cast-for-age
					lb.											
2 ..	..	..	..	..	..	150	..	3	150	..	..	..	3	153	..	..
3 ..	143	..	..	3	1,332	150	..	3	293	..	..	100	6	399	..	..
4 ..	279	..	100	6	3,251	100	50	2	379	50	90	195	8	722	10	..
5 ..	400	85	195	8	5,880	..	100	..	400	185	175	280	8	948	20	..
6 ..	350	370¶	280	7	8,960	..	..	2	250	345	252	250	7	1,104	28	125
7 ..	350	450¶	250	7	9,605	..	..	3	225	450	200	250	7	1,132	50	125
8 ..	350	450¶	250	7	9,605	..	..	2	225	410	220	250	7	1,112	30	165
9 and later	350	450¶	250	7	9,605	..	..	2	270	355	225	250	7	1,107	25	175

* Shorn in the spring—say October.
† Cut per head used is: Wethers 10½ lb., ewes 9 lb., weaners 6½ lb., rams 15 lb.
‡ Bought off shears—say November.
§ After lambing—say January.
‖ Culling at the rate of 10 per cent of weaners (except in year 7 when it was assumed that there was heavier culling to get rid of extra stock). Culling assumed to take place soon after shearing.
¶ Includes some dry ewes.

The changes in stock numbers carried under this programme are shown in Table XVIII. No extra sheep are shorn until year three as sheep are purchased off shears. The number of extra sheep shorn in year three is 146, as lambs will not be dropped until after shearing time and will not be shorn until they are weaners a year later (the figure of 146 allows for 5 per cent deaths during the preceding year). The flock reaches a stable position in year seven when 450 wethers, 350 ewes, 250 weaners are shorn. Twenty-five weaners are sold annually as culls and 175 aged sheep are sold.

(b) The Need for Additional Labour

In addition to the case considered above, other situations examined were: (1) where the grazier has to hire additional casual labour to cope with the extra work entailed; (2) where one extra permanent employee has to be engaged on a full-time basis. The effect of these assumptions is to reduce the profitability of aerial pasture improvement—in the first case slightly; in the second case, substantially.

In the first case, the additional casual labour used was assessed as costing £10 for each extra hundred adult sheep carried.[22] During the first four years of this improvement programme, expenses are increased by approximately £100 over Budget I, thus making the net cost on 1,000 acres equal to £5,163. In the long run, the extra cost of hiring casual labour will reduce the annual net income from £1,793 to £1,705. It is clear that this will have only a minor effect on the profitability of an aerial pasture improvement programme so that a separate table has not been included. *The return on capital is reduced to around* 18 *per cent.*

BUDGET II

The second case is outlined below. If an additional employee is added to the farm labour force, profitability is much more severely affected. The cost of hiring a permanent employee is taken at £750. If it is assumed that an additional full-time worker is required to handle the 1,100 extra sheep carried on 1,000 acres the long-run net income gain will be reduced from £1,793 to £1,043 per annum. In most cases, however, the additional permanent worker should be able to handle a considerably larger number of sheep; and so for the purpose of this budget it was assumed that when a permanent extra man is employed 1,500 acres will be top-dressed annually. This would enable an increase of approximately 1,600 in the number of sheep shorn.[23]

[22] Contract crutching was taken to cost £4 10s. 0d. per hundred sheep, and the use of casual labour for drenching at 15s. 0d. per hundred sheep; dipping 15s. 0d. per hundred sheep; foot-pairing £1 5s. 0d.; and lastly, a miscellaneous category including the treatment of footrot was included, and this was put at £2 15s. 0d. per hundred sheep.

[23] It will be seen that a factor which may inhibit an improvement programme is the absence of sufficient suitable land to justify the employment of another man. While this can be a real problem at times a grazier can vary his labour requirements considerably by choosing to run different types of stock. If labour is short a greater proportion of beef cattle and dry sheep can be carried; with surplus labour, breeding replacements or even fat lambs may become economically desirable. It is not possible to allow for these variations in this study.

TABLE XIX

Budget II: Estimate of Receipts and Expenses of Aerial Pasture Improvement on 1,500 *Acres*

(One additional permanent employee)

Financial Year	Change in Expenditure								Change in Income				Net Financial Result	
	Seed and Incidentals	Super-phosphate* at 1 cwt. per acre	Extra Sheep†	Permanent Labour	Chemicals and Casual Labour‡	Aerial Contract Charges§	Capital Costs (Fences, etc.) of Running Extra Sheep‖	Total	Wool from Extra Sheep¶	Extra Wool from Original Flock**	Sale of Culls and c.f.a. Sheep††	Total	Net Cost; Expenses less Receipts	Excess of Annual Receipts over Expenses
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	£	£	£	£	£	£	£	£	£	£	£	£	£	£
1	1,012·5‡‡	1,252·5	..	..	..	393·7	..	2,658·7	..	..	..	..	2,658·7	..
2	..	1,252·5	1,113·7	..	33·7	393·7	..	2,793·7	..	375	..	375	2,418·7	..
3	..	1,252·5	1,113·7	..	114·0	393·7	..	2,874·0	500	750	..	1,250·0	1,624·0	..
4	..	1,252·5	1,033·1	750	160·5	393·7	112·5	3,702·4	1,219·1	750	19·0	1,987·9	1,714·5	..
5	..	1,252·5	581·2	750	270·0	393·7	356·2	3,603·7	2,205·0	750	37·5	2,992·5	611·2	..
6	..	1,252·5	105·0	750	379·5	393·7	431·2	3,312·0	3,360·0	750	380·6	4,490·6	..	1,178·6
7	..	1,252·5	157·5	750	399·0	393·7	375·0	3,327·7	3,601·9	750	421·9	4,773·7	..	1,446·0
8	..	1,252·5	105·0	750	399·0	393·7	412·5	3,312·7	3,601·9	750	489·4	4,841·2	..	1,528·5
9	..	1,252·5	105·0	750	399·0	393·7	281·2	3,181·5	3,601·9	750	506·3	4,858·1	..	1,676·6
10 and later	..	1,252·5	123·0	750	399·0	393·7	..	2,918·2	3,601·9	750	506·3	4,858·1	..	1,939·9

* £16 14s. 0d. per ton.
† Cost of ewes £4 5s. 0d., wethers £3 17s. 6d., rams £35 each.
‡ Shearing at £21 per 100 sheep shorn, chemicals for drenching, etc., £5 per 100 adult sheep, casual labour £10 per 100 adult sheep for 1st three years.
§ £5 5s. 0d. per ton.
‖ £1 5s. 0d. per additional sheep carried; of this 10s. 0d. in the 2nd year after increase in sheep numbers and 15s. 0d. in the 3rd year.
¶ Cuts per head—Wethers 10·5 lb., ewes 9 lb., weaners 6·5 lb. Wool valued at 5s. 0d. per lb.
** 1 lb. per acre (*i.e.*, per sheep) in 2nd year and 2 lb. in the 3rd and each succeeding year.
†† Culls sold at £1 5s. 0d. each, cf. a sheep at £1 15s. 0d. each.
‡‡ Includes £750 for seed, £225 for erection of a bulk fertiliser shed, £37 10s. 0d. for airstrip construction.

A budget for such a case is given in Table XIX. It was assumed that the extra employee was first engaged in the fourth year of the pasture improvement programme. Under these conditions, the added costs incurred in an aerial pasture improvement programme will exceed the additional income obtained for a period of five years, and the total additional cost over these five years will be £9,027. In the long run, the additional income obtained will be £1,940. *The percentage rate of return on capital under these assumptions* (i.e., *of Budget II*) *is* $13\frac{1}{2}$ *per cent.*

No allowance has been made for building a house on the property for the new permanent employee. In some cases this accommodation will not be necessary. Where such additional accommodation has to be constructed by the grazier, the cost of a house will have to be added to the capital costs incurred. This cost will probably be in the vicinity of £2,000. *Such an expenditure would reduce the profitability of an aerial pasture improvement programme to* 12 *per cent.*

(c) The Effect of Different Wool Prices

The effect of different wool prices is illustrated in Table XX. In this Table the net cost of an aerial pasture improvement programme under two different labour situations (*i.e.*, Budgets I and II) is given. This net cost is the total net expenditure incurred until extra income begins to overtake extra expenditure (*i.e.*, the sum of the entries in column 13, Table XVII). As the wool price is increased the net cost of pasture improvement falls—because the extra income derived from the sale of a larger quantity of wool reduces the net costs.[24]

As shown in Table XX it will normally be four to five years before the extra income aerial topdressing exceeds the extra costs of it. Even when wool prices are very favourable the landholder has to be prepared for his additional costs to exceed receipts for the first four financial years.[25]

The effect of changes in wool prices on the additional annual income when stock numbers are stabilised, is also shown. Where no additional labour is required (*i.e.*, Budget I) annual income is increased by £315 for each increase of 6d. in the price of wool. (Allowance is also made here for a proportionate increase in the value of culls and cast-for-age sheep). In Budget II, where an additional permanent man is employed and 1,500 acres treated the increase in annual income is slightly less than £500 for each 6d. increase.

[24] Allowance was also made for the change in the price of sheep purchased.

[25] From the financial point of view it has been advisable to prepare these budgets in terms of financial years. In fact this makes the initial period when costs exceed returns appear larger than if calendar years were used. Expenditure associated with aerial pasture improvement will normally be made in February and March—*i.e.*, three months before the end of the financial year. The bulk of the income will be obtained when the wool is sold—usually between November and January. If the "accounting year" used were one ending just after the wool is sold, the lag in incomes would be cut by one year.

TABLE XX

The Effect of Different Wool Prices on the Financial Returns from Aerial Pasture Improvement

Net Wool Price*		3s. 0d.	3s. 6d.	4s. 0d.	4s. 6d.	5s. 0d.	5s. 6d.†	6s. 0d.	6s. 6d.	7s. 0d.	7s. 6d.‡	8s. 0d.
Budget I—												
1. No Additional Labour Used (1,000 acres improved)—												
Total Net Cost §	£	5,709	5,525	5,341	5,157	5,066	5,042	5,020	4,997	4,974	4,950	4,927
Number of Years Extra Costs Exceed Extra Income	No.	5	5	5	5	4	4	4	4	4	4	4
Additional Annual Income when Programme Fully Implemented	£	531	846	1,162	1,478	1,793	2,109	2,425	2,740	3,056	3,372	3,687
Estimated Long-term Percentage Return on Capital	Per cent	6·2	10·2	13·2	16·4	19·1	21·6	24·6	26·0	28·1	30·0	31·8
Budget II—												
2. Extra Permanent Labour (1,500 acres improved)—												
Total Net Cost §	£	11,699	9,993	9,580	9,304	9,028	8,751	8,475	8,310	8,275	8,240	8,204
Number of Years Extra Costs Exceed Extra Income	No.	9	6	5	5	5	5	5	4	4	4	4
Additional Annual Income when Programme Fully Implemented	£	2	486	971	1,455	1,940	2,424	2,909	3,394	3,878	4,363	4,847
Estimated Long-term Percentage Return on Capital	Per cent	0	3·0	7·4	10·7	13·7	16·0	19·0	21·2	23·5	25·5	27·5

* Wool price obtained by grazier after deducting cost of marketing (*i.e.*, commission, warehousing, insurance, bulk classing, road and rail freight).

† Estimated average net return per lb. of merino wool (Tablelands) 1955-56 and 1957-58.

‡ Estimated average net return per lb. of merino wool (Tablelands) 1956-57.

§ This figure is the sum of the first four years of column 13, Table XVIII (for the 5s. 0d. no labour situation) and the sum of the first five years of column 14, Table XXI(for the 5s. 0d. permanent labour situation).

The last line for each labour situation shows the long-term (discounted) percentage return on capital invested at the different wool prices. The average net wool price realised by Tableland graziers during each of the last three seasons is also indicated in the Table. It will be seen that an aerial improvement programme of the type outlined here would have returned 16 per cent even at the low 1955-56 and 1957-58 wool prices, in the less favourable labour situation.

In one respect the conditions envisaged here do not bring out the full benefit of a pasture improvement programme. At very low wool prices graziers whose properties are improved will be able to switch profitably to meat production (both fat lambs and beef) whereas graziers relying on natural pastures will have considerable difficulty in fattening animals. At these low wool prices the profitability of an improvement programme is therefore underestimated.

(d) Other Assumptions

In this section it is proposed to examine briefly the effect of varying two other assumptions made earlier. The first of these is that the carrying capacity of aerially improved pasture increases by 1.1 dry sheep per acre over four years and then remains at that level despite additional annual applications of 1 cwt. of superphosphate. This assumption was varied to allow a further increase of .9 dry sheep per acre in the following six years of the aerial pasture improvement programme so that finally three dry sheep per acre are carried instead of 2.1 dry sheep in the earlier budget (as estimated by graziers in Table X).

Under these conditions initial costs are increased slightly (more sheep have to be purchased) but the permanent net annual gain after ten years is raised from £1,793 to £3,780. (When the wool price is 5s. 0d. and no additional labour is used.) *This raises the profitability of this programme from* 19.1 *per cent to* 24.3 *per cent.*

A similar adjustment was made to the budget where permanent labour is employed. As sheep numbers were increased by 3,000 in this case (*i.e.*, an additional two sheep per acre on 1,500 acres) two extra permanent employees were allowed for. *Under these conditions* (i.e., *Budget II*) *the percentage rate of return on capital is raised from* $13\frac{1}{2}$ *per cent to* $18\frac{1}{2}$ *per cent.*

Secondly, an examination was made of the effect of increasing (or decreasing) the wool yield per sheep. A 1 lb. increase (or decrease) in cut per sheep will change the long-run annual income by £267 (*i.e.*, in the case of Budget I with no additional labour and the wool price at 5s. 0d.). Such a change will be equivalent to a change of approximately 5d. in the net price of wool.

7. CONCLUSION

An attempt has been made above to assess the profitability of an aerial pasture improvement programme under a variety of different conditions. Although the conditions listed were so numerous that it became very complicated to keep track of the different situations discussed, the list was

by no means exhaustive. However, it is felt that this examination should be of value to graziers working under a particular set of circumstances which may in some respects differ from those given. It should provide a guide to the preparation of a budget adapted to any individual property.

In past years of high wool prices, many graziers have used aerial pastures improvement as a means of developing their properties as rapidly as possible and have not scrutinised the costs too closely. The generous taxation concessions available have meant that the grazier undertaking an aerial pasture improvement programme has been able to reduce his tax burden considerably. The foregoing discussion should convince many that aerial pasture improvement remains a profitable long-term investment even at the lower wool prices which have been ruling in 1955-56 and in 1957-58.

For those graziers who are mainly interested in the capital value of their asset, as opposed to the additional income it may earn, aerial pasture improvement is also a sound investment. *Over a four-year period, the net cost of improvement (apart from the purchase of extra sheep) will be somewhat less than* £3 *an acre, so that a person who pays tax at the rate of* 10*s.* 0*d. in the* £1 *will have invested an additional* 30*s.* 0*d. an acre in such an improvement programme. While the increase in the capital value of his property is difficult to estimate, it would have risen at least* £5 *an acre.*

Lastly, it may be desirable to point out that while an attempt has been made above to examine whether aerial pasture improvement pays under certain specific conditions, nothing has been said about the relative profitability of improving country by means of aerial topdressing instead of using a prepared seed bed. In many cases, country which has been improved aerially could not have been improved in any other way; but in others, the problem is to discover when it is economically advisable to use aerial methods in preference to the more orthodox method of seed bed preparation. The factors influencing this decision will be: additional cost of clearing required for seed bed preparation; what machinery the grazier has available for such work; and how much labour he could devote to the cultivation. It is hoped to examine these questions in some detail at a later stage.

APPENDIX I

The Saving from Bulk Handling

Bulk handling can only be used where unloading equipment from rail trucks is available locally. At the moment there are only a few unloading grabs available for this work in the State, but further equipment is likely to become available soon. The standard contract charge for unloading at present is 6s. 0d. per ton, but this cost may be completely recouped by the cheaper road-freight in bulk lorries. Bulk road cartage rates average 1s. 3d. per ton mile over distances in excess of five miles; comparable charges for bagged fertiliser are 1s. 6d. to 2s. 0d.

With bulk handling, no labour is required to load the aircraft though some storage facility on the strip becomes advisable. The cost of a fertiliser shed—judging by 12 survey farmers who erected them—is likely to be in the vicinity of £3 to £4 per ton of fertiliser storage space. On the other hand if a field bin of, say, 10 ft. x 10 ft. x 3 ft. is used the cost per ton will be considerably lower.

So far tarpaulins have been used as covering for these bins but it is probably cheaper to use thin polythene sheeting costing less than 1½d. per sq. ft. (or approximately £1 to 12 tons). Damage to such sheeting by wind flap can be kept to a minimum by the use of rope nets to cover the stack (at a cost of £5 10s. 6d. per 600 sq. ft.).[25]

How does the cost of bulk handling compare with using bagged fertiliser? This is probably best examined by using an example which is reasonably typical of some of the conditions under which such a change is likely to be made. For this example, we take a property using 60 tons of fertiliser and assume that it is 300 rail miles from the source of fertiliser supply and 20 miles by road from the nearest rail head. Under these conditions the costs on the property will be as follows:—

TABLE XXI

A Comparison of the Cost of Bagged and Bulk Fertiliser

Items	Bagged Fertiliser	Bulk Fertiliser
	£ s. d.	£ s. d.
Superphosphate (60 tons)*	832 10 0	771 0 0
Rail Freight (300 miles)	138 0 0	138 0 0
Road Freight†	105 0 0	75 0 0
Cost of Unloading (at siding—6s. 0d. ton) ..	....	18 0 0
Cost of Handling at Airstrips (8s. 0d. ton) ..	24 0 0	....
Total Costs (excluding storage)	1,099 10 0	1,002 0 0

* At £13 17s. 6d. per ton in bags and £12 17s. per ton in bulk.
† At 1s. 9d. a ton mile bagged and 1s. 3d. a ton mile bulk.

The saving in direct cash costs from the use of bulk handling for 60 tons is therefore almost £100. If gypsum is used instead of superphosphate, the saving is even larger—almost £250—as the price differential between bulk and bagged gypsum is much greater. Before we can arrive at the net economic benefits of bulk handling some allowance has to be made for the erection of some type of storage on the airstrip. Even if the most costly type of storage is erected—a bulk shed constructed at a cost of £4 per ton—the saving from bulk handling with superphosphate would pay for such a shed in less than three years. It seems obvious therefore that for any grazier using a moderate amount of fertiliser, bulk handling should result in considerable savings.

[25] This particular method of storage and cover was worked out by Mr. Brian Harris of Australian Fertilisers Ltd.

APPENDIX II

List of Licensed Aerial Agricultural Operators in Australia

State	Operator	Address
N.S.W. ..	Aerial Agriculture	Airport, Bankstown.
	Aerial Fertilising and Aerial Liquid Spraying.	Yambil Street, Griffith.
	Airfarm Associates Pty. Ltd. ..	P.O. Box 224, Tamworth.
	Air Spraying and Spreading ..	477 Kiewa Street, Albury.
	Air Spray Services Corporation ..	40 Darlinghurst Road, King's Cross.
	Caleula Agricultural Airways ..	Mullion Creek.
	Farmair	Hangar 276, Bankstown.
	Hazair Agricultural Service ..	72 Icely Road, Orange.
	Hazelton Air Taxi and Charter Service.	Toogong via Cudal.
	Marshall's Spreading Service ..	590 Paine Street, Albury.
	Airland Improvements	P.O. Box 52, Cootamundra.
	McNeill Air Fertilising & Crop Dusting.	P.O. Box 75, Muswellbrook.
	Pasture Improving Aviation Service	.....
	New England Airspread Fertilizers Pty. Ltd.	" Pandora ", Walcha, N.S.W.
Vic./Tas. ..	Aerial Cropdusters & Sprayers Pty. Ltd.	443 Little Collins Street, Melbourne.
	Air Mist Pty. Ltd.	443 Bourke Street, Melbourne.
	Airspread Australia	4 Judd Parade, Mentone.
	Farmair	Tinamba.
	Pastoral Aviation	53 Patterson Street, North Carlton.
	Proctors Rural Services	63 Downey Street, Alexandra.
	Schutt Airfarmers Pty. Ltd. ..	P.O. Box 15, Cheltenham.
	Skyfarmers Pty. Ltd.	12 Commercial Road, Morwell.
	Southern Aerial Super Services Pty. Ltd.	C/o. Branton & Eltham, 87 Murray Street, Hobart.
	Super Spread Aviation Pty. Ltd. ..	.....
	Victorian Aerial Farming Aids ..	P.O. Box 19, Minyip.
Q'land ..	Agricultural Aviation Pty. Ltd. ..	293 Queen Street, Brisbane.
	J. & A. Bjelke-Petersen	P.O. Box 141, Kingaroy.
	Hardy Bros. Spraying Co. ..	227 Agnew Street, Norman Park.
	Airwork Coy. Pty. Ltd.	Airport, Archerfield.
	W. P. Kemp..	56 Outlet Crescent, Bardon, Queensland.
	Queensland Air Planters Pty. Ltd...	P.O. Box 52, Childers.
S.A. ..	Robby's Aircraft Co. Ltd. ..	Airport, Parafield.
	Super Spread Aviation Pty. Ltd. ..	Airport, Parafield.
W.A. ..	Aero Service Pty. Ltd.	Airfield, Maylands.
	Airwork Pty. Ltd.	C/o. Weir & Roderick, 103 St. Georges Terrace, Perth.
	R. S. Couper	P.O. Box 79, Albany.
	Dogett Aviation & Engineering Co.	Aerodrome, Maylands.
	Farmair Pty. Ltd.	189 Railway Parade, West Perth.
	David Gray & Co. Ltd.	10 Railway Parade, West Perth.
	Strickland Taylor & Co.	214 St. Georges Terrace, Perth.
	Rural Aviation Coy.	21 Harvey Street, Victoria Park.
	W. H. Beynon	68 Tuan Street, Victoria Park.

APPENDIX III

Department of Civil Aviation

Official Landing Area Requirements—Agricultural Operations

The Department of Civil Aviation is responsible for the safe conduct of all air service operations throughout the Commonwealth.

2. In this regard it has become necessary to promulgate suitable standards for small landing strips from which aerial agricultural operations are conducted. You, as the farmer, may be responsible for the preparation of a particular airstrip and the following physical requirements for such strips have been officially approved and are circulated for your guidance:—

Requirement	Standard
(*a*) Maximum allowable longitudinal gradient between strip ends for " one-way " operations (see para. 4 below).	4·6° (or 1 : 12½)
(*b*) Maximum allowable longitudinal gradient for two-way operations (see para. 4 below).	1·2° (or 1 : 50)
(*c*) Maximum allowable longitudinal gradient on any part of the strip.	The change of grade shall be such that aircraft can execute take-offs and landings with safety. The assessment shall be determined by the company chief pilot after flight test.
(*d*) Maximum allowable transverse grade (sectionized).	(1) The central 40 ft. section 1·8; (or one in 33). (2) Adjacent 20 ft. section each side of the central 40 ft. section 2·8; (or one in 20). (3) Remaining 60 ft. each side of the 80 ft. section (for run-off)—Such a grade as would accommodate the aircraft with safety in the event of run-off. *Note.*—The assessment of (3) above shall be determined by the company chief pilot after physical examination.
(*e*) Total minimum strip width.	200 ft.
(*f*) Minimum width smooth for landing and take-off.	80 ft.
(*g*) Minimum take-off or approach path gradient—Normal.	2·3° (or 1 : 25) to a distance of 3,000 ft. from end of strip.
(*h*) Minimum take-off or approach path gradient—curved path.	2·3° (or 1 : 25) or 1,000 feet directly along the prolongation of the centre line of strip. From this point 50 ft. clearance of all obstuctions is necessary.
(*i*) Width of approach or take-off path.	200 ft.
(*j*) Length of strip required for take-off.	AIP/AGA-4/1 prescribed length or on specific approval from the Regional Director, the length prescribed in the relevant PA chart.

3. The surface of the area described in items (f) and (j) shall be such that a motor car or truck can be driven over it at a speed of not less than 30 m.p.h. without undue discomfort to the occupants and shall be free of all obstructions which would impede the take-off or landing of the aircraft to be used.

4. When the longitudinal gradient of any strip exceeds 1.2 degrees (1:50), all take-offs shall be made down hill and all landings shall be made up-hill.
Effective 25th November, 1957.

Minimum strip length required for aircraft operating in agricultural operations at maximum all-up-weight; 1,500 feet for Piper PA-18A; 2,000 feet for Tiger Moth DH82, Fletcher FU24, De Havilland Beaver Auster J5, Cessna 180, De Havilland DH83, Fairchild Argus; 2,500 feet for Percival EP9; 3,500 for Avro Anson.

The lengths quoted above are based on assumed conditions and may be reduced when the aircraft is operating in accordance with a performance chart. The performance chart enables the pilot to take advantage of the factors which apply at the time, e.g., wind, temperature, runaway slope, loading etc.

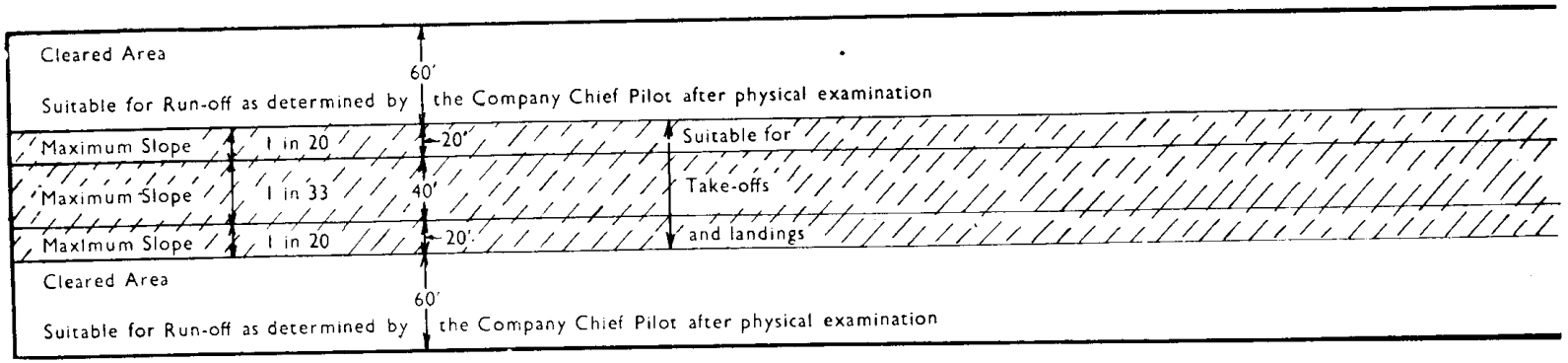
In all cases, however, the pilot and aircraft operator should consult the relevant Department of Civil Aviation publication for current information relating to strip length requirements.

APPENDIX III—*continued*

Department of Civil Aviation

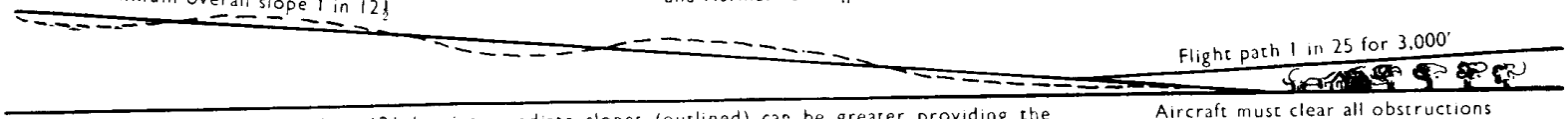
OFFICIAL SPECIFICATIONS FOR STRIPS—AERIAL AGRICULTURAL OPERATIONS

Plan View of Approved Strip of Minimum Dimensions



Note—The minimum length required will depend on the aircraft used, the loading required and various other factors. The aerial agricultural operator will advise you in this regard

Side Elevation of Strip with Maximum Slope and Normal Take-off Path



Maximum longitudinal slope 1 in 12½ but intermediate slopes (outlined) can be greater providing the aircraft can take off and land with safety. This determination must be made by the Company Chief Pilot after physical examination

Aircraft must clear all obstructions by 50 feet

APPENDIX IV

The Permissible Maximum Weights of Different Aircraft

Aircraft	Normal All-up-Weight (at Take-off)	Agricultural All-up-Weight (at Take-off)*	Useful Load available for Fuel, Oil and Payload
DH-82 (Tiger Moth) (Dusting)	1,825	2,000	601
DH-82 (Spraying) ..	1,825	1,825	405
DH Beaver	5,100	5,490	2,386
EP 9 Percival	3,550	3,820	1,427
FU24 Fletcher	3,500	3,910	1,622
Cessna 180	2,550	2,850	1,056
Auster J6G..	2,450	2,450	825
DH-83 (Fox Moth) ..	2,100	2,100	607
Bristol Freight	40,000	42,000	13,635

* The difference between this and the preceding column are the overload officially permissible for agricultural operations.

APPENDIX V

Accidents in Aerial Agricultural Operations

Year	Accidents per Thousand Stage Flights	Landing Accidents Per 1,000 Landings	Take-off Accidents Per 1,000 Take-offs
1953.. ..	·36	·11	·08
1954.. ..	·17	·04	·09
1955.. ..	·25	·05	·07
1956.. ..	·18	·04	·05

Total Fatal Accidents in Aerial Agriculture Operations

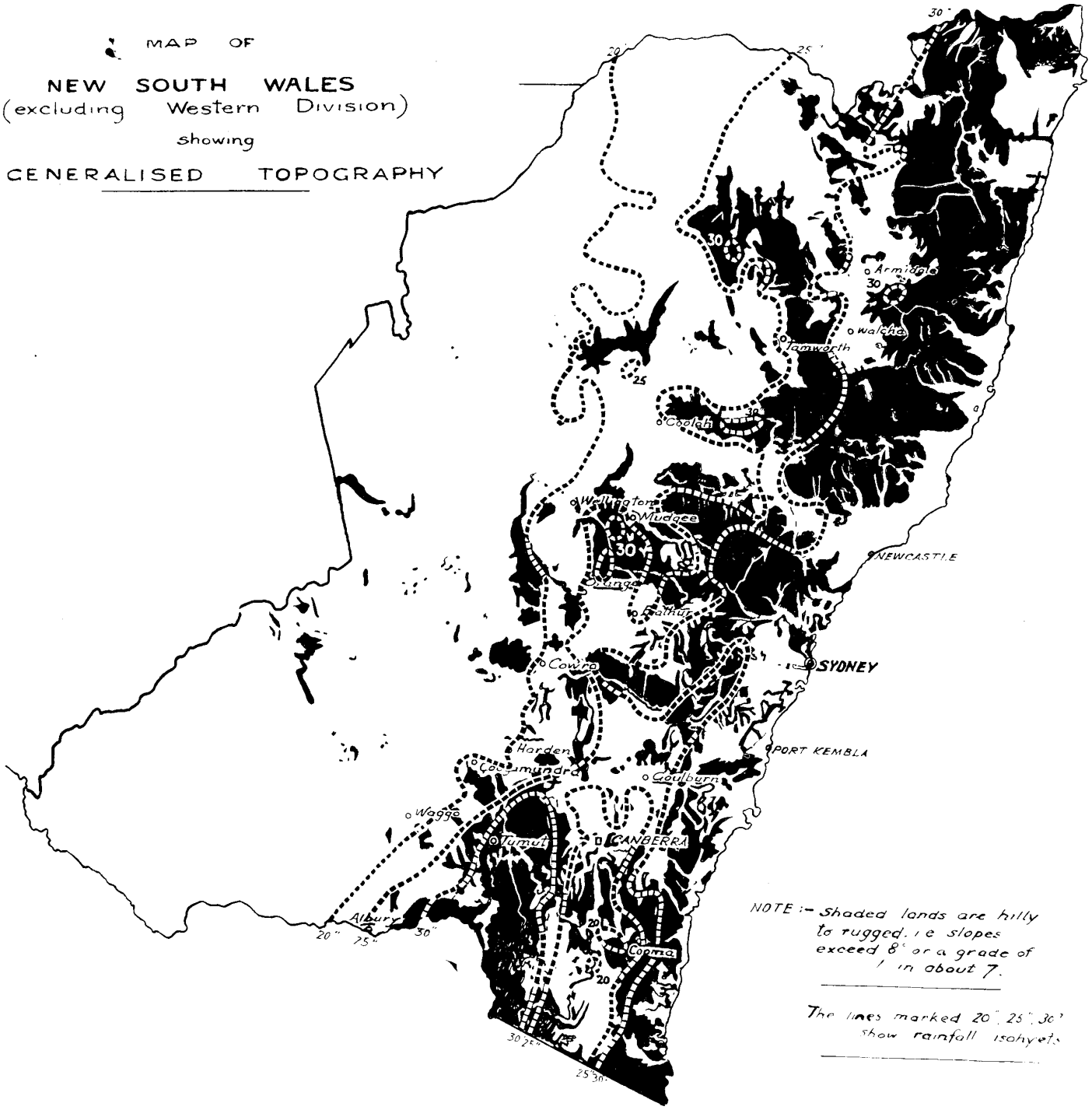
1953	1954	1955	1956	1957
..	1	2	1	1

MAP OF

NEW SOUTH WALES
(excluding Western Division)

showing

GENERALISED TOPOGRAPHY



NOTE :- Shaded lands are hilly to rugged. i e slopes exceed 8° or a grade of 1 in about 7.

The lines marked 20", 25", 30" show rainfall isohyets