

ECONOMIC ASPECTS OF STOCKING AND FEEDING POLICIES IN THE SHEEP INDUSTRY IN SOUTHERN AUSTRALIA

(Invited Paper)

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Summary

Numerous stocking rate trials suggest that the great majority of graziers on improved pastures are operating far below the "maximum profit" stocking rate. At "normal" stocking rates on improved pastures, the data suggests that the "elasticity of production" is 0.9 or higher, i.e. a 10% increase in sheep per acre will result in a 9% increase in wool per acre all other factors (fertiliser, supplementary feed) being held constant. On this basis, and using typical variable sheep costs and prices, it seems that most growers could earn returns on additional capital of 25% to 50% from a moderate increase in stocking rate. The market value of sheep is far less than the capitalised value of marginal product of extra sheep.

Even at stocking rates double or treble the normal the elasticity probably remains quite high (over 0.7) but on the other hand the cost per sheep of providing for adverse seasons rises quite steeply.

For a given climatic environment the most profitable size of drought reserve depends largely on (i) initial cost plus holding costs (pit silage from pasture seems to be the cheapest) and (ii) stocking rate. At low stocking rates on improved pasture (say 2 sheep per acre) the most profitable reserve might be, say, 1 bale of hay per sheep, assuming wheat is available for purchase in drought years. With a stocking rate of 6 sheep per acre, the maximum-profit reserve might be say 4 bales per sheep. Growers may prefer to go beyond this, to purchase additional "insurance".

The practice of regular seasonal feeding to raise stocking rate is probably quite profitable when the supplement is not an addition to an existing surplus (as it frequently is) and where it can be produced cheaply. On the latter point there are promising new techniques, e.g. fodder "rolls" left in the paddock for autumn-early winter feeding.

I. INTRODUCTION

It is now widely recognised that the great majority of graziers in the high-rainfall and wheat-sheep zones are operating well below the maximum-profit stocking rates for sheep. This is hardly surprising given the great changes in technology of recent decades-improved pastures, fertilisers, trace elements, improved fodder conservation techniques and animal health measures, rabbit control etc. In this new environment, the grazier is adjusting cautiously, not only because of ignorance of the new technical possibilities but also because of the risks of higher stocking (drought and disease), capital limitations, and the limits imposed by reproduction rates.

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How profitable is higher stocking? For a given pasture,[†] wool price and sheep cost, the main determinants are the relationships between stocking rate and (i) wool cut per head, (ii) reproduction rate, and (iii) drought losses. Of the three relationships, we are least ignorant about the first.

After collating the results of many stocking rate trials in southern Australia, Chisholm (1965) discovered a linear relationship between cut per head and stocking rate on improved pastures, such that each additional sheep per acre reduced wool cut by approximately 0.6 lb (0.27 kg) for a typical self-replacing merino flock (0.4, 0.5, 0.7 lb or 0.18, 0.23, 0.32 kg, for merino ewes, crossbred ewes and wethers respectively), with other inputs (e.g. fertiliser, supplementary feed) constant. Admittedly there are large standard errors about the regression, but it provides a valuable rule of thumb. The experimental sheep were generally run under close-to-commercial conditions, though Chisholm suggests that the farm relationship might be somewhat higher than 0.6 lb.

II. ELASTICITY OF PRODUCTION

Another way of looking at this relationship is in terms of the “elasticity” of wool production with respect to stocking rate (E_p), which is measured by

$$\frac{\% \text{ increase in wool per acre}}{\% \text{ increase in sheep per acre}}$$

Applying this concept to apparently diverse experimental results reveals an underlying pattern. The experimental data suggests that at district-average stocking rates, in near-average seasons, the experimental E_p is 0.9 or higher. At higher stocking rates, the experimental E_p is lower, e.g. at stocking rates double the district average (i.e. double the rate at which the average farmer would stock **the pasture used in the experiment**, the elasticity is generally around 0.8 or higher; at treble, perhaps 0.7).

Note that a grazier running large sheep on good pastures at a given “grazing pressure”^{*} may have the same E_p as one running small sheep on average pastures at the same grazing pressure, though their stocking rates and wool cut per head will be very different. I suspect that this elasticity concept would be found to be very useful in extracting generalisations from experimental data in many fields; yet this purely physical concept is used solely by economists, being apparently ignored by physical scientists.

III. PROBLEMS OF INFERENCE

Can we infer from experiment data to the farm situation in terms of elasticities, as implied above? Davidson and Martin’s (1965) study of the relationship between experimental and farm **yields** discusses some of the problems involved, but it must be remembered that their finding of average farm yields consistently lower than experimental yields need not imply lower farm elasticities for a particular level of inputs.

[†]To confine an over-large topic, pasture fertiliser rates and fodder crops have not been considered.

^{*}“Grazing pressure” refers to the ratio of animals to feed available. Chisholm (1965) uses wool cut per head as an indicator of grazing pressure, though it would seem that allowance should be made for other factors such as size of sheep.

The practice of massive fertiliser applications prior to an experiment may give tidier results, but it also compounds the problems of inference.

From the viewpoint of farm management extension, stocking rate experiments might serve two purposes:

- (i) to demonstrate to surrounding graziers that they are understocked;
- (ii) to provide the grazier with an estimate of *his* optimum stocking rate, under **his** conditions.

If (ii) cannot be achieved—i.e. if we can infer from the experimental results only to the odd grazier whose pastures etc. are identical with the experimental pastures—why do any more stocking rate experiments, except as simple farm type demonstrations? I suggest that we need some experimental “feasibility studies” regarding (ii) —e.g. by testing predictions made for farms on the basis of experimental results from local stocking rate trials. One method of inference which might be worth testing is set out below.

It seems likely that most farmers evaluate stocking rates by reference to the condition of their sheep: they select a grazing pressure which is “unlikely” to reduce their animals to lower than a minimum acceptable level of condition (e.g. “forward store”). Grazing pressure, and hence sheep condition, is probably closely related to E_p , and I suggest that all graziers stocking at the same grazing pressure will also be at the same E_p . As a working hypothesis, it seems plausible that if a grazier is stocking at a grazing pressure say 25-50% above the average (it is unlikely that it could be quantified very exactly), his E_p with respect to sheep numbers will approximate the elasticity on the experimental production function at a stocking rate 25-50% above that at which the average grazier would stock the experimental pasture.

As illustration, OABC (Figure 1) represents the experimental production function (average for a range of seasons) with A indicating the stocking rate which would be regarded as normal grazing pressure for the experimental pasture—say 2 sheep per acre. D represents the stocking rate and average wool production of a local farmer on poorer pasture and ODE his (unknown) production function. If the extension officer rates the farmer’s grazing pressure as 25%

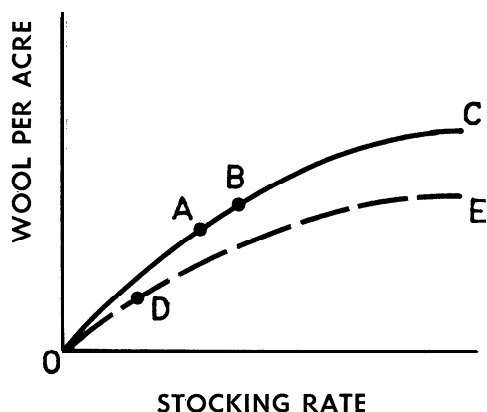


Fig. 1.—Hypothetical wool production functions (see text).

higher than the district norm (after considering wool cut, size of sheep, pastures etc.) then his likely E_p at D is given by point B on the experimental production function, corresponding to a stocking rate of 2.5. From this, estimates can be made of the profitability to the farmer of higher stocking at various levels, without regular feeding. Since stocking rate trials cannot be conducted on every farm, working hypotheses such as the above must be formulated and tested if problems of inference are to be tackled scientifically.

The effect of varying both feeding rate and stocking rate can be visualized in terms of a "production surface" which can be derived from experiments. The problem then becomes one of comparing the surfaces for different pastures and seeking generalisations.

IV. DIMINISHING RETURNS AND INCREASING COSTS

As stocking rate rises, the marginal product (extra wool per acre) falls, and marginal costs (extra costs per acre) rise, especially as a result of the increasing cost of drought protection. The fall in marginal product (M.P.) is illustrated in Table 1, which assumes a fall in wool cut (long-term average) of 0.7 lb (0.32 kg) for every extra sheep per acre, plus a fall in sheep sales per head (lower lambing % etc.) equivalent to 0.3 lb (0.14 kg) of wool over the mixed flock. (Strictly, optimum stocking rate must be calculated separately for ewes and wethers).

V.M.P. (column 7) must be compared with marginal cost (M.C.) to determine the maximum-profit stocking rate. For the many graziers who could add one sheep per acre without incurring additional overheads (permanent labour, fencing, water, etc.), M.C. is likely to be \$1.20 to \$1.80—say \$1.50 per acre* (much more when replacements must be purchased) plus "marginal drought costs".

TABLE 1

Hypothetical long-term averages for mixed Merino flock under drought feeding conditions

1	2	3	4	5	6	7
Sheep per Acre	Wool per Sheep lb (kg)	Sheep Sales per Head (Wool Equivalents) lb (kg)	Total Output per Head lb (kg)	Total Output per Acre lb (kg)	Marginal Product (M.P.) lb (kg)	Value of Marginal Product (Wool at \$0.50 per lb) \$
1	11.6 (5.3)	2.4 (1.1)	14 (6.4)	14 (6.4)	—	—
2	11.6 (5.3)	2.4 (1.1)	14 (6.4)	28 (12.8)	14 (6.4)	7.00
3	10.9 (5.0)	2.1 (1.0)	13 (6.0)	39 (18.0)	11 (5.2)	5.50
4	10.2 (4.6)	1.8 (0.8)	12 (5.4)	48 (21.6)	9 (3.6)	4.50
5	9.5 (4.3)	1.5 (0.7)	11 (5.0)	55 (25.0)	7 (3.4)	3.50
6	8.8 (4.0)	1.2 (0.5)	10 (4.5)	60 (27.0)	5 (2.0)	2.50
7	8.1 (3.6)	0.9 (0.4)	9 (4.0)	63 (28.0)	3 (1.0)	1.50

*Dipping, drenching, contract shearing and crutching, veterinary expenses, rams, interest on flock value, miscellaneous.

3Leaving aside drought, this suggests a maximum-profit stocking rate of approx. 6.5 **sheep per acre** in the situation depicted in Table 1. But four important qualifications attach to this rosy conclusion.

(i) As stocking rate rises, the size of the “minimum-cost fodder reserve” rises†. “Marginal drought costs” refer to the increase in the expected costs per acre associated with the larger fodder reserve needed to “insure” the higher stocking rate. These costs rise slowly, then rapidly, as stocking rate rises (Figure 2) : not only must more sheep per acre be fed, but the feeding period and perhaps the supplement per sheep also increases (Chisholm 1965).

As a hypothetical illustration of how “drought insurance premiums” might “explode” as stocking rate increases, if the minimum-cost reserve rises from 3 bale of hay per sheep at 3 sheep per acre, to 3 bales per sheep at 7 sheep per acre, the expected annual feed costs per acre might rise from \$0.60 to \$4.00 and the marginal drought costs for the seventh sheep per acre might be around \$2.00 per acre. Drought insurance might reduce the maximum-profit stocking rate to **around 5½ sheep per acre** in Table 1. As Chisholm (1965) says (p. 22) “hand-feeding costs cause the long-term optimum stocking rate to be lower than the optimum stocking rate for the average feed year”.

(ii) It is clearly unreasonable to assume that overheads per acre (especially permanent labour) will be constant over the range of stocking rates in Table 1. A grazier stocking at 6 per acre might have sufficient excess capacity to carry 7 per acre, so that only sheep variable costs would need to be considered; but if we assume 2,000 sheep per man, and a 1,000 acre property, the move from 2 to 6 sheep per acre would have added \$4,000 p.a. or more to permanent labour costs-i.e. \$1.00 per sheep. Thus we have a “long-run” M.C. of \$2.50 per sheep or more, rather than the \$1.50 used earlier. Additional fencing, fertiliser etc. would add to this long-run M.C., and further lower the estimated maximum profit stocking rate to **under 5 sheep per acre**.

(iii) A further downward adjustment to stocking rate is required when we consider risk. The curve showing the relationship between profit per acre and

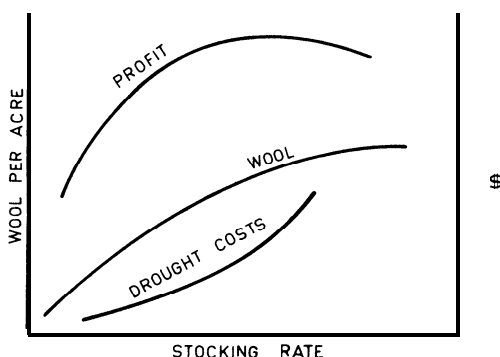


Fig. 2.-The effect of stocking rate on profit.

†The “minimum-cost reserve” minimizes expected costs, where expected costs are the sum of holding costs, replacement costs, and penalty costs, each weighted by probability. Penalty costs usually take the form of sheep dying or being sold cheaply, or high prices being paid for fodder purchased during drought.

stocking rate is of the shape shown in Figure 2, i.e. rather flat around the peak. This suggests that if x sheep per acre is the maximum-profit stocking rate, then $x-1$ sheep per acre is nearly as profitable, much less risky, and more likely to **be** preferred by the farmer. In terms of our example, the optimum stocking rate for a farmer moderately averse to risk might be 4 **sheep per acre**.

(iv) On the other hand we have not considered the possibilities of regular seasonal feeding as a means of slowing up the depression of wool cut and sheep sales per head as stocking rate rises. Experimenters have not tackled this problem methodically—it requires a range of combinations of stocking and feeding rates such as recently instituted by A. H. Bishop at Hamilton Research Station. Nevertheless there are some indications that the use of **cheap** supplementary feed in autumn-winter might raise the maximum-profit stocking rate considerably. And at high stocking rates, the more elaborate grazing systems (e.g. rotational grazing) may push the optimum stocking rate a little higher (C.S.I.R.O. 1965).

In summary, the optimum stocking rate at normal wool prices for the commercial farmer will be well below the stocking rate which maximises wool production per acre, below the maximum-profit rate for the average season, and probably well below the “crash-point” for the pasture-animal complex which is being studied by numerous researchers. It is easy to exaggerate the gap between the optimum and the actual.

V. MARGINAL RETURNS ON CAPITAL

On improved pastures, the returns to extra capital invested in higher stocking, **with no increase in other inputs** except fodder reserve, are almost certainly very **high**, at least for the many graziers who could carry more sheep without employing more permanent labour.

The extra net income and return on additional capital available to “conventional stockers” breeding their own replacements have been estimated on the following assumptions :

(i) Stocking rate (S) is increased 25 % from initial levels of 2 or 3 mixed sheep per acre.

(ii) Marginal costs (C) excluding drought are \$1.50 or \$3.00 per sheep per annum, the latter figure being relevant to the minority of graziers for whom a 25% increase in stocking would involve heavy additional overheads. such as permanent labour, fencing, water. * (These costs exclude interest, since we are estimating percentage return on capital.) In Cocks’ (1963) survey in the Western District of Victoria, marginal fixed asset expenditure for an additional 400 sheep per farm averaged only 46 cents per sheep, suggesting an annual depreciation and maintenance charge of less than 3 cents per extra sheep. There is considerable excess capacity on many farms, so that marginal costs are low for moderate increases in stock numbers.

*The figure of \$3.00 per sheep would also approximate marginal costs where no additional overheads were required but sheep replacements were purchased (involving sheep depreciation).

(iii) The E_p is either 0.9 or (to be pessimistic) 0.8.

(iv) The wool price (P) is \$0.50 per lb (1.10 per kg) net of marketing costs.

(v) Initial output per sheep (W), including the wool equivalent of sales of surplus sheep, is 10 lb or 11 lb (4.5 kg or 5.0 kg) per annum.

The estimates of Net Marginal Revenue (N.M.R.) from a 25% increase in stocking **rate** in Table 2 are derived from the revenue equation $N.M.R. = 0.25S(E_pWP - C)$.

For the favourable cost situation ($C = \$1.50$), Table 2 suggests marginal returns on capital (and on the extra work done by the grazier) of 3 1% to 43% pa. Even with a wool price of 40 cents per lb (88 cents per kg) returns would range from 21% to 3 1% p.a.

In the less favourable cost situation ($C = \$3.00$), returns are still good at 11% to 22%, but if the wool price fell to 40 cents per lb (88 cents per kg) net, the return from increased stocking would fall to around the overdraft rate.

Where replacements are purchased, sheep depreciation and losses (say \$1.20) must be included, and total marginal costs might exceed \$4.00 per sheep if extra permanent labour etc. were required. In this case, even with wool at 50 cents per lb (\$1.10 per kg), increased stocking would be unprofitable, despite the fact that it would greatly increase output per acre. I should stress again that we have been talking about increasing **only** stocking rate, with fertiliser, supplementary feed etc. held constant.

Experimental evidence suggests that the E_p for prime lamb output (weighted for quality) falls more rapidly than for wool as stocking rate increases. Nevertheless, at conventional stocking rates, E_p for wool plus lamb output is probably close to 0.9, and increased stocking is highly profitable.

TABLE 2

Net marginal revenue per acre from a 25% increase in stocking rate. (Wool price \$0.50 per lb net)

Weight of Wool		E_p	Marginal Costs (C) = \$1.50			Marginal Costs (C) = \$3.00		
			Stocking rate (S)	Stocking rate (S)	%*	Stocking rate (S)	Stocking rate (S)	%*
lb	(kg)		2	3		2	3	
			\$	\$		\$	\$	
11	(5.0)	0.9	1.72	2.59	43	0.97	1.46	22
		0.8	1.45	2.17	36	0.70	1.05	16
10	(4.5)	0.9	1.50	2.25	37	0.75	1.12	17
		0.8	1.25	1.87	31	0.50	0.75	11

*The % columns give percentage return on extra capital. Allowing for working capital and with sheep valued at \$7.00 on average over all ages, capital requirements per sheep are \$8.00 (for $C = \$1.50$) and \$9.00 (for $C = \$3.00$).

VI. THE VALUE OF A SHEEP

The market value of sheep is apparently much lower than productive value, as measured by the capitalised value of their net marginal product. In Table 2, ($C = \$1.50$) net marginal revenue per extra (mixed) sheep ranges from \$2.50 to \$3.44 per annum. Capitalising at 10% gives productive values of \$25 to \$34.40 per sheep. (This procedure implies that the additional income is "in perpetuity", which is consistent with the earlier assumption that the extra sheep include an ewe component sufficient for a self-replacing flock.) Ewes would have a very high valuation for an understocked property if all progeny were retained until the optimum stocking rate was reached, and the resultant increase in returns were capitalised.

Sheep prices will rise steeply as farmers become more aware of this situation. This price rise will induce an increase in sheep numbers in a number of ways; e.g. sheep, especially ewes, will be slaughtered later; culling rates will be reduced; intensive shepherding and feeding to raise lambing percentages and survival rates will become more profitable.

The question "How much can one afford to spend to raise lambing percentages $x\%$?" will be increasingly asked. Answers can be obtained from parametric budgets, obtained by applying prices and costs to a demographic model of the sheep flock. (In fact this approach can be used to evaluate changes in a number of the biological parameters on which animal research concentrates.) Byrne (1964) has constructed such a model for a "steady state" flock. Using realistic assumptions, and valuing cull ewe hoggets at \$5.50, the increased returns from increasing lambing percentages from 70% to 90% would justify spending 42 cents per ewe per annum (net of any increase in wool cut if special feeding were employed). But for a situation of understocking, where the aim of higher lambing percentages is to increase the flock, the break-even cost might approach \$2.00—i.e. it might be worth spending annually 10 cents per ewe per 1% increase in lambing percentage.

Most stocking rate experiments are with dry sheep. Work on effect of stocking rate on reproductive performance, and research on reproduction generally, rates a very high priority on economic grounds, since reproduction is one of the major limits to the adoption of higher stocking.

VII. DROUGHT POLICIES

A second major limit is drought and the fear of drought. The major strategies available to the grazier are:

(i) To sell sheep: this is likely to be very expensive for properties already understocked, though it may well be the most economic long-run policy in the semi-arid areas such as Queensland (see Dillon and Lloyd 1962).

(ii) To buy feed (or agistment) during drought, at high prices.

(iii) To hold a drought reserve.

In (under-stocked) improved pasture areas, a combination of (ii) and (iii) is prescribed. In the southern areas, the situation contrasts with Queensland in that grain is usually available at reasonable prices, and droughts are less "open-

ended". (In Victoria, the autumn "break" virtually always arrives, though occasionally not until spring.) When the reserve is exhausted, the odds dictate that grain be purchased and the sheep retained, excluding perhaps the old wethers. It cannot be assumed that the Dillon-Lloyd findings for Queensland (that the minimum-cost reserve is only a few months supply of feed in most cases) will also apply to well-stocked properties in southern areas.

Drought frequency and duration is a function of stocking rate. At low conventional rates the minimum-cost reserve will generally be small (two months supply or less) since infrequent droughts involve high between-drought holding costs, such that the cost of the fodder, when fed, exceeds the then ruling price per food unit; e.g. for baled hay in a shed, annual holding costs approximate \$2 per ton, so that hay valued at \$13 initially and held for ten years costs \$33 per ton, even at moderate interest rates.

Little empirical work has been done, but some unpublished case studies for Victorian farms suggest that the curve of expected costs rises slowly beyond its minimum, i.e. if the minimum-cost reserve for a given stocking rate etc. is x bales per sheep, a reserve of $x + 1$ bales is only slightly more costly. Thus extra "insurance" can be purchased at a low premium, except perhaps when the relevant "interest rate" (the opportunity cost of capital) is high. The Faculty of Agricultural Economics at the University of New England is now offering a service under which, for a small fee, the minimum-cost reserve for a particular property, and associated information, can be estimated by computer (Officer and Dillon 1965).

Table 3 suggests that pit silage from pasture is by far the cheapest long-term drought reserve, on a food unit basis. Admittedly, other factors need to be considered (e.g. protein, feeding out costs) but silage would seem to warrant more attention by researchers and farmers.

The already-mentioned disparity between the market value and productive value of sheep has implications for drought policy. It provides an economic argu-

TABLE 3

Comparative costs of long-term fodder reserves per 100 food units (\$)

	Pit Silage (Pasture)	Baled Pasture Hay	Grain in Silo
Initial Value	0.60*	1.23-1.78†	2.50-3.00‡
Annual Holding Cost\$.	0.08	0.24-0.27	0.28-0.30
10 year total (excl. feeding out)	1.40	3.63-4.78	5.30-6.00

*\$1.40 production cost (including labour) per ton of 230 Starch Equivalents. (Cost survey by J. B. Bardsley, Victorian Department of Agriculture.)

†\$9.00 (efficient production cost including labour) to \$13.00 (net market value) per ton of 730 Starch Equivalents.

‡Oats at \$0.60 per bushel; wheat at \$1.40 per bushel.

98% (interest plus insurance) on fodder value, plus 4% depreciation, plus maintenance, insurance and 7% interest (on average depreciated value) of storage structure, plus 2½ % p.a. wastage in storage for silage and hay.

ment for active government intervention towards drought mitigation. National losses result not only from actual drought, but also from potential drought: conventional stocking rates represent inefficient resources allocation, and fear of drought is partly responsible for under-stocking. The suggestion of a rationalisation of wheat storages, to integrate them with drought demands, is worth close study (Morley and Ward 1965).

VIII. REGULAR SEASONAL FEEDING

On the question of “*feeding for production*”, I have been unable to find any compelling evidence that hand-feeding sheep which are in better than “store” condition (an unavoidably vague term) gives profitable wool responses at normal wool and fodder prices. The subject of “special purpose feeding” (e.g. feeding ewe weaners, or ewes before mating or lambing) seems to defy generalisation.

Regular seasonal feeding of conserved fodder *to raise stocking rate* is probably quite profitable when the supplement is not an addition to an existing “surplus” (as it frequently is) and where it can be produced cheaply. The term “surplus” refers to both (a) the substitution of conserved feed for pasture which would otherwise be eaten (McClymont 1956) ; and (b) the condition of the sheep; if, in the absence of supplement, the increase in stocking rate would not reduce the sheep below store condition, the supplement would strictly be viewed as “feeding for production”. However the grazier frequently views it as “feeding to raise the stocking rate”, since the supplement is used to permit an increase in stocking rate without reducing sheep condition below *the minimum level he will accept*. With reasonable efficiency and wool at 50 cents net per lb (\$1.10 per kg), most programmes of joint increased-stocking-and-feeding will give returns on capital of around 15% to 20% p.a. (Lloyd 1959), but it is likely that most or all of the profit derives from the extra stock, with extra feed viewed by the grazier as a “technical complement”. The grazier apparently selects a “second-best optimum”, within the constraints imposed by his attitude towards his sheep. If we are prepared to dismiss such humanitarian constraints as technically inefficient and hence irrational (a dubious proposition!) we can say that most of the conserved fodder fed to sheep in non-drought years is “wasted”. But at high stocking rates, regular seasonal feeding has an important economic role, which can only be adequately defined by experimental designs which take account of production economics theory (Lloyd 1958).

The cost of regular seasonal feeding of conserved fodder will probably be reduced by advances in agricultural engineering. Large fodder “rolls” left in the paddock for autumn-winter feeding is one promising new technique, capable of producing hay at \$4 per ton (including labour and allowing for wastage).

It seems likely that the ratio of sheep prices to conserved fodder costs will rise, which theoretically suggests an increasing role for fodder conservation. Even at current prices and techniques, many farmers who own hay-making equipment can make large profits from expanding pasture hay production as a cash crop. Marginal costs are generally below \$6 per ton*, even if labour is included, and

*In situations where hay-cutting depresses subsequent autumn-winter growth, a heavy additional cost is involved.

market values are seldom below \$13 per ton net. In programming a fairly typical Western District property, Cocks (1963) found pasture hay as a cash crop took priority over increased stocking.

A "three-tier" system of fodder conservation may prove the minimum-cost method of supporting intensive grazing: fodder rolls for regular seasonal feeding, baled hay in a shed for minor droughts, and pit silage for major droughts, with contractors being used to avoid excessive machinery overheads.

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