Ley Farming

By R. ROE*

THE Old English word "ley" (spelled variously as "lay", "lea" or "lye") is listed in the Oxford Dictionary as meaning "fallow or unploughed land". In Middle English usage the word ley meant "land that has remained untilled for some time; arable land under grass; land laid down for pasture; grassland". The word ley, with these definitions, is designated in the dictionary as obsolete. However, the term is now in common use, being revived by the Stapledon school of British grassland workers (Stapledon and Davies, 1941). As used by this school it has a quite specific definition, being regarded as an area of grassland sown as part of a rotation. Two points about this definition are important. Firstly, the grassland or pasture is one phase of a land-use system involving arable cropping, and, secondly, as the system is a rotation, a relatively short period under grassland is implied. The tendency exists for the terms ley, pasture and grassland to be used synonymously, but this is incorrect by the definition of the modern authors of the term. Such usage misses the important point that the ley, in addition to being an important source of nutrients for livestock, is the fertility-building phase in a rotation involving arable cropping.

In Australia in recent years attention has been focussed by Cornish (1949) and others on the failure of cereal crops, notably wheat, to show any appreciable increase in yield, despite the availability of better varieties and the employment of better techniques. This has been attributed to a decline in soil fertility under the fallow-crop rotation that has been. almost universally practised. remedy suggested by Davies (1952) and others is to introduce a pasture phase into the rotation with cereals. The merit of this proposal has been amply demonstrated by Bath (1951) who recorded marked increases in the yield of wheat when it was grown in rotation with subterranean clover leys, and by Shier and Cullinane (1948) who recorded an improvement in quality as well as an increase in yield following two years of lupins in rotation with wheat. The greater use of short-term clover-rich pastures in rotation with cereal cropping is undoubtedly the most valuable use to which leys could be put in Australia at the present time.

In the more climatically favourable areas, however, such as the New England Region of New South Wales, it is suggested that the ultimate aim of the present livestock farmer should not be permanent or even relatively long-term pastures. There are advantages to be gained and the climatic potential of the region for production of nutrients for stock and human consumption would be more fully exploited (by including an arable phase in rotation with pastures of shorter duration, that is, the adoption of ley farming in the true sense.

Although the use of pastures, grazed **in situ,** is the cheapest form of fodder production for stock, and the actual production of nutrients is high, the practice results in a waste of nutrients. On the better class soils total production of dry matter from pastures sown with productive strains of forage species, and adequately fertilised, is high. Hilder (unpublished data) has recorded an annual dry matter production of approximately 10,000 lb. per acre. Using the feeding standards for sheep published by Woodman (1954) and basing the calculation on the dry matter requirement of a 100 lb. animal (this assumes that the quality of the diet, that is, Starch Equivalent and Protein Equivalent, would be adequate as it should be on a well managed pasture), this production would be adequate to support 8 sheep per acre throughout the year. This, in fact, is the rate of stocking which Hilder's pasture has maintained, but in general, on quite productive pastures, the annual rate of stocking is rarely as high as 4 sheep per acre. Sometimes cattle may be employed in an attempt to clean up surplus production and this reduces the wastage of nutrients. This less than optimum stocking rate is mainly due to uneven production by the pasture throughout the year. It is low in winter and the production in this season, as measured by Hilder, would support only one sheep per acre. The winter feed supply for stock can be improved by "autumn saving" and other management devices, or the provident farmer can conserve some of his surplus spring production as hay or silage. However, the fact remains that by grazing alone (which is the management practice generally followed in the New England Region) it is impracticable to utilise all the fodder that is available. When fodder is conserved, not only is there a considerable loss of nutrients, but the

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practice is expensive and, therefore, reduces one of the attractive features of "pasture feeding", namely its cheapness.

In a pasture, and particularly a clover-rich ley, there is a considerable production and accumulation of nitrogen. Measurements of the extent of this accumulation have not been made under local conditions but data from New Zealand (Walker et al., 1955) place the rate of nitrogen accumulation at 400-500 lb. per acre per annum. Melville and Sears (1952) report an annual yield of 600 lb. nitrogen per acre from very highly productive New Zealand pastures under heavy stocking. The nitrogen yield of Hilder's pasture, referred to above, would not be as great as this but a yield of 300 lb. per acre would be a conservative estimate. Potentially this is equivalent to an application of nitrogen at the rate of 12 cwt. sulphate of ammonia per acre.

It is suggested that this valuable source of nitrogen, plus that which has accumulated in the soil during previous years under pasture, should be exploited by way of an arable crop. Of course the complete nitrogen yield for the year (300 lb.) would not all be available for an arable crop. Bear (1953) asserts that 1.5 per cent. of the nitrogen in ploughed-in organic residues is required for micro-biological break down of these residues. This would mean that little or none of this nitrogen would be available for a crop during the season following the incorporation of the organic residues in the soil. In Hilder's pasture, with 10,000 lb. of dry matter production per acre for the year all virtually available for ploughing in, 150 lb. of nitrogen per acre would be immobilised. This would leave 150 lb. nitrogen per acre available for the crop. This is equivalent to 6 cwt. per acre of sulphate of ammonia and this calculation takes no account of the accumulated reserves of nitrogen in the soil which Walker et al. (1955) have shown may be considerable.

It is clear that very large amounts of nitrogen can be provided in the soil by ploughing in productive pasture. However, these high returns of nitrogen are only obtained while the pastures are productive and productivity generally declines with age. Davies and Williams (1948) have demonstrated that this is so (with the exception perhaps of a few isolated instances, such as some Leicester pastures classed as "super old pasture") in the favourable pasture environment of Great Britain. Pollitt (1947) has also demonstrated that the older the sward the less productive it becomes. In the New England Region of New South Wales some pastures have shown a marked decline in productivity after a number of years and these pastures can only be brought back to a productive state by ploughing or heavy fertilizing with, among other things, nitrogen (Barrow — unpublished data). Thus it would appear that to realise the full potential of a pasture as fodder for grazing stock, it should not remain down too long. In addition, to capitalise on its fertility-building capacity it should be ploughed before becoming "run-down", i.e., it should be used as a ley.

Examples of increases in yield of arable crops which have followed pasture, compared with the more common system where no pasture is included in the rotation may be quoted from experiments carried out by officers of the N.S.W. Department of Agriculture (Anon., 1948). In the "Red Clover in Maize and Oats Rotations" Experiment at the New England Experiment Farm several rotations have been compared over a period of 24 years.

One such comparison was as follows:—

Rotation 1. Maize-spring oats.
Rotation 2. Maize-spring oats-red clover.

The average yields of maize and oats over the full period were:—

	Maize	Oats
Rotation 1.	28.3 bush. per acre.	24.8 bush. per acre.
Rotation 2.	47.8 bush. per acre.	36.0 bush. per acre.

In another investigation carried out by officers of the N.S.W. Department of Agriculture the average yield of potatoes grown without pasture in the rotation was 2.25 tons per acre, whereas when the potato crop followed a temporary clover pasture the yield was 4.06 tons per acre. It is not suggested that these increases in yield can be ascribed solely to increased soil nitrogen following the ley, but nevertheless the increases were due to the leys whatever their mode of action.

In both cases the increases in crop yields following pastures were substantial. The absolute yields were not high, but in both experiments no fertilizer was used on the arable crops. In addition the leys were of extremely short duration (about 12 months) and consisted of a pure stand of clover. This may not be the best form of ley to build up soil fertility. Davies (1949) has stressed the value of the grass-legume combination in leys to increase soil fertility.

At the present time the proposal that in those areas where highly productive fertility building pastures can be grown there should be less permanent pasture and more arable cropping in rotation with leys may not be particularly attractive. Prices for stock products are reasonably good and labour requirements for raising livestock are at a minimum. In contrast the labour costs for cropping are high and the prices obtained often barely cover these costs at present levels of yield. However, the adoption of such a system need not lead to fewer stock numbers because the higher average carrying capacity of the more productive leys would result in the same number of stock being carried on a smaller area. In addition, high yielding, high quality arable crops could be grown for use either as human food or for intensive or supplementary feeding of livestock. Crops produced under these conditions would have higher average yields and be of better quality nutritionally because they would be supplied with more nearly optimum levels of soil nitrogen. At the present time this plant nutrient is very expensive although valuable supplies are often untouched in pastures which are permitted to remain down for too long a period.

It is suggested,' therefore, that farmers with access to good soils in the more favourable climatic regions of Australia, should not regard livestock farming as the ultimate in land-use. They should bear in mind that where changes in economic circumstances make the practice feasible, arable cropping in rotation with leys, that is, ley farming, is not only advantageous from their own point of view, but it is a national obligation as well.

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DISCUSSION

Mr. COTSELL: With respect to the data on pasture deterioration, are the findings by Davies and other workers in England based on soils already at high fertility level? If this is the case are those findings fully applicable to the raw infertile soils of New England which have not yet had their fertility built up?

ANS.: Yes, Davies' findings were based on high fertility soils. To be applicable in the New England, pastures would need to be down for some years to build up fertility.

Mr. BARROW: (1) In the discussion of the decline of pasture with age if management is efficient then a pasture should not decline. It is difficult to show that pasture decline is a true decline and not due to inefficient management. (2) With respect to the reference to "Pollitt" the rate of nitrogen application depended on the age of the pasture and hence any tendency to greater yield was accentuated.

ANS.: With regard to the first point, management of pastures is never perfect, so that pasture productivity will decline under most conditions of management.

Mr. ROBERTS: Could Mr. Roe be more specific? Would he suggest that wheat should be grown in rotation with leys in the New England district?

ANS.: Not necessarily wheat but I would like to see more wheat grown in the better rainfall areas and less in the marginal areas. I would also like to see more corn and protein rich cereals such as soybeans grown in the New England. United States workers by breeding new strains have extended soybean production into areas previously considered unsuitable for this crop.

Mr. MOLESWORTH: Would a chisel plough used on the keyline system to aerate the soil restore a permanent pasture which was running out?

ANS.: You could probably use this method to invigorate a declining pasture. The aeration would stimulate the release of nutrients. However, if the permanent pasture was so run down as not to contain species which would benefit from the increased fertility, the procedure would scarcely be worthwhile.