PASTURE MEASUREMENT TECHNIQUES AS APPLIED TO STRAIN TESTING

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It is now well recognised that within almost any species of pasture plants there are distinct varieties or strains which differ in certain characters such as colour, growth habit, herbage yield, disease resistance, flowering time, or persistency. Plant breeders produce bred strains that are superior in some particular characters to the strains already in existence. In pasture plants most of the plant breeding will be toward increasing the yield of herbage, so that a simple and reliable method of measuring production is essential for this work.

At any pasture research station many strain comparisons must be made and often different methods are employed for the various phases of the work. At the Grasslands Division the locally bred strains are continually being compared with commercial lines and with selected strains produced by overseas plant-breeding institutions. When a large number of seed lines are being plot tested for type, small plots of 0.0005 acre or rows 10 links long are used and a broad selection is made on general appearance. The next stage in the strain testing is the use of blocks of spaced single plants which are scored by visual means. Glenday has compared this "eye scoring" of single plants with actual weighing of the same plants, and has shown that both methods gave similar F ratios and coefficients of variation, and that the conclusions to be drawn were identical for both methods. After this the actual measurement of herbage from pasture swards is undertaken and bred strains compared with the most important strains previously used.

In the past the two main methods of measurement at this station have been the paddock system using movable enclosures to give herbage weights and

the small plot system where plots were mown and clippings discarded. Both these methods have been adequately described by Lynch (1947) and further compared by Sears (1951).

The first of these methods is recognised as a standard procedure in most countries. It is most useful on complex swards where perhaps no mowing technique can duplicate the effects of the grazing animal, and as no complicated apparatus is necessary, it can be used anywhere. Lynch (1951) has shown that the method of managing the measuring frames can greatly influence the yields recorded and he concludes that his "standard" technique may be the most satisfactory for the majority of trials. Cowlishaw (1951) found that measuring frames had a sheltering effect on pastures so that the yield measured inside the frame would be higher than the true paddock level. Where intermittent grazing is practised this sheltering effect can be overcome by moving the frame from the measurement position until the paddock is to be grazed. The one serious disadvantage of the paddock and frame technique for strain comparisons on a research station such as the Grasslands Division is the large area of land required. As long as one is comparing only 2 strains in paddocks of only 0.1 acre, then 5 replications can be arranged on 1 acre and on fairly uniform land results will be satisfactory. When 5 or 6 strains are to be compared the land requirement forbids the use of this paddock method and some small plot technique becomes essential.

The use of small plot trials has been standard practice at this station for some time. As a rule all herbage has been removed by mowing and the only return made has been a routine annual topdressing. These trials are simple to carry out and can be useful on a short-term basis at least. This method was used in the trial reported by Gorman (1951) where 4 strains of white clover were compared both with and without ryegrass and with 4 replications of each in a total area of 0.1 acre. Hudson (1933) found that this technique was not very satisfactory owing to weed invasion and pasture deterioration, and to overcome these difficulties he introduced his system of "alternate mowing and grazing." This method certainly helped maintain pasture yields much better than the original mowing method, but the period of open grazing of plots of different yield led to transference of fertility between plots (Sears 1951; Lynch 1947). To

overcome this defect, Lynch (1947) developed his mowing with return of clippings and Sears (1944) devised his mowing and grazing with proportionate return of dung and urine.

Lynch's method has much to commend it. It is simple and requires no special apparatus, but there are limitations to its extended use. The main drawbacks are due to the bulk of clippings being returned. Thus, plots must be cut when growth is short or there is too much material to return and smothering is induced. Also, unless conditions are especially favourable as regards ample moisture and an active worm population, the clippings will -not be readily decomposed and will cause trouble at subsequent cuttings. One extension of this technique that I would like to see carried out is to dry and grind the herbage removed and to return this to the plots in proportion to their individual yield. As there is seldom much variation in chemical analysis of herbage from different treatments, it would usually be satisfactory to bulk all herbage for drying and returning, but if there is any marked difference in composition, herbage from each treatment could be treated separately. This extension of Lynch's method has not been tried at Grasslands Division owing to the lack of drying equipment of suitable capacity.

Sears's method may be said to have advantages over many other methods in that it brings in the grazing animal and overcomes fertility transference, but certain disadvantages will probably preclude its general adoption. The technique is fundamentally satisfactory as long as the dung and urine collected are returned in proportion to the yields of individual plots instead of being returned equally to all replicates as in Sears's trials. One weakness in this method is the need to mow a strip from each plot for measurement before grazing takes place. Animals will often concentrate on this strip, overgrazing the new growth if the standing grass is not palatable or causing pugging if the ground is wet. Thus there are times when the mown strip can be picked out from the surrounding plot even after weeks of regrowth. Then, too, as the whole block of plots is open grazed, differences in palatability between strains may result in different intensities of grazing, the palatable strains being grazed more severely than the unpalatable and so being handicapped at subsequent measurements. However, the main drawback to this technique, and one

that is fundamental to the method, is the large labour demand to conduct a trial. It is found that an average sized experiment of 0.2 to 0.3 acre of plots is very nearly a full-time job for 2 men for a whole working week when the area is being grazed. After the actual mowing and weighing are completed, animals have to be fitted with collecting utensils which require emptying morning arid afternoon during the 3 or 4 days of grazing. Also during this time the return proportions have to be calculated, the dung dried and ground, and then when grazing is completed and the excreta returned all the apparatus has to be thoroughly washed for storage and any damage repaired. Thus the cost of carrying out such a trial is large, the drain on manpower resources is great, and the method can be used only at a centre having the necessary buildings and apparatus. Apart from all these economic factors it can be categorically stated that the job is not one relished by the staff concerned.

To overcome some of the disadvantages of these existing methods and to enable strain comparisons to be determined simply, it was decided to try a new technique. As strain trials can be carried out in pure sowings or simple mixtures, it was considered unnecessary to introduce any grazing effect an'd so mowing only was to be used. Small plots are suitable for this type of trial so that many strains could be tested with adequate replication. It was decided to return to the plots some form of nutrients that would not have the disadvantages involved in either the Lynch or Sears methods. A mixture of fertilisers was therefore planned for return to the plots after mowing. This mixture is the crux of the technique now being used.

EXPERIMENTAL METHOD

1. Calculation

The combination of fertilisers to be used was based on the analysis of pastures at Palmerston North as reported by Sears, Goodall, and Newbold (1948). These workers determined that an average pasture composed of 70 per cent ryegrass, 23 per cent white clover, 3 per cent red clover, 2 per cent other species, and yielding 14,000lb. of dry matter per annum contained the following amounts of the main plant nutrients :—N_2, 6301b.; CaO, 1541b.; P_2O_5, 154lb.; K_2O, 574lb.; and organic matter returned in dung, 2520lb. To obtain a mixture of fertilisers that would return

the main nutrients removed in the herbage, a calculation was made as shown in Table I.

TABLE I.

CALCULATION OF FERTILISERS TO RETURN NUTRIENTS REMOVED IN HERBAGE*
(weight lb. for pasture yielding 14,000lb. of D.M.)

		Organic Matter	P_2O_5	K_2O	N_2	CaO
Amount required	lb.	2520	154	574	630	154
Blood and bone	1000	700	113	—	72	155
Dried blood	2100	1820	—	—	200	—
Superphosphate	200	—	42	—	—	—
Muriate of potash	975	—	—	580	—	—
Sulphate of ammonia	1430	—	—	—	300	—
Limestone	2004	used to counteract acidity				
Total	7709	2520	155	580	632	155

*These figures are for the herbage and fertilisers analysed at Palmerston North.

A mixture of the amounts of the fertilisers detailed will replace the nutrients and organic matter removed in the pasture and will also guard against any major changes in soil acidity. All the materials used can be kept mixed without any spoilage or loss of nutrients due to interaction. As the weight of 77091b. of mixed fertiliser is equivalent to 14,000lb. of dry herbage, it follows that 250 grams of the fertiliser will be equivalent to 1lb. of herbage dry matter.

2. Experimental Procedure

During the past 4 years the strain trials at this station have been conducted using the new technique and one of these trials will be detailed to illustrate the method. This trial involved 6 strains of cocksfoot which were to be compared. A 'latin square" layout was used so that there were 6 replications of each of the 6 strains and these were sown in plots each 0.002 acre (6 links x 33.33 links). At the end of the plot layout two small paddocks were sown with one of the cocksfoot strains. These were grazed and growth measured by duplicate frames in each paddock. (All frames used by the author are 6 links x 16.66 links— approximately 4ft. x llft., as this gives an area for measurement of 0.001 acre). Owing to the position of these paddocks the yields could not be included in a statistical comparison with the plots, but they served as useful controls. Plots and paddocks were sown with

cocksfoot 251b. per acre, white' clover 3lb. per acre, and false Italian ryegrass 51b. per acre as cover.

For the measurement of herbage yield the plots and frames were mown with a 4ft. bar type power mower, and the green herbage weighed and then sampled for analysis of both dry matter and botanical composition. After the necessary calculations were completed the mixed fertiliser was returned to the plots-250 grams of fertiliser per lb. of dry herbage. When the plot yields were high and the fertiliser to be returned much over 2lb. per plot, the fertiliser was 'divided and half returned immediately after cutting and the other half held for 7 to 10 days. The amount of this mixture that can be applied to pasture without causing damage is fairly large, but if too much is added and weather is hot and dry, some injury may result, After the total fertiliser application was completed plots required no further care until there was sufficient growth to warrant a further measuring cut. As an example of the amount of this fertiliser mixture that can be applied safely, the highest-yielding strain in the cocksfoot trial has had a return of 61.25lb. per plot, equivalent to 30,625lb. per acre, over $3\frac{1}{2}$ years, At the end of that time the pasture in the plots was very similar to that of the same strain in the grazed paddocks.

TECHNIQUE COMPARISONS

A number of trials that have given considerable information on the suitability of the new technique for comparing pasture strains has been conducted. At both Palmerston North and Lincoln a trial has been carried out in which a number of perennial ryegrass strains were compared using Sears' technique in one block and the new technique in an adjacent block. Although such layouts did not allow accurate statistical comparisons of the results, it was found that each technique gave similar results as far as the order of superiority of the strains was concerned. The degree of similarity of the grass and clover yields when measured by the 2 methods in a trial at Palmerston North is shown in the graphs in Fig. 1.

Apart from these trials, there have been others at Palmerston North in which a number of variations in the fertiliser mixture has been compared with the original standard mixture, with dung and urine being returned to mown plots, and with grazed paddocks. having frame measurement. The results of these have

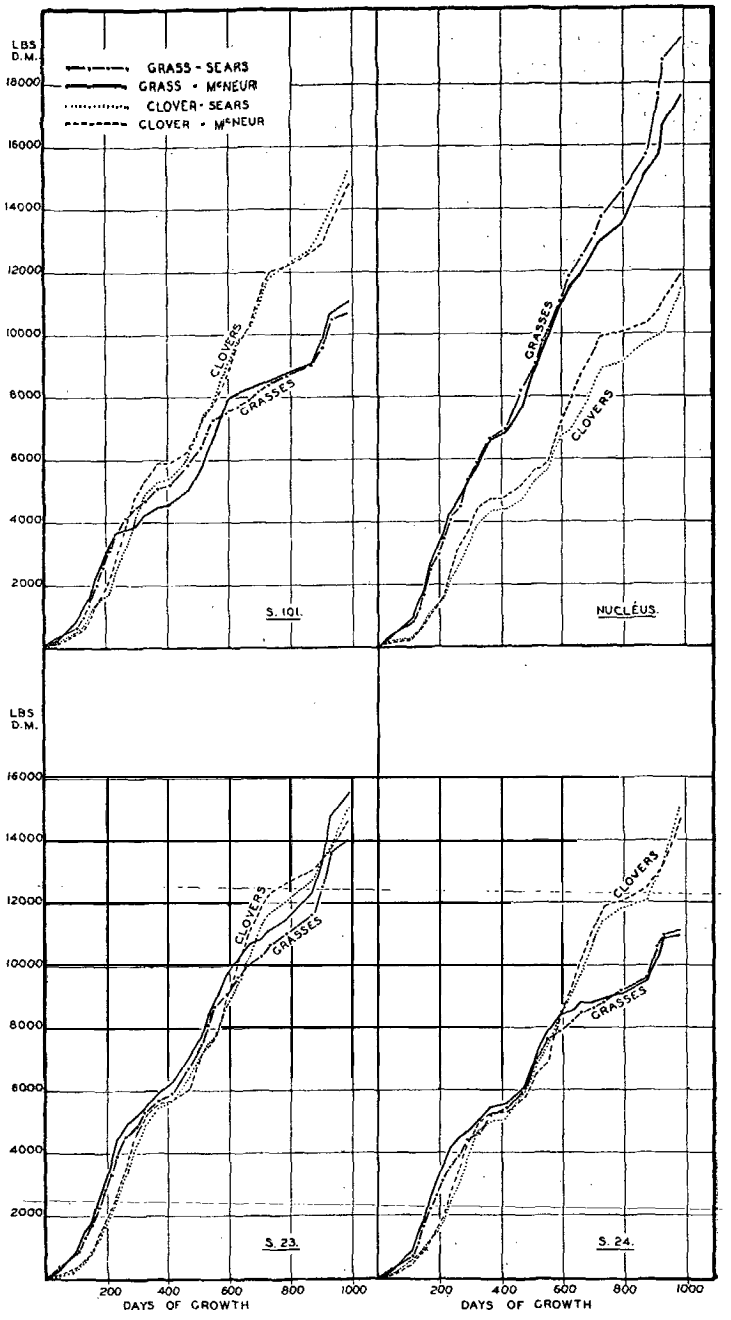

Fig. 1, showing the comparative yields of the grass and clover components in plots of perennial ryegrass when measured by the Sears v McNeur techniques.

all indicated that the original mixture is as satisfactory as any that has been tried and also that it is very similar to dung and urine as far as its effect on pasture yield is concerned. When the comparisons with clung and urine were made it was found necessary to decrease the rate of fertiliser return to 240 grams per lb. of herbage, probably on account of the loss of nitrogen from the urine between the time of its analysis and its utilisation by the plants.

It should be stated that although the fertiliser mixture was originally based on the analysis of average mixed herbage, its use need not be limited to such a sward. In our trials it has been used on many plots from pure ryegrass to pure red clover and the "standard" mixture seems quite suitable for returning to all these swards.

CONCLUSION

This new technique of pasture measurement has been used at the Grasslands Division for 4 years and has proved valuable as a method for comparing the herbage production of various strains of different pasture species. As small plots are used, a good number of strains can be adequately compared on a limited area of land.

This technique is most suitable for sorting out a number of strains or even species of pasture plants. After this has been carried out the 2 or 3 superior ones may well be compared in more complex pasture mixtures with the use of grazed paddocks with measurement by movable frames.

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DISCUSSION

Q. (Lynch): I suggest that the technique has application only to strains testing and is not safe enough to use in fertiliser trials. There would be many pitfalls if it were applied generally. We know that minor element deficiencies are fairlv widesnread. We know that different nasture species respond in different ways; red clover responds very well to molybdenum. I am not sure that we can disregard these minor elements in proportional returns. At Grasslands thev have had indications of sulnhur deficiencies. Can the technique be-used safely outside research stations ? Is the amount of phosphate returned adequate in view of the smell uptake ?

A. The method is able to be used anywhere. If phosphate were returned in relation to the yield it would still hold the same ratio. In one case we increased the phosphate by 100 per cent and the there was no difference in our area anvwav.

A. (Prof. Walker) : Some of Mr Lynch's objections are very good and real, but I am quite sure that the technique tried in various parts of the country plus perhaps a trace of molybdenum and any other minor elements not physically returned would be extremely valuable.

A. (Dr. Hamilton) : Results emphasise the extremely valuable part played by the animal; 33 tons of fertiliser per acre per annum equals full return of dung and urine. This underlines the story Levy and Sears have been trying to tell for years and that large and not fully realised part played by the animal in returning fertility.

Q. On Northland farms only very limited areas are available for cutting for hay and certain paddocks are cut far boo often. Could you recommend a suitable manurial programme for such paddocks?

A. It would be easy to make the mixture recommended, but nobody would be prepared to pay the £55 per acre it would entail.

A. (Dr. Melville): At the Grasslands Congress in 1962 we will still be talking of the relative value of techniques. Mr Lynch would be the first to agree that his methods are of approximation. We are establishing link by link a chain of precise measurements and are *moving* toward ideal methods, but there will never be a sinde one.