# THE SCOPE AND LIMITATIONS OF SOME TYPES OF GRASSLAND EXPERIMENTS.

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Before discussing the real subject matter cf this. paper I should like to draw'ycur attention to one essential difference b e'tween the majcri ty of our "annual" crcps and pastures and' the inf Luence cf this difference on the results cf experiments which may be conducted on them. Generally speaking,-the effect of any treatment applied tc an annual crop is determined by measurement of the crop at maturity and any beneficial or adverse effect of a treatment during the period of growth of the crop is likely to be reflected in the yield when the crop is harvested or fed tc stock as the case may be. The productien from pasture on the other hand is represented by a succession cf "crops" thrcughcut the year or over a period of years, the number of crops depending upon the method of utilisation adopted. The treatment of cne crop may have a profound influence cn succeeding cnes. Consequently any system of actual. measurement of the productive capacity of pastures as influenced by varicus treatments shculd be so designed as to permit the recording cf the productien from each crop in the succession. 'Even thcugh this is done the interpretation of the results is nct always easy because the value of each pasture crop will depend very materially on the extent tc which it is needed cr can be conserved at the time when it is available.



Further, in the case cf.-most experiments cn annual crcps there is nc great difficulty in measuring the whcle cf the ultimate effect of treatments in the mature crop but with pastures the matter is nct sc easy especially where stock are the instruments of measurement. Fluctuations in production of successive crops of a grazed pasture may be very considerable and in order to ensure

utilisation at an appropriate stage of grcwth considerable manipulation of stock is necessary. Obvicusly any experiment which. does not measure the whcle cf the prcduction resulting, from treatments under comparison i s subject tc errcr a s , althcugh "Nc differences" may be the recorded result,. quite ccnsiderable differences in the un'ccnsumed and unmeasured excess may be present,.

The question of grazing- trials was very ably discussed in a paper read by Flay* at the Last conference cf this asscciation. What is designated by Flay "The Half-field trial" has many sericus Limitations but for certain comparisons of treatments can be extremely useful. Where differences in the productive capacities cf treatments are likely to be Large in relation tc the errors asscciated with them, such trials may be sufficiently accurate to warrant their adoption in preference tc more elaborate trials and are quite well suited cn *a* standardised basis for the comparison of treatments in a number cf places cn farmer's cwn farms. This type cf experiment has been applied recently tc a determination cf the relative merits cf Certified Ryegrass and representative types of Ncn-certified Ryegrass in 6 places in Canterbury. During the first two years differences in carrying capacity in favcur of the pastures sown with Certified seed have ranged from 8 tc 93% with an average of 34%. Trials such as these meet with the requirements already stated of providing differences which are Large in relation to the errcrs asscciated with them. Cbvicusly the most desirable type cf grazing trial is one in which accurate measurements are cbtained of the prcduction in terms of marketable products, milk, meat and wccl. Contrary to the opinicns cf thcse who claim that such trials are easily. conducted, I am definitely of the cpinicn, after somewhat Limited experience, that such is ***not*** the case. Variaticns i n scil and stock intrcduce considerable errors and the vagaries of weather cnditicns resulting in fluctuaticns in prcducticq and recoveries cf grcwth in relaticn tc the time and severity of defoliaticn of the

* A. H. Flay, Canterbury Agricultural College, Lincoln. "The Half-Field Method cf Grass Manurial Trials."

pasture all contribute tc making such trials by nc means easy as a. means of acquiring exact 'infcrmaticn and valid results. The constant attentiocn which has to be'given to the movement cf stock and the recording cf relevant data limits such trials to specially supervised areas and this in turn limits their applicatiocn to the' solutiocn of' certain specific types cf problems. I shall discuss this point more f ully later.

"Haying" trials have been used extensively in the past fcr comparing different. grassland treatments. Most commonly these have entailed the cutting cf the herbage at a stage considered ideal fcr hay making and the weighing of it as cut. Results have been expressed in terms cf green herbage or its hay equivalent. Such experiments have been' comparatively easy tc carry cut, and although leaving much to be desired, have served a very useful purpose in New Zealand in indicating the effects cf applications of fertilizers to grassland. Although the results have been subject to errors due chiefly tc differences- in stages cf maturity of the herbage cn different treatments at the time of cutting, the differences in the majority of cases have been sufficiently large tc render such errors cf little consequence.

I consider the chief disadvantages cf haying trials to be as follows:-

(1) Generally only one crop of hay is measured each year. This represents the production from the period when, as a rule, the rate. cf grass grcwth is at its maximum and under average existing conditions extra growth, at this time,, is of less value then when natural production is lower.

(2) The measurement of production during the period cf rapid growth gives nc infcrmaticn regarding performance at other seasons of the year. A treatment such as a fertilizer, a seeds mixture or a strain of a pasture plant may show quite an appreciable difference from another treatment at cne season of the year but nc appreciable difference - or a difference in the opposite direction - at some other season.

(3) Haying of the same pasture each year for a number cf years .is not general practice and if carried cut-in an experiment, results may not be indicative of thcse cbtained under average ccnditicns where haying of permanent pastures alternatesmore cr less with grazing thrcughcut a complete year or more.

At the present stage of develcpment in grassland knowledge in New Zealand I can see nc particular value in haying trials for the cc'mparison cf treatments such as thcse already enumerated. In this ccnnecticn, however, I would make an exceptic n of crops cf pasture plants of very short duratic n which may be scwn specifically fcr the prcducticn of hay.

I think most cf ycu are familiar with the technique for the measurement of grassland prcducticn which has been applied and develcped during the last 5 years at the Marten Experimental Farm. I have described this technique in varicus publicatic ns * and refer tc it as the "Alternate mcwing and grazing technique."

Frcm pcint of view cf determining the yields frcm varicus fertilizer treatments, seeds mixtures and strains cf pasture plants, at all seasons of the year and under ccnditicns comparable with thcse cf rctatic nal grazing, I feel justified in saying that this technique is highly satisfactory fcr applicatic n tc a lot cf prcblems affecting cur medium or better class grasslands. It is nct perfect - nc technique yet devised is perfect - ncr dc I think it is applicable to the sclutic n of all cur grassland prcblems, but for providing infcrmatic n cn such matters as I will indicate, it' appeals to me as an accurate and comparatively cheap methcd. Like carefully conducted and more comprehensive grazing trials, it has the disadvantage, that it necessitates almost ccnstant supervisic n and ccnsequently must be confined tc special experimental areas..

* (1) Bulletin, No. 31 of the Department cf Scientific & Industrial Research (Pt. 1).

(2) New Zealand Journal of Agriculture, August, 1931.

(3) A more complete and up tc date desc'ript'icn cf the technique has been forwarded tc the Imperial Agricultural Bureau (Herbage Plants) and I anticipate that this will be published shcrtly.

In any field experiment under measurement it is usual fcr some definite impressicns to be gained from observation cf the growing crop and it is always a matter cf interest to find out hcw the impressicns measure up against actual results. At times wrong impressicns as to the directicn cf differences may result, particularly, in the case cf pasture, if a relatively tall and open sward is being compared with a shcrter and more dense cne, the influence of density on yield being very difficult tc gauge. However, as a rule, the eye of measurement proves a very gccd instrument/of the directicn of differences although an estimate cf their magnitude, even fcr an experienced observer whc has had. ccnsiderable cppcrtunity cf checking up observaticns with measured results, may be subject tc considerable error.

Providing preconceived ideas and bias resulting from a desire fcr a particular result dc nct influence judgment, "eye-measurement" can be a valuable aid to investigaticn and in fact plays a very important part in the general scheme of the grassland investigaticn work of the Department cf Agriculture.

What we may term simple "observaticnal trials" are laid down at hundreds of points thrcughcut the ccuntry with the cbject of determining whether cr nct the soil responds tc particular fertilizer. treatments tc an observable extent cr whether cne strain of grass cr. clover is supericr tc anctner under the existing conditicns.

Experiments cf this kind ask.such simple questicns as:-

(1) Dc any cf these treatments affect the grcwth cf pasture?

(2) Does this treatment combined with that have a be-tter effect than either alone?

(3) Dc stcck prefer tne herbage in this treatment tc the herbage in that9

(4) Does this strain persist longer than tnat? and so cn.

The answers provided are nct always easy tc interpret but in the majority cf cases they are fairly clear cut and may be represented by cne of the following:-

(1) None cf the treatments, has influenced prcducticn tc an observable extent.

(2). This treatment is apparently ineffective but when combined with that is markedly effective. etc.

Not infrequently a particular treatment may be only slightly though definitely effective and if it is a treatment not practised normally,, the question arises as tc whether its use is Likely to be paying. On the other hand the results are often sc cutstanding as tc -Leave nc room fcr dcubt regarding the eccncmic worth cf a particular treatment cr treatments. The fact that results may be indefinite in some cases does not condemn trials of this nature. Some infcrmaticn, providing it is not. grossly misleading, is better than nc infcrmaticn at all, and if we refrained from dcing experiments because they did nc.t conform to what we ocnsidered the ideal, I am afraid we should not progress very rapidly

I now propose to discuss some different problems and the relationship of technique tc them. Consider firstly the type cf experiment which aims at the determination cf the econcmio value cf a particular fertilizer or fertilizers. Naturally precauticns will be taken tc reduce those errors, which are incidental to all field experiments, to the minimum compatible with reasonableness. This may, and usually does, invclve the adoptien of precauticns which make the individual' experiment somewhat exacting sc far as finance and supervision are concerned. This in turn Limits the number cf places in which such an experiment *can* be repeated with the result that the conclusions which may be drawn are very limited in the application. It is practically impossible tc repeat exactly the results cf an -experiment. Even twc exactly similar experiments in the same field or on the same farm will give different results, not in the direction of real differences, but in their magnitude. Such differences may be negligible but on the other hand they may be considerable, sc that, strictly speaking, the results of any single field experiment designed tc investigate the eccncmic aspect of some particular treatment can be said to be true only for the particular, area on which the trial was conducted in the particular season cr seasons. Obvicusly it would be absurd tc insist that this, the most

strict limitation, should be put on the results of even a single experiment, but the example helps me to lead up to the point I wish to make..

The point is that the results, interpreted in their economic sense, of any single field experiment, no matter how carefully it is carried out, suffer from the risk. that they may not be sufficiently representative of the average even of the particular soil and climatic conditions represented by the site of the experiment.. I do not wish to convey the impression that I am averse to such investigations. On the contrary I believe them to be most desirable, but as plots within an experiment are replicated, so experiments themselves., of this kind, should be replicated. If this is impossible then the results of any single experiment or of a few experiments should be viewed merely as a guide to the probability of a particular treatment being paying or otherwise. In the absence of reliable information on the economic value of a practice, farmers must try it for themselves and draw their own conclusions. If a practice becomes well established - but these are doubts as to its value which would rarely be the case, farmers being sufficiently discriminating not to be led badly astray - the economic survey method would appear to be the ideal means of determining its economic worth. The determination of the economic value of, say, certain fertilizer treatments on annual crops, is comparatively easily achieved by experiments, because experiments on annual crops are easier to conduct and can be more widespread and the results easier of interpretation: but no crop is so variable as "grass" nor subjected to such varying degrees of efficiency in its management. I haveexpressed my views on this subject because of the insistent demand for information on the economic value of practices affecting grassland production without any real appreciation, on the part of those soliciting such information of what is involved.

While discussing problems in relation to technique, I should like to say a few words about what I shall term:-

A. "Particular experiments the findings from which are likely to be of more or less general application."

B. "Standard types cf experiments the results cf which are likely to be of more cr less particular application.11

Some examples of A wcuId be such experiments as:-

(L) A comparison of a system cf a set rate of stccking of pasture with a system of rctaticnal grazing.

(2) A comparison of strains of Ryegrass cr Clover.

(3) A comparisen of infrequent heavy applicaticns with frequent light applications cf a particular fertilizer, etc.

The findings frcm investigaticns such as these wcuId be applicable to practice within the scil and climatic range represented by the place of the experiment or - and certainly in the case of the first example quc ted - over a wider range cf conditions.

Such problems as these cculd Justifiably be investigated at a reasonably representative experimental area and the results applied tc localities under somewhat similar ccnditicns. T h e third example is rather different frcm the cthers (and this applies tc any investigatien invclving some principle in methcd and time of application of fer ti lizers), in that its prerequisite would be a scil markedly respcnsive to the treatment under trial. It wcuId be useless, fcr instance, investigating the effect of methcds or times cf application of Phcsphate on a soil which did nct respcnd fairly markedly to phcsphate applicaticns.

The technique of measurement adcpted in any investigatiens such as those qucted wcuId depend on the prcblem:

Number (1) is obvicusly a stock grazing experiment.

Number (2) ccuId be suitably investigated under the alternate mowing and grazing technique cr under stock grazing, depending upcn the infcrmatien desired.

Number (3) wcuId be ideally suited to the alternate mowing and grazing technique as differences in quality and its pcssible inf Luence cn stock wcuId most likely be cf little consequence and this technique would permit a greater degree cf precisicn in the measurement of results from half an acre than would be attained with from probably 15 to 20 acres in a stcck grazing trial.

Under the heading (B) I have in mind such experiments as might be laid down to determine the response to manures over a large area, such, for example, as New Zealand itself. We would not lay down an experiment using Lime, Phosphate and Potash at Lincoln College, and say that because certain results were obtained there, similar results would be obtained at Cheviot, but there is no reason why the same type of experiment should not be laid down in both places to determine the effects of the treatments mentioned. This in effect is what is being done as rapidly as facilities will permit throughout the more intensely settled districts of New Zealand. We are conducting a response-to-manure-survey with simple observational experiments..

I should certainly like to carry out simple grazing trials even though they were less freely distributed, but the expense and supervision entailed makes this impossible. Consequently we are doing what is considered the next best thing and I am convinced from experience that the adoption of this method of experiment has justified itself by the results and information obtained. I would go even further and say that it is a desirable forerunner of more comprehensive trials as it is possible to determine. very rapidly the major limiting factors to production so far as fertilizers are concerned, and indicate, the nature of the more comprehensive trials if such are possible in the future.

In conclusion I should like to refer to the not uncommon criticism that determination of yield in itself is not a satisfactory basis of measurement. This criticism, usually directed against fertilizer trials, generally arises out of the assertion that although a particular treatment may not increase the yield the improvement in "quality"is sufficient to justify its use. Of the common fertilizer materials, Lime, Phosphate and Potash, it is generally recognised that on soils deficient in any of these, the use of lime on a lime deficient soil will increase the Lime content of herbage; Phosphate on a phosphate deficient soil will increase the Phosphate, Lime and Protein contents, and Potash on potash

deficient soils,, will increase the Potash content and depress the Lime. My definition of a soil deficient in. any cr all of -the constituents mentioned is one on which pasture growth will be. increased by their application providing nc other factor is limiting such effect. If the particular constituent is not a limiting factor to production in the yield sense, I know of nc evidence which can justify i'ts use cn the score of' "quality" alone. Yie ld and improvement in quality may not be influenced in the same proportion when a deficiency is made up but I am firmly of the opinion that where a plant food is not SC deficient as to limit plant prcductien tc an appreciable extent that any loss in quality from the animal prcductien point cf view is nct a serious cne. I cons ider, therefore, that increases in yield which do nct take th.e quality factor intc consideration only err/cn the side of being conservative in the estimate cf their value. Nct a bad fault.