15 December 1944

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Dear Mrs Cashen,

Thanks for your letter and for letting me know what you have been doing.

One point about differences between response curves from different plots which have been exposed to the same series of weather sequences is that they are not independent but, on the contrary, very much more alike than if, for instance, the regression series for one plot had been derived from 40 years' experience, while that for another plot had been derived from a different forty years.   The ordinary tests of significance treat the regression coefficients as though the latter were the case.   Consequently, even large and consistent differences such as those shown by the Nitrogen sequence on Broadbalk are very liable to appear insignificant if tested in this way, i.e. as estimates based on independent samples.   I fancy that both the work of Mackenzie and Wishart on barley, and that of Kalamkar on the

root-crop from Barnfield were criticised rather unfairly in this way.

If I wanted to satisfy myself that two plots both shewing a clear maximum differed in the date of their maximum, I am inclined to think that I should take the difference of yields, $y_1 - y_2$, and test the significance of the linear coefficient, b_1, found on predicting this difference. This, of course, would be the difference between the b's for the separate curve, but the sampling error with which it would be compared would depend only on the variation of the yield-difference between plots, and not on their absolute variation from the curve for slow changes. For plots differing in average yield, one might try some variation like $y_1 - \lambda y_2$, where λ is a constant which might be determined, I should think, by making b = 0 (regression, on rainfall generally, zero) for the compounded yield. If in such a case b_1 were significant, it would, I think, unquestionably mean an earliness or lateness in the readiness of the crop to respond to rainfall.

As you know, in all the work leading up to your thesis I was rather afraid of pressing you to carry out an elaboration of tests which would be appropriate for very good data, but which might well be regarded as misplaced energy when applied to the records of the Park grass.   However, I expect in the case of any apparently large difference in date of maximum you would be able to satisfy yourself as to the statistical significance by some such method as that sketched above.

Yours sincerely,