The development of fodder farms - organised solely to produce fodder for sale, i.e., lucerne, is also suggested for some areas, notably the Waikato, and in irrigation areas in Canterbury.

MR. HAMILTON (in reply): There is no doubt that improved management with better utilization of feed produced was a major factor in the increase in production obtained in the period of 1930-34 when the area topdressed declined. At the same time, the area topdressed approximately doubled from 1934-41 but there is no corresponding increase in production. In regard to the suggestion that special fodder farms growing lucerne or other crops for hay might be an advantage, I feel that there is some confusion between production per farm and national production. The use of fodder grown on other areas would no doubt increase production on individual farms buying hay, but nationally production would not be assisted at all and might, in fact, be lessened.

"THE CRUDE FIBRE COMPLEX IN ANIMAL NUTRITION"

by

R. S. Lancaster.

The Henneberg system of feed evaluation with which everyone is familiar, and which has proved the basis of our rationing systems for a long period, has been subjected to considerable criticism in recent years. In this paper are discussed certain points of comparison between the Henneberg system and a modified system proposed by Maynard, involving the determination of lignin and cellulose in lieu of crude fibre. The material for the discussion was obtained in the course of an investigation of the Animal Research Division into animal diseases which appear to have some nutritional origin or association. It was considered necessary to carry the investigation into the composition of the feeding stuffs involved beyond the restricted limits of the Henneberg system, and to this end, the methods proposed by Maynard were adopted with slight modifications.

When this investigation was commenced, animal nutrition studies were being carried out by Canterbury Agricultural College, using the Henneberg system for the evaluation of feeds. The College collaborated with the Animal Research Division in the animal diseases investigation with the result that we now have a considerable quantity of data comparing the standard and modified methods of analysis and feed evaluation.

The chief criticism levelled at the crude fibre determination is the heterogeneity of the product. Unfortunately this important part of the crude fibre problem cannot be discussed tonight. Without going into any detail, I can say that our results amply confirm this criticism. It appears that crude fibre consists mainly of cellulose and lignin, two diametrically opposite entities from a nutritional point of view, lignin being relatively indigestible, cellulose being relatively digestible. It is difficult to justify the use of crude fibre in feed evaluation, on the grounds of its chemical composition, whilst there is reason to believe that more useful information would be gained by determining the more definite chemical entities, lignin and cellulose.

A point of considerable interest in feed studies is the relationship of chemical composition to digestibility. Although the literature on this question is conflicting there appears to be a fair body of opinion that lignin and

crude fibre exert a depressing influence on the digestibility of organic matter in feeds. Indeed, the correction factor applied for crude fibre in calculating starch equivalents is an attempt to express quantitatively the depressing effect of crude fibre on digestibility.

It has been possible to crystallize these general conceptions into more definite ideas by the calculation of correlation coefficients between cell-wall constituents and digestibilities. It is quite impossible to present the full data from which these calculations were made, in a short paper, so we must take them as read.

TABLE I.

Variables	Correlation Coefficients R.
Lignin and digestibility of organic matter ..	- .978
Lignin and digestibility of crude fibre ..	- .954
Lignin and digestibility of cellulose	- .919
Lignin and digestibility of pentosans	- .905
Crude fibre and digestibility of organic matter	- .944
Cellulose and digestibility of organic matter	- .808
Lignin and crude fibre of feed	+ .935
Lignin and cellulose of feed	+ .770

This table shows the correlation coefficient R. for certain variables. The variables are on the one side the percentage content of lignin, cellulose and crude fibre, and these are correlated with digestibility of organic matter and other constituents.

The lignin content of the feeds is seen to be strongly correlated negatively with the digestibility of the total organic matter and the digestibilities of the cell-wall constituents cellulose plus crude fibre. Lignin would thus appear to exert a strong depressing effect upon digestibility or organic matter as a whole and upon the more important cell-wall constituents. Calculation of the correlation coefficient between crude fibre content of the feeds and the digestibility of organic matter shows that here, too, a strong negative correlation exists. This result is somewhat surprising in view of what has been said above about the composition of the crude fibre fraction, and the fact that the fraction is itself not only highly digestible, but also exhibits a strong negative correlation between its digestibility and the lignin content. As will be seen from the table, the crude fibre and lignin contents are highly correlated positively and it is possible that the negative correlation between crude fibre and digestibility of organic matter exists by virtue of this fact. A similar situation exists in the case of cellulose which is negatively correlated with digestibility and positively with lignin. A test of the validity of the above explanation of a somewhat anomalous situation may be made by calculating the partial correlation coefficient between crude fibre and digestibility holding the lignin content constant, and between cellulose and digestibility on the same basis. The result gives r = -.403 + -.410 respectively. Though these fall just below the 5% level of significance which is 0.497 for 17-3 degrees of freedom, they are sufficiently high to indicate that irrespective of lignin variations, both crude fibre and cellulose exert an apparent residual depressing effect upon the digestibility of organic matter. Such a situation may be bound up in some way with the mechanical structure of the plant which is not measurable by these chemical means.

Whatever be the true influence upon digestibility of crude fibre, cellulose and lignin, the correlation between digestibility of organic matter and the lignin is sufficiently high to justify an attempt to calculate digestibility from lignin content with sufficient accuracy for many purposes.

TABLE II

DIGESTIBILITIES OF ORGANIC MATTER

FEEDS	OBSERVED	CALCULATED
Turnip	95.3	90.8
Rape	89.5	90.5
Kale	89.7	88.4
Sub-clover - Ryegrass I	84.8	83.4
Italian Ryegrass	83.1	82.8
Lupins	83.9	80.5
Light Land Pasture II	78.9	76.6
Light Land Pasture I	73.5	73.1
Sub-clover Ryegrass II	68.8	66.9
Sub-clover Hay	73.6	73.7
Lucerne Hay II	65.4	69.3
Oat Sheaf Chaff	59.8	65.7
Lucerne Hay I	59.1	63.7
Ryegrass Straw	60.2	59.2
Linseed Cavings	50.1	45.7

As has been pointed out in this paper, the many criticisms levelled at crude fibre and nitrogen free extract estimations would, on the score of failing to isolate fractions with definite chemical and nutritional properties, appear to be justified. At the same time, the above demonstration of the strong negative correlation between crude fibre and digestibility of organic matter not only justifies to a large extent the use of the crude fibre figure for correcting starch equivalent values for the indigestible portions of the food, but also probably explains much of the success attending this system.

TABLE III

Feeds	Crude Fibre Correction Factor	Lignin Content
Succulent:		
Turnip	20.1	1.1
Rape	2.8	1.2
Kale	3.3	1.9
Sub-clover - Ryegrass I	4.2	3.6
Italian Ryegrass	4.7	3.8
Lupins	4.2	4.6
Light Land Pasture I	–	–
Light Land Pasture II	6.6	7.1
Sub-clover Ryegrass II	–	–
Roughages:		
Sub-clover Hay	12.6	6.9
Lucerne Hay II	14.8	8.4
Oat Sheaf Chaff	7.4	9.6
Lucerne Hay I	19.0	10.3
Ryegrass Straw	19.8	11.8
Linseed Cavings	17.9	16.4

The crude fibre correction terms employed in the calculation of starch equivalent values of the feeds studied are shown in table 3, along with the lignin content of the feeds, both quantities being reduced to a dry matter basis. It will be observed that there appears to be a general relationship within the two groups of feeding stuffs. A correcter term derived from lignin rather than crude fibre and the consequent evaluation of a feeding stuff on a basis of protein ether extract plus lignin estimations rather than on the basis of present methods would appear to be a possibility, and a profitable line for future study.

DISCUSSION - See Dr. Barnicoat's paper, page 22.