Onderstepoort Journal of Veterinary Science and Animal Industry, Volume 15, Numbers 1 and 2, July and October, 1940.

Printed in the Union of South Africa by the Government Printer, Pretoria.

Supplementation of Winter Grazing in the Transvaal with Special Reference to the Maintenance Protein Requirement of Sheep.

By D. B. SMUTS and J. S. C. MARAIS, Section of Nutrition, Onderstepoort.

In a previous paper (1940) it was shown that an acute protein deficiency exists in the natural grazing of the Transvaal and that this deficiency, which was shown not to be due to a difference in food intake during the different seasons, prevails for almost six months of the year. On the basis of the above results, it was further demonstrated that the magnitude of the protein deficiency is such that it necessitates a daily catabolism of tissue protein in order to provide for the inevitable nitrogenous losses associated with the protoplasmic activities constituting life. It is, therefore, conceivable that this condition of tissue catabolism operating over a considerable portion of the year may indeed be the primary if not the exclusive cause of the highly emaciated condition of stock during winter. In fact, according to the existing laws of nutrition, it seems impossible for any animal to maintain its normal intensity of tissue metabolism under a continual strain of protein shortage. The natural response under such conditions will in all probability be a reduction in intensity and rate of metabolism in order to conserve as much of its own tissues as possible. Such a state of affairs ultimately leads to a reduced vitality and consequently an increased susceptibility to disease from which large numbers of animals may indirectly succumb annually.

From the above consideration of existing conditions, it is evident that sheep husbandry can never, under the prevailing nutritional conditions, be established on a sound and permanent basis. Fortunately the condition is not beyond repair, since the only requirement is a judicious and economical method of supplementary winter feeding. Such a method of supplementation is simplified by the fact, that our national animal feed, namely maize, can be or is cultivated on nearly every farm and should therefore be available to serve as an excellent basic feed for winter feeding. On the other hand it is appreciated that the practical applicability of supplementary winter feeding is largely a matter of economics. It is, therefore, essential that the purpose and requirements of winter supplementation should be clearly understood. Thus it will be absolutely fallacious to try and obtain any form of production, namely fattening, growth etc., during winter at the expense of supplementary feeding. Production should be attained exclusively during summer, when the natural food is plentiful and of a good nutritional value. Winter supplementation should have as its only object the prevention of tissue catabolism, i.e. the breakdown of tissue which has been synthesized during summer. For this reason it is of the utmost importance that only the minimum quantities of feed necessary to replenish the inevitable daily losses associated with the normal animal metabolism, should be fed. With this view in mind, the work to be reported on was conducted in order to obtain more information on the supplementary feeding value of some concentrates as well as the most efficient level at which they should be fed.

Experimental.

The original object was to conduct a series of supplementations on grazing cut during the months of April and July. Due to the fact that biological value determinations were also made on the same cuts there was not enough left to study the supplementary effect of a number of concentrates. Consequently only a few of the more practical feeding stuffs or combinations thereof were investigated. In order to augment this data a grass of more or less similar protein content as that of April was utilized for further supplementation studies. Five Merino wethers, previously used in the determination of the biological values of the grazing during the different seasons of the year, were utilized for these studies. They were therefore accustomed to the metabolism cages and this type of work. The grass, together with the supplementary feed were fed twice daily. Mineral supplementation was practised in all cases.

The metabolism cages were cleaned daily and the daily collection of faeces and urine aliquoted and stored over the 10 day collection period. At the end of the collection period the faeces were ground and representative samples taken for analysis. Representative samples of the composite 10 day urine and faecal aliquots were analyzed for total nitrogen. Prior to the collection period which lasted 10 days a preliminary period on the same ration and of the same duration was inserted.

Experimental Results.

The results obtained from the various supplementations are summarized in Table 1. It will be noted that in the first investigation, April grazing of 0·73 per cent. nitrogen, which was previously shown (Smuts and Marais, 1940) to be inadequate in respect of protein for the maintenance of mature sheep, was supplemented by 5 grams of urea. By the addition of the latter substance the nitrogen intake was increased from approximately 3·6 grams to 6 grams with the result that a complete positive nitrogen balance was created. The biological value probably on account of the higher level of nitrogen intake is now reduced to 75 in comparison with 82 for the grazing alone. Both the apparent and true digestibilities are increased, the former to a greater extent than the latter. From these results it is clear that sheep can utilize urea nitrogen to replenish the daily unavoidable nitrogenous losses associated with maintenance. This finding is in agreement with the hypothesis of Mitchell and Kendall, namely that the endogenous nitrogen is of a non-protein nitrogenous nature and can therefore be partially replaced by nitrogen of a non-protein nature. Thus it is not necessary in the utilization of such compounds as urea or ammonium salts by sheep for maintenance to assume that these compounds are necessarily transformed by micro-organisms into intact protein before it can actually be utilized by the system. In fact there exists ample evidence to support the view that no specific and selected combinations of amino acids are necessary for maintenance and that the endogenous nitrogen losses may, therefore, in all probability be directly satisfied by the simple nitrogenous compounds arising from the conversion of urea *in vivo*. When however the value of urea for growth purposes is to be assessed the position becomes quite different. To establish beyond doubt the growth-promoting value of urea, the basal ration should be complete but nitrogen free, so that the only source of nitrogen will be of urea origin. Otherwise the results will be ambiguous, since the effect observed may in reality be one of displacement rather than actual utilization, that is, the protein of the basal ration is simply displaced by urea for maintenance, and utilized for growth. The growth-promoting value of urea thus measured, is therefore not due to urea as such but to the protein contained in the basal ration. Hence any experiment, which neglects the above essentials, and claims that urea promotes growth, must be accepted with reserve, since the validity of the results is open to criticism.

In the second investigation July grazing containing 0·49 per cent. nitrogen was supplemented by 112 grams maize. As is clearly illustrated by the data, these sheep are in complete negative nitrogen balance. The utilization of the nitrogen contained in this supplementation is utilized extremely well as is indicated by the biological value of 85. The apparent digestibility is exceptionally low while the true digestibilty, which takes into account the metabolic faecal nitrogen is 91 per cent. From the difference in apparent and true digestibility it is clear that the faecal nitrogen contains a high proportion of metabolic faecal nitrogen which is of endogenous nature, that is, the portion associated with the weight of the animal rather than with the dry matter consumption (Schneider, 1935). Of practical interest is the fact, that 112 grams of maize fed in conjunction with July grazing is insufficient to replenish the daily unavoidable nitrogenous losses of mature sheep. When the same grazing is supplemented with 56 grams of peanutmeal, the total nitrogen intake is raised to approximately 65 grams daily. From the metabolism results it is evident that notwithstanding the increase in protein intake there is still a considerable negative nitrogen balance. In fact, it appears from the figures that the magnitude of this negative nitrogen balance is greater than in the case of maize. From this it would appear either that peanut protein is not as efficiently utilized as that of maize or that portion of the protein is catabolized for energy purposes. The effect of both these metabolic reactions will result in a decrease in the biological value. The average biological value of 47 obtained for the peanut supplementation in comparison with the average value of 75 obtained for the urea supplementation at approximately the same level of nitrogen intake, makes the second assumption of an energy deficiency the most probable. Under the conditions of the experiment sheep will naturally try to replenish both the unavoidable and inevitable nitrogen and energy losses associated with the minimum metabolism of the protoplasm from the experimental ration which is inadequate to meet these requirements. Consequently it is conceivable that under these circumstances only part of the requirments of each is met, causing a negative nitrogen balance to prevail. This argument is furthermore supported by the data obtained from the supplementation of 200 grams of straw with peanut meal in which the energy is supplied in the form of 200 grams of starch. In this case the total nitrogen intake arising mainly from the 32 grams of peanutmeal is only 3·38 grams. This nitrogen, now that the energy requirements are taken care of, is utilized with a 94 per cent efficiency against 47, when no starch is fed. This comparison again stresses the importance of eliminating all possible nutritional factors before the effect of one nutritional component can be systematically studied. Furthermore, it illustrates that the level of protein feeding under practical conditions is determined by the available energy.

In the fourth investigation grass of 0·81 per cent. nitrogen, equivalent in protein content to that of April grazing, was supplemented by only 60 grams of maize. The result, as will be seen from the figures, is that while the apparent digestibilty is as low as 35 per cent., the nitrogen of the supplement ration is utilized with a 100 per cent. efficiency. In this supplementation the grass contributed the major portion of the total nitrogen intake and is, therefore, in all probability the reason for the low apparent digestibility. If, however, wheat straw with a lower nitrogen content than July grazing is supplemented by 150 grams maize and 100 grams starch, the biological value is decreased to 98 per cent., the apparent digestibility increased to 42 per cent. and a positive nitrogen balance is obtained. The result in comparison with the peanut supplementation of wheat straw, indicates that maize can be better utilized in practice for supplementary feeding purposes.

When grass of the same nitrogen content as was fed to mature sheep is now supplemented by 81 grams maize in case of young sheep. the total nitrogen intake is much less, due to the smaller consumption of grass. The ratio of grass protein to maize protein is much narrower as in the previous supplementation with mature sheep. Consequently the average apparent digestibility of 43 is higher, due to the higher proportion of better digestible maize protein. The absorbed nitrogen of this supplementation is utilized with a 100 per cent. efficiency so that these sheep are in a positive nitrogen balance. If now, however, half of the maize is displaced by an equivalent amount of peanutmeal, so that the total nitrogen intake is almost double that of the previous period, the approximate digestibility increases to 63, while the positive nitrogen balance remains more or less of the same magnitude. With a further increase in nitrogen intake by the addition of 80 grams peanutmeal instead of 40, the apparent digestibility increased further to 72 and the biological value decreased to an average value of 49. From this data it is clear that the level of protein feeding exerts a marked effect on the efficiency of utilization. Hence from a practical point of view it is definitely uneconomical to feed in excess of the requirements of growing sheep since the extra growth obtained is not justified by the increase in feed expenditure. However, apart from the level of protein intake, it is quite possible that the constitution of the amino acid complex contained in the supplementation of grass, maize and peanut is not fully balanced in respect of the indispensable amino acids necessary for growth. That this is in reality the case is clearly demonstrated by a comparison of the biological values of the above supplements with that in the second last series of metabolism studies. In the latter case April grazing containing 0·77 per cent. N is supplemented by a mixture of maize and white fishmeal, so that the total nitrogen intake is approximately 18·5 grams. Hence the level of nitrogen intake is in excess of that of the peanut and maize supplementation. Nevertheless as will be seen from the data a biological value of 55 in comparison with 49 is obtained. This difference clearly illustrates that the amino acid composition in regard to the indispensable amino acids is superior for tissue synthesis in the first case. It is therefore clear that a maize and peanut supplementation of grazing is inferior to a maize and fishmeal supplementation. Interesting, however, are the data in the last investigation where less of the fishmeal protein and a larger proportion of the maize protein is included in the supplementation. Under these conditions even with a lower level of nitrogen intake the biological value drops from 55 to 48. A detailed study of the respective values indicates that the same if not a greater proportion of the absorbed nitrogen in the latter case has been catabolized. This in the face of the small positive nitrogen balance can only be explained by the fact, that a larger proportion of the available amino acids was catabolized probably on account of some indispensable amino acid deficiency.

It has already been established with rats that maize is deficient in lysine and trytophane. Consequently the larger proportion of the inferior maize protein included in the second mixture may in all probability be the cause of the lower biological value and the poorer utilization of the mixed protein supplementation for synthetic purposes. However, for maintenance purposes maize is an excellent supplement, as is seen from the data in which 200 grams of wheat straw is supplemented by 150 grams of maize. The total nitrogen intake of 3·38 grams daily is utilized with a 98 per cent. efficiency so that sheep on this level of maize feeding, if the energy intake is sufficient, will be kept in positive nitrogen balance.

Discussion.

A detailed survey of the entire data on the different supplementatious as reported in this paper brings to light certain points of great interest in the practical application of winter supplementation. From this data it appears fairly definite that there also exists an energy deficiency in the protein deficient grazing. Hence July grazing supplemented by 56 grams peanutmeal shows a poorer biological value than the same grazing supplemented by 112 grams maize, which contains a greater supply of available energy. When however, peanutmeal, together with wheat straw is provided with additional energy in the form of 200 grams starch the biological value is almost of the same magnitude as that of maize at the same level of nitrogen intake. It is, therefore, clear that under practical conditions it will be futile to rectify the existing protein deficiency with a minimum quantity of protein unless the energy requirements are satisfied. For this reason maize, as is shown in the July grazing supplementation with 112 grams of maize, fulfils a dual purpose namely in providing at the same time both these deficient elements. Consequently maize must be looked upon as an ideal supplementary concentrate during the winter period.

Another fact of importance is that urea which is a non-protein nitrogenous compound can be utilized to supply the maintenance of nitrogen requirement of sheep. As has been shown in this investigation a positive nitrogen balance can be obtained when grazing of approximately 0·73 per cent. nitrogen is supplemented by 5 grams of urea. If therefore a cheap form of carbohydrates like molasses or starch can be economically procured, the maintenance requirement of energy and nitrogen can be satisfied by a suitable mixture of these materials with urea. Under our conditions there is, however, little chance of obtaining such cheap forms of carbohydrate. For this reason maize is indicated as the cheapest and most economical form of winter supplementation. From the data on the supplementation with growing sheep it appears as if maize is not fully balanced in respect to the indispensable amino acids and hence unable to promote tissue synthesis efficiently. It was however clearly indicated in the introductory remarks that the aim of winter supplementation should not be directed towards obtaining growth but merely as a precautionary measure in prohibiting catabolism of tissues synthesized during the summer. Consequently maize may also be successfully utilized with young stock in maintaining the integrity of their tissues.

Summary and Conclusions.

By means of metabolism experiments on mature and young sheep it was shown that approximately 81 grams of maize will supplement April grazing successfully in respect of protein if the energy requirements are satisfied. Due to the fact, that 150 grams maize efficiently supplement 200 grams of wheat straw with a lower nitrogen content than July grazing, it can be implied that it will also supplement July grazing successfully. Urea nitrogen has been shown to be utilized by sheep for maintenance purposes but must not be expected to promote growth unless experiments conducted under controlled conditions prove the contrary.

REFERENCES.

MITCHELL, H. H., NEVENS, W. B., AND KENDALL, F. E. (1922). The relation between the endogenous catabolism and the non-protein constituents of the tissues. *J.B.C.*, Vol. 52, No. 2, p. 417.

SMUTS, D. B., AND MARAIS, J. S. C. (1940). The utilization by sheep of the proteins contained in the natural grazing during the different seasons of the year. *Onderstepoort J. Vet. Sci. and An. Ind.* (in Press).

SMUTS, D. B., AND MARAIS, J. S. C. (1939). The amino acid deficiencies of certain plant proteins. *Onderstepoort J. Vet. Sci. and An. Ind.* (in Press).

SCHNEIDER, B. (1935). The subdivision of the metabolic nitrogen in the faeces of the rat, swine and man. *J.B.C.*, Vol. 109, No. 1.

TABLE 1.

Supplementation of Grazing with Concentrates.

Animal No.	Average Wgt.	Food Intake.				Dry Matter Intake.	Nitrogen Intake.	Nitrogen in Faeces.	Metabolic Faecal Nitrogen.	Absorbed Nitrogen.	Nitrogen in Urine.	Endogenous Nitrogen.	Food Nitrogen Retained.	Biological Value.	Nitrogen Balance.	Apparent Digestibility.	True Digestibility.
		Grazing.	Maize.	Peanut Meal.	Urea.												
April Grazing (0·73 per cent. N) + 5 grams Urea.																	
	Kgm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.				
38248	42	500	—	—	5	455	5·99	2·94	2·59	5·64	2·57	1·18	4·25	75	0·48	51	94
49612	45	575	—	—	5	523	6·53	3·16	3·40	6·53	3·18	1·48	4·83	77	0·19	52	100
38252	40	476	—	—	5	433	5·81	3·02	1·95	4·74	2·57	1·07	3·24	68	0·22	48	82
38240	40	600	—	—	5	546	6·72	3·37	3·11	6·46	2·67	1·60	5·39	84	0·68	50	96
38249	39	325	—	—	5	296	4·75	2·12	1·95	4·58	2·22	1·09	3·45	75	0·41	55	97
												Average.......		75	—	51	94
July Grazing (0·49 per cent. N) + 112 grams Maize.																	
100	48	413	112	—	—	483	3·85	2·74	2·66	3·77	1·61	1·01	3·17	84	−0·50	29	98
101	43	150	112	—	—	241	2·57	1·72	1·21	2·06	1·44	1·03	1·65	80	−0·59	33	80
102	43	331	112	—	—	408	3·45	2·39	2·12	3·18	1·33	1·01	2·86	90	−0·27	31	92
103	45	306	112	—	—	385	3·33	2·28	2·31	3·33	1·61	1·21	2·93	88	−0·56	32	100
104	46	231	112	—	—	316	2·96	2·04	1·58	2·50	1·64	1·21	2·07	83	−0·72	31	84
												Average.......		85	—	31	91
July Grazing (0·49 per cent. N) + 56 grams Peanut Meal.																	
105	44	438	—	56	—	455	6·85	3·21	2·59	6·23	4·44	1·32	3·11	50	−0·80	53	91
106	44	385	—	56	—	406	6·59	3·14	2·64	6·09	4·56	1·45	2·98	49	−1·11	52	92
107	36	370	—	56	—	392	6·50	3·43	2·58	5·65	3·98	0·94	2·61	46	−0·91	47	87
108	40	438	—	56	—	455	6·85	3·36	2·59	6·08	4·65	1·44	2·87	47	−1·26	51	89
109	40	244	—	56	—	276	5·89	2·82	1·24	4·31	3·89	1·52	1·94	45	−0·82	52	73
												Average.......		47	—	51	96

TABLE 1—(*continued*).

Grass (0·81 *per cent. N*) + 60 *grams Maize.*

Animal No.	Average Wgt.	Food Intake.				Dry Matter Intake.	Nitrogen Intake.	Nitrogen in Faeces,	Metabolic Faecal Nitrogen.	Absorbed Nitrogen.	Nitrogen in Urine.	Endogenous Nitrogen.	Food Nitrogen Retained.	Biological Value.	Nitrogen Balance.	Apparent Digestibility.	True Digestibility.
		Grazing.	Maize.	Peanut Meal.	Urea.												
	Kgm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.				
21	38	540	60	—	—	559	5·34	3·31	2·63	4·66	1·48	1·67	4·66	100	0·55	38	87
22	48	520	60	—	—	540	5·20	3·26	2·75	4·69	1·55	1·77	4·69	100	0·39	37	90
23	37	520	60	—	—	540	5·20	3·65	2·48	4·03	1·49	1·59	4·03	100	0·06	30	78
												Average.......		100	—	35	84

Grass (0·81 *per cent. N*) + 81 *grams Maize.*

Animal No.	Average Wgt.	Grazing.	Maize.	Peanut Meal.	Urea.	Dry Matter Intake.	Nitrogen Intake.	Nitrogen in Faeces,	Metabolic Faecal Nitrogen.	Absorbed Nitrogen.	Nitrogen in Urine.	Endogenous Nitrogen.	Food Nitrogen Retained.	Biological Value.	Nitrogen Balance.	Apparent Digestibility.	True Digestibility.
30	20	251	81	—	—	308	3·36	1·88	1·79	3·27	0·71	1·00	3·27	100	0·77	44	97
31	20	318	81	—	—	370	3·91	2·33	2·15	3·73	0·647	1·00	3·73	100	0·93	40	95
32	20	316	81	—	—	368	3·89	1·92	2·13	3·89	0·779	1·00	3·89	1000	1·19	51	100
33	16	300	81	—	—	353	3·76	2·41	2·05	3·40	0·603	0·80	3·40	100	0·75	36	90
												Average.......		100	—	43	96

TABLE 1—(*continued*).

Animal No.	Average Wgt.	Food Intake. Wheat Straw.	Food Intake. Maize.	Food Intake. Starch.	Dry Matter Intake.	Nitrogen Intake.	Nitrogen in Faeces	Metabolic Faecal Nitrogen.	Absorbed Nitrogen.	Nitrogen in Urine.	Endogenous Nitrogen.	Food Nitrogen Retained.	Biological Value.	Nitrogen Balance.	Apparent Digestibility.	True Digestibility.
	Kgm.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.				
50	46	200	150	100	411	3·38	2·07	2·34	3·38	1·18	1·01	3·21	95	0·13	39	100
60	49	200	150	100	411	3·38	2·00	2·46	3·38	1·06	1·27	3·38	100	0·32	42	100
70	42	200	150	100	411	3·38	1·78	1·85	3·38	1·43	1·36	3·31	98	0·17	47	100
80	43	200	150	100	411	3·38	2·12	2·34	3·38	1·20	1·26	3·38	100	0·06	37	100
90	43	200	150	100	411	3·38	1·94	2·47	3·38	1·30	1·12	3·20	95	0·14	43	100
											Average.......		98	—	42	100
Peanut.																
51	51	200	Peanut. 32	200	410	3·54	2·55	2·25	3·24	1·37	1·07	2·94	91	—0·38	28	92
52	46	200	32	200	410	3·54	2·42	2·05	3·17	1·14	1·10	3·13	99	—0·02	32	90
53	46	200	32	200	410	3·54	2·51	2·13	3·16	1·49	1·15	2·82	89	—0·46	29	89
54	50	200	32	200	410	3·54	2·59	2·46	3·41	1·38	1·35	3·38	99	0·43	27	96
55	48	200	32	200	410	3·54	2·46	2·05	3·13	1·42	1·06	2·77	94	0·34	31	90
											Average.......		94	—	29	97

TABLE 1—(*continued*).

Animal No.	Average Wgt.	Food Intake. Grazing.	Food Intake. Maize.	Food Intake. Peanut Meal.	Dry Matter Intake.	Nitrogen Intake.	Nitrogen in Faeces.	Metabolic Faecal Nitrogen.	Absorbed Nitrogen.	Nitrogen in Urine.	Endogenous Nitrogen.	Food Nitrogen Retained.	Biological Value.	Nitrogen Balance.	Apparent Digestibility.	True Digestibility.
								Grass 0·81 per cent. N + 40 grams Maize + 40 grams Peanut Meal.								
	Kgm.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.				
35	25	350	40	40	400	6·84	2·39	2·32	6·77	4·30	1·30	3·77	56	0·15	65	99
36	21	350	40	40	400	6·84	2·36	2·24	6·72	3·76	1·18	4·14	62	0·72	66	98
37	21	350	40	40	400	6·84	2·71	2·48	6·61	3·72	1·13	4·02	61	0·41	60	97
38	21	350	40	40	400	6·84	2·69	2·40	6·55	3·30	1·18	4·43	67	0·85	61	97
39	22	350	40	40	400	6·84	2·51	2·32	6·65	3·80	1·29	4·14	62	0·53	63	97
											Average.......		62	—	63	98
								Grass (0·81 per cent. N) + 40 grams Maize + 80 grams Peanut.								
40	22	350	40	80	447	10·19	2·52	2·50	10·17	5·87	0·92	5·22	51	1·80	75	100
41	25	350	40	80	447	10·19	3·06	2·77	9·90	6·33	1·13	4·70	47	0·80	70	97
42	25	350	40	80	447	10·19	3·05	2·68	9·82	5·88	1·15	5·09	52	1·26	70	96
43	26	350	40	80	447	10·19	3·05	2·68	9·82	6·79	1·35	4·38	45	0·35	72	98
44	21	350	40	80	447	10·19	2·75	2·58	10·02	5·90	1·09	5·21	52	1·54	73	99
											Average.......		49	—	72	96
								April Grazing (0·77 per cent. N) + 200 grams Mixture 2.								
			Mixture 2.													
16	33	500	200	—	—	18·51	3·34	3·27	18·44	9·22	1·65	10·87	59	5·95	82	99
17	30	500	200	—	—	18·51	3·79	3·27	17·99	9·22	1·50	10·27	57	5·50	80	97
18	29	500	200	—	—	18·51	4·10	3·27	17·68	9·76	1·45	9·37	53	4·65	78	96
19	30	500	200	—	—	18·51	3·50	3·27	18·28	9·28	1·50	10·50	52	5·73	81	99
20	32	395	200	—	—	17·64	3·57	2·77	16·84	8·94	1·60	9·50	56	5·13	84	95
											Average.......		55	—	87	97
								April Grazing (0·77 per cent. N) + 200 grams Mixture 1.								
			Mixture 1.													
22	27	500	200	—	—	16·67	3·96	3·27	15·98	8·99	1·35	8·34	46	3·72	76	96
23	27	500	200	—	—	16·67	3·98	3·27	15·96	10·34	1·35	6·97	44	2·35	76	96
24	27	500	200	—	—	16·67	3·77	3·27	16·77	8·10	1·35	9·42	58	4·80	77	97
25	27	500	200	—	—	16·67	3·90	3·27	16·04	9·67	1·25	7·62	48	3·10	77	96
26	30	500	200	—	—	16·67	4·35	3·27	15·59	10·56	1·50	6·53	42	1·76	74	94
											Average.......		48	—	76	96

MIXTURE (1)—
Maizemeal.................................. 330
White fishmeal.............................. 150

MIXTURE (2)—
Maizemeal.................................. 280
White fishmeal.............................. 200