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PROJECT REPORT No. 85

EVALUATION OF NUTRITIONAL CHARACTERISTICS OF TRITICALE VARIETIES

NOVEMBER 1993

PRICE £3.00

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EVALUATION OF NUTRITIONAL CHARACTERISTICS OF TRITICALE VARIETIES

by

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Final report of a one month project submitted by Mr Christopher Green, Semundo Ltd, Unit 55, Clifton Road, Cambridge CB1 4FR. The work was funded by a grant of £1,800 from the Home-Grown Cereals Authority (Project No. 0035/1/92).

CONTENTS

INTRODUCTION

Triticale is a man-made cereal produced by hybridising wheat (Triticum spp) and rye (Secale cerale). This combines the hardiness and disease resistance of rye with the grain quality of wheat. Potentially triticale can out-yield other cereals, particularly when grown on light soils. The protein quality is generally slightly better than wheat with proportionally more lysine and methionine.

There are an increasing number of varieties of triticale available but little or no data on nutritional characteristics. Growing conditions can also significantly influence the composition of the grain.

This study was to investigate the differences in the chemical constituents of a number of triticale varieties grown at three different sites.

METHODOLOGY

Varieties :-

Samples of a number of varieties of triticale were submitted to ADAS from three sites (Gleadthorpe, Norfolk, and Cambridge) as follows :-

GLEADTHORPE	NORFOLK	CAMBRIDGE
Alamo	Alamo	Alamo
Cumulus	Cumulus	Cumulus
Purdy	Purdy	Purdy
Trick	Trick	Trick
CWT 1983/79	CWT 1983/79	CWT 1983/79
Lasko	Lasko	-
-	-	WWT 85/89

Chemical Analysis :-

Each sample was analysed for the following using the standard ADAS methods. References to these are available on request.

Dry Matter

Bulk Density

Crude Protein
Oil (method B)
Crude Fibre
Ash

Neutral Detergent Fibre (amylase)
Starch
Sugar

NCGD (digestible OM)

In addition a composite sample of each variety underwent a more comprehensive analysis for minerals and amino acids as follows.

Minerals

Calcium
Total Phosphorus
Phytate Phosphorus
Magnesium
Sodium

Amino Acids	Histidine
	Arginine
	Aspartate
	Proline
	Alanine
	Cysteine
	Tyrosine
	Valine
	Leucine
	Glutamate
	Glycine
	Threonine
	iso-Leucine
	Lysine
	Methionine
	Serine

Energy Values :-

For each variety estimates of Metabolisable Energy (ME) for poultry and ruminants, and Digestible Energy (DE) for pigs, were made using appropriate equations.

Statistical Analysis :-

An analysis of variance (ANOVA) was carried out to differentiate the effects of variety and site. As there was only one sample of WWT 85/89 (ie no replicates) this sample was excluded from the main analyses. Missing data values were calculated for the Cambridge "Lasko" sample using the formula of Snedecor and Cochran (1967) in order to allow this variety to be included in the main statistical analyses.

Mean results for variety and site are presented, together with the appropriate SED and level of significance (** - $p < 0.01$; * - $p < 0.05$; NS - not significant) for each of the main parameters. It was not possible to carry out a detailed statistical analysis on the data generated from the composite samples because there was no replication. Overall mean results and standard deviations are presented for these.

No statistical analysis was carried out on the estimated energy values.

RESULTS

The full analytical results for individual samples are presented in Appendix I.

1) Dry Matter (mean results %)

Variety -

Alamo	Cumulus	Purdy	Trick	CWT 1983/79	Lasko	SED	Sig
88.67	88.57	87.93	88.13	88.60	87.95	0.245	*
b	b	a	ab	b	a		

Site -

Gleadthorpe	Norfolk	Cambridge	SED	Sig
87.97	88.35	88.61	0.392	*
a	ab	b		

2) Bulk Density (mean results kg/Hl)

Variety -

Alamo	Cumulus	Purdy	Trick	CWT 1983/79	Lasko	SED	Sig
68.87	67.27	68.57	68.87	70.13	68.87	1.695	NS

Site -

Gleadthorpe	Norfolk	Cambridge	SED	Sig
64.37	68.42	73.50	1.199	**
a	b	c		

3) Crude Protein (mean results % DM)

Variety -

Alamo	Cumulus	Purdy	Trick	CWT 1983/79	Lasko	SED	Sig
13.11	13.22	13.40	13.44	14.15	13.43	0.556	NS

Site -

Gleadthorpe	Norfolk	Cambridge	SED	Sig
14.22	12.74	13.42	0.393	*
b	a	ab		

4) Oil (mean results % DM)

Variety -

Alamo	Cumulus	Purdy	Trick	CWT 1983/79	Lasko	SED	Sig
1.57	1.53	1.73	1.57	1.50	1.53	0.101	NS

Site -

Gleadthorpe	Norfolk	Cambridge	SED	Sig
1.93	1.35	1.43	0.072	**
b	a	a		

5) Crude Fibre (mean results % DM)

Variety -

Alamo	Cumulus	Purdy	Trick	CWT 1983/79	Lasko	SED	Sig
2.93	2.47	2.67	2.97	3.03	2.50	0.168	*
b	a	ab	b	b	a		

Site -

Gleadthorpe	Norfolk	Cambridge	SED	Sig
2.68	2.83	2.77	0.119	NS

6) Ash (mean results % DM)

Variety -

Alamo	Cumulus	Purdy	Trick	CWT 1983/79	Lasko	SED	Sig
1.90	1.97	1.97	1.90	2.03	2.04	0.068	NS

Site -

Gleadthorpe	Norfolk	Cambridge	SED	Sig
2.06	1.88	1.96	0.048	*
b	a	ab		

7) Neutral Detergent Fibre (mean results % DM)

Variety -

Alamo	Cumulus	Purdy	Trick	CWT 1983/79	Lasko	SED	Sig
8.37	7.93	9.33	9.33	10.10	8.34	0.297	**
ab	a	bc	bc	c	a		

Site -

Gleadthorpe	Norfolk	Cambridge	SED	Sig
8.95	8.97	8.79	0.210	NS

8) Starch (mean results % DM)

Variety -

Alamo	Cumulus	Purdy	Trick	CWT 1983/79	Lasko	SED	Sig
63.53	62.60	63.70	63.43	62.70	62.52	1.783	NS

Site -

Gleadthorpe	Norfolk	Cambridge	SED	Sig
62.95	62.67	63.63	1.261	NS

9) Sugar (mean results % DM)

Variety -

Alamo	Cumulus	Purdy	Trick	CWT 1983/79	Lasko	SED	Sig
3.10	3.40	2.87	2.83	3.16	3.02	0.386	NS

Site -

Gleadthorpe	Norfolk	Cambridge	SED	Sig
2.72	3.37	3.11	0.273	NS

10) NCGD (Digestible OM) (mean results % DM)

Variety -

Alamo	Cumulus	Purdy	Trick	CWT 1983/79	Lasko	SED	Sig
92.97	92.86	92.16	92.16	91.1	92.51	0.248	**
c	bc	b	b	a	c		

Site -

Gleadthorpe	Norfolk	Cambridge	SED	Sig
91.75	92.67	92.52	0.175	**
a	b	b		

11) Minerals (from analyses of the composite samples)

	Mean % DM	SD
Calcium	0.04	0.005
Total Phosphorus	0.45	0.022
Phytate Phosphorus	0.37	0.052
Magnesium	0.14	0.010
Sodium	< 0.02	-

12) Amino Acids (from analyses of the composite samples)

	Mean g/kg DM	SD
Histidine	3.51	0.203
Arginine	5.81	0.753
Aspartate	8.03	0.148
Proline	12.29	0.795
Alanine	5.47	0.219
Cysteine	2.71	0.064
Tyrosine	4.17	0.116
Valine	5.80	0.169
Leucine	8.29	0.210
Glutamate	34.79	2.250
Glycine	6.19	0.259
Threonine	4.60	0.131
iso-Leucine	4.29	0.155
Lysine	4.50	0.107
Methionine	1.87	0.116
Serine	4.59	0.155

13) Estimated Energy Values (MJ/kg DM)

	Metabolisable Energy (Poultry)	Digestible Energy (Pigs)	Metabolisable Energy (Ruminants)
Alamo	14.29	16.00	13.95
Cumulus	14.35	16.16	13.93
Purdy	14.34	16.12	13.82
Trick	14.29	16.02	13.82
CWT 1983/79	14.25	16.02	13.67
Lasko	14.33	16.14	13.89
WWT 85/89	14.42	16.02	13.76

DISCUSSION

The key varietal differences are considered below. Site differences are mentioned where they exist though agronomic details (eg fertiliser application, weather conditions) were not supplied. Where comparisons to tabulated values are made these refer primarily to the figures for triticale quoted in the "UK Tables of Nutritive Value and Chemical Composition of Feedingstuffs" (MAFF, 1990) which is the most recent and comprehensive collection of this type of data.

Dry Matter - Although significant differences were observed between varieties and site, the range of individual results was relatively narrow (1.7% units between 87.4% and 89.1%).

Bulk Density - Quite large variations in individual results were observed. These were significantly attributed to site rather than varietal differences.

Crude Protein - There was a significant difference between sites though not between varieties. The mean values for all varieties except CWT 1983/79 are slightly less than the tabulated value of 13.8% . They are all higher than wheat and barley though, which have average crude protein contents of 12.8% and 12.9% respectively. Protein quality, ie amino acid profile, is referred to in more detail below.

Amino Acids - The mean results generally are a little lower than tabulated values even after considering the slightly lower mean crude protein contents. The relative proportions of each are fairly similar compared with the tabulated values however. The variation which does occur in the individual results (ie between varieties) is greater for some amino acids than others. Serine, glutamate and methionine show the greatest variation whilst cysteine, lysine and aspartate show the least. Analysis of a greater number of samples would be necessary to separate the effects of variety and site.

Compared with wheat these analyses confirm that triticale has a higher content of lysine, which is generally the first limiting amino acid in non-ruminant diets. The content of the sulphur containing amino acids, which are often next limiting, is lower than wheat though which does agree with the recent tabulated values though not with earlier literature.

Oil - There were no significant differences due to variety though there was a significant site effect. All the mean values are lower than the 2.2% tabulated value.

Crude Fibre - A significant varietal difference does exist with Cumulus and Lasko having lower fibre contents than Alamo, Trick and CWT 1983/79. Purdy is intermediate. The mean values are slightly higher than the tabulated value (2.4%) though like all cereals when compared with other feeds the crude fibre content is relatively low.

Ash - There was a significant effect of site though not of variety.

Neutral Detergent Fibre (NDF) - There are highly significant varietal differences with Cumulus having the lowest NDF content and CWT 1983/79 the highest. There was no effect of site. Interestingly all the mean values are lower than the tabulated value of 11.9%.

Starch - There were no significant differences between sites or varieties. The tabulated mean value is 51.6% from 14 samples with starch contents ranging from 37.9% to 68.8%. All the individual results in this study come just within the top end of this range, and thus give considerably higher mean values. Unfortunately the tables make no reference to the varieties which were included though 5 of the samples analysed specifically for poultry had a mean starch content of 62.5%, which is very similar to the results observed here.

Sugars - There were relatively large differences in individual results though these were not significantly attributable to either variety or site.

NCGD (digestible OM) - Highly significant differences due to both variety and site were obtained though the range of individual values was not particularly wide. The variety with the lowest NCGD was CWT 1983/79 which also had the highest fibre content. The results are similar to the tabulated mean of 91.7% .

[Variety WWT 85/89 - The analysis of the single sample of this variety was broadly in line with the others. Of most note are the crude protein which is at the low end of the range; oil which is relatively high particularly for a sample from Cambridge; and starch which is at the upper end of the range.]

Minerals - The analysis of the composite samples of each variety show little variation in the concentrations of calcium, total phosphorus and magnesium. Sodium is very low in all samples. Most variable is phytate-phosphorus ranging between 70% and 90% of the total phosphorus. This is important for non-ruminants because phytate-phosphorus is used much less efficiently than some other sources of phosphorus such as dicalcium phosphate.

Energy Values -

The only way to truly assess the digestible or metabolisable energy content of a feed is in an animal feeding trial. These are expensive, time consuming and impractical to carry out on every batch of a particular feed. Where there is sufficient 'in vivo' data it is often possible to derive reasonable regression equations using the levels of some of the chemical constituents in order to predict the energy content. Generally the more data that is available the more accurate the equation is likely to be. Where there is insufficient data on a single feed type there are some general equations available which can be used over a range of feed types though the result is likely to be slightly less accurate.

Poultry - Apparent Metabolisable Energy (AME) - A specific equation for triticale is published in the "European Table of Energy Values for Poultry Feedstuffs" (WPSA). The range of individual values is narrow between 14.19 MJ/kg DM and 14.41 MJ/kg DM. This compares with a value of 14.45 MJ/kg DM quoted in those tables.

Pigs - Digestible Energy (DE) - An even narrower range of DE's for pigs was found between 16.00 MJ/kg DM and 16.16 MJ/kg DM using an equation suitable for straights based on protein, oil and nitrogen-free extract contents. The standard value currently utilised by ADAS is 16.1 MJ/kg DM.

Ruminants - Metabolisable Energy (ME) - These values have been estimated the from the NCGD (digestible organic matter) content and range from 13.66 MJ/kg DM to 13.95 MJ/kg DM. For comparison the tabulated value is 13.8 MJ/kg DM.

Given that equations used for estimating energy contents are based either on fairly limited `in-vivo' data for triticale or are general equations suitable for a range of feeds then an accuracy of +/- 0.5 MJ/kg would actually be regarded as good. Therefore the figures for individual varieties cannot be considered as absolute and in practice on the basis of energy content it probably would be very difficult to differentiate between them in a feeding trial. If only this data were available then for rationing purposes with any of the varieties considered in this study it would be possible to use a single mean value for each species as follows :-

Poultry	AME	14.1 MJ/kg DM	(12.6 MJ/kg as fed)
Pigs	DE	16.1 MJ/kg DM	(14.1 MJ/kg as fed)
Ruminants	ME	13.8 MJ/kg DM	

Marginal Prices - The above energy values and other mean analytical data were used in simple least-cost feed formulations for each species to give an indication of the marginal price of triticale. Forecast prices for new crop wheat and barley were used as well as typical spot prices for a range of other ingredients. The prices calculated are shown below.

Broiler	£ 114 /tonne	
Pig Grower	£ 112 /tonne	
Dairy	£ 116 /tonne	*

* The marginal price calculated in the dairy example must be interpreted with care because this would only give a very low inclusion rate of 1.5% .

The full formulations are shown in Appendix II. It must be remembered that they are just examples for a single situation. Considerably different results could be obtained if for example the prices and availability of some of the other feeds changed.

CONCLUSIONS & AREAS FOR FURTHER WORK

This study highlighted a number of significant differences in chemical composition between varieties. The number of differences attributable to site emphasise that growing conditions can significantly influence the composition of the grain. Further work on agronomic information which may explain these differences would be useful.

In nutritional terms the differences between varieties appear relatively small. Since the results all generally lie within the range of values found in samples used in `in-vivo' trials then published measured energy values can be used with confidence with these particular varieties. Had a wider range of results been found then further feeding trials looking at individual varieties might have been justified.

Triticale can contain components such as trypsin inhibitors which have a negative effect on animal growth and performance. This study made no attempt to assess these to ascertain if varietal differences exist. Feeding trials would be necessary to determine their effect on individual species. This work could be of considerable importance to plant breeders.

The exercise to calculate marginal prices showed triticale to have a similar value to wheat in the pig and poultry formulations and a slightly higher value in the ruminant formulation, though only for a very low inclusion rate in the latter. Further work could give a clearer picture of the value of triticale by determining the marginal price in a wider range of formulations and examining the sensitivity of these to factors such as changes in other ingredient prices.

REFERENCES

MAFF (1990) "UK Tables of Nutritive Value and Chemical Composition of Feedingstuffs", Rowett Research Services Ltd., Aberdeen.

Snedecor, G.W. and Cochran, W.G. (1967) "Statistical Methods", Iowa State University Press, Ames.

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APPENDIX 1 - Analytical Data

Variety - Alamo

Individual Samples -

		Site		
		Gleadthorpe	Norfolk	Cambridge
Dry Matter	(%)	88.3	88.6	89.1
Bulk Density	(kg/Hl)	66.2	70.8	69.6
Analysis of Dry Matter				
Crude Protein	(%)	14.0	12.9	12.4
Oil (Method B)	(%)	1.9	1.4	1.4
Crude Fibre	(%)	2.6	3.1	3.1
Ash	(%)	2.0	1.8	1.9
Neut Det Fibre	(%)	8.1	8.5	8.5
Starch	(%)	60.3	65.6	64.7
Sugars	(%)	2.9	2.8	3.6
NCGD (dig OM)	(%)	92.8	92.8	93.3

Composite Sample -

(NB -all results are expressed on a dry matter basis)

Calcium	(%)	0.04
Total Phosphorus	(%)	0.43
Phytate Phosphorus	(%)	0.30
Magnesium	(%)	0.15
Sodium	(%)	< 0.02
Histidine	(g/kg)	3.2
Arginine	(g/kg)	6.2
Aspartate	(g/kg)	7.9
Proline	(g/kg)	11.5
Alanine	(g/kg)	5.4
Cysteine	(g/kg)	2.6
Tyrosine	(g/kg)	4.2
Valine	(g/kg)	5.8
Leucine	(g/kg)	8.3
Glutamate	(g/kg)	31.0
Glycine	(g/kg)	5.8
Threonine	(g/kg)	4.5
iso-Leucine	(g/kg)	4.2
Lysine	(g/kg)	4.5
Methionine	(g/kg)	1.8
Serine	(g/kg)	7.2

Variety - Cumulus

Individual Samples -

		Site		
		Gleadthorpe	Norfolk	Cambridge
Dry Matter	(%)	88.1	88.6	88.5
Bulk Density	(kg/Hl)	60.7	67.3	73.8
Analysis of Dry Matter				
Crude Protein	(%)	14.2	13.2	12.3
Oil (Method B)	(%)	2.0	1.2	1.4
Crude Fibre	(%)	2.5	2.4	2.5
Ash	(%)	2.1	1.9	1.9
Neut Det Fibre	(%)	8.6	7.7	7.5
Starch	(%)	62.0	60.3	65.5
Sugars	(%)	2.8	4.0	3.4
NCGD (dig OM)	(%)	91.9	93.4	93.3

Composite Sample -

(NB -all results are expressed on a dry matter basis)

Calcium	(%)	0.04
Total Phosphorus	(%)	0.44
Phytate Phosphorus	(%)	0.33
Magnesium	(%)	0.14
Sodium	(%)	< 0.02
Histidine	(g/kg)	3.4
Arginine	(g/kg)	5.7
Aspartate	(g/kg)	7.9
Proline	(g/kg)	12.0
Alanine	(g/kg)	5.1
Cysteine	(g/kg)	2.7
Tyrosine	(g/kg)	4.0
Valine	(g/kg)	5.6
Leucine	(g/kg)	8.1
Glutamate	(g/kg)	35.5
Glycine	(g/kg)	6.0
Threonine	(g/kg)	4.5
iso-Leucine	(g/kg)	4.1
Lysine	(g/kg)	4.3
Methionine	(g/kg)	1.7
Serine	(g/kg)	7.7

Variety - Purdy

Individual Samples -

		Site		
		Gleadthorpe	Norfolk	Cambridge
Dry Matter	(%)	87.4	88.0	88.4
Bulk Density	(kg/Hl)	63.7	67.7	74.3
Analysis of Dry Matter				
Crude Protein	(%)	13.9	12.5	13.7
Oil (Method B)	(%)	2.1	1.4	1.7
Crude Fibre	(%)	2.7	2.9	2.4
Ash	(%)	2.1	1.8	2.0
Neut Det Fibre	(%)	9.7	9.4	8.9
Starch	(%)	65.2	62.0	63.9
Sugars	(%)	2.5	2.7	3.4
NCGD (dig OM)	(%)	91.6	92.6	92.3

Composite Sample -

(NB -all results are expressed on a dry matter basis)

Calcium	(%)	0.03
Total Phosphorus	(%)	0.47
Phytate Phosphorus	(%)	0.40
Magnesium	(%)	0.16
Sodium	(%)	< 0.02
Histidine	(g/kg)	3.4
Arginine	(g/kg)	5.9
Aspartate	(g/kg)	7.8
Proline	(g/kg)	13.0
Alanine	(g/kg)	5.3
Cysteine	(g/kg)	2.8
Tyrosine	(g/kg)	4.2
Valine	(g/kg)	5.7
Leucine	(g/kg)	8.2
Glutamate	(g/kg)	36.0
Glycine	(g/kg)	6.1
Threonine	(g/kg)	4.5
iso-Leucine	(g/kg)	4.2
Lysine	(g/kg)	4.4
Methionine	(g/kg)	2.1
Serine	(g/kg)	7.5

Variety - Trick

Individual Samples -

		Site		
		Gleadthorpe	Norfolk	Cambridge
Dry Matter	(%)	87.8	87.9	88.7
Bulk Density	(kg/Hl)	64.1	68.1	74.4
Analysis of Dry Matter				
Crude Protein	(%)	14.3	12.5	13.5
Oil (Method B)	(%)	2.0	1.3	1.4
Crude Fibre	(%)	2.9	2.8	3.2
Ash	(%)	2.0	1.8	1.9
Neut Det Fibre	(%)	9.1	9.5	9.4
Starch	(%)	63.0	65.2	62.1
Sugars	(%)	2.7	3.4	2.4
NCGD (dig OM)	(%)	91.7	92.7	92.1

Composite Sample -

(NB -all results are expressed on a dry matter basis)

Calcium	(%)	0.04
Total Phosphorus	(%)	0.43
Phytate Phosphorus	(%)	0.32
Magnesium	(%)	0.13
Sodium	(%)	< 0.02
Histidine	(g/kg)	3.7
Arginine	(g/kg)	6.3
Aspartate	(g/kg)	8.1
Proline	(g/kg)	13.0
Alanine	(g/kg)	5.7
Cysteine	(g/kg)	2.7
Tyrosine	(g/kg)	4.2
Valine	(g/kg)	5.9
Leucine	(g/kg)	8.4
Glutamate	(g/kg)	36.5
Glycine	(g/kg)	6.5
Threonine	(g/kg)	4.9
iso-Leucine	(g/kg)	4.4
Lysine	(g/kg)	4.6
Methionine	(g/kg)	1.9
Serine	(g/kg)	8.8

Variety - CWT 1983/79

Individual Samples -

		Site		
		Gleadthorpe	Norfolk	Cambridge
Dry Matter	(%)	88.6	88.5	88.7
Bulk Density	(kg/Hl)	66.9	68.2	75.3
Analysis of Dry Matter				
Crude Protein	(%)	14.3	13.1	15.1
Oil (Method B)	(%)	1.9	1.3	1.3
Crude Fibre	(%)	3.0	3.2	2.9
Ash	(%)	2.0	2.1	2.0
Neut Det Fibre	(%)	9.9	10.2	10.2
Starch	(%)	63.6	62.0	62.5
Sugars	(%)	2.7	4.0	2.8
NCGD (dig OM)	(%)	90.5	91.4	91.4

Composite Sample -

(NB -all results are expressed on a dry matter basis)

Calcium	(%)	0.05
Total Phosphorus	(%)	0.46
Phytate Phosphorus	(%)	0.42
Magnesium	(%)	0.15
Sodium	(%)	< 0.02
Histidine	(g/kg)	3.7
Arginine	(g/kg)	6.6
Aspartate	(g/kg)	8.1
Proline	(g/kg)	13.5
Alanine	(g/kg)	5.5
Cysteine	(g/kg)	2.8
Tyrosine	(g/kg)	4.4
Valine	(g/kg)	6.1
Leucine	(g/kg)	8.7
Glutamate	(g/kg)	38.0
Glycine	(g/kg)	6.2
Threonine	(g/kg)	4.6
iso-Leucine	(g/kg)	4.6
Lysine	(g/kg)	4.5
Methionine	(g/kg)	1.8
Serine	(g/kg)	8.6

Variety - Lasko

Individual Samples -

		Site		
		Gleadthorpe	Norfolk	Cambridge
Dry Matter	(%)	87.6	88.0	-
Bulk Density	(kg/Hl)	64.6	68.4	-
Analysis of Dry Matter				
Crude Protein	(%)	14.7	12.2	-
Oil (Method B)	(%)	1.7	1.5	-
Crude Fibre	(%)	2.4	2.6	-
Ash	(%)	2.2	1.9	-
Neut Det Fibre	(%)	8.3	8.5	-
Starch	(%)	63.6	60.9	-
Sugars	(%)	2.7	3.3	-
NCGD (dig OM)	(%)	92.0	92.8	-

Composite Sample -

(NB -all results are expressed on a dry matter basis)

Calcium	(%)	0.04
Total Phosphorus	(%)	0.49
Phytate Phosphorus	(%)	0.45
Magnesium	(%)	0.13
Sodium	(%)	< 0.02
Histidine	(g/kg)	3.4
Arginine	(g/kg)	5.9
Aspartate	(g/kg)	8.2
Proline	(g/kg)	11.5
Alanine	(g/kg)	5.5
Cysteine	(g/kg)	2.7
Tyrosine	(g/kg)	4.1
Valine	(g/kg)	5.9
Leucine	(g/kg)	8.3
Glutamate	(g/kg)	34.0
Glycine	(g/kg)	6.1
Threonine	(g/kg)	4.6
iso-Leucine	(g/kg)	4.3
Lysine	(g/kg)	4.6
Methionine	(g/kg)	1.9
Serine	(g/kg)	7.6

Variety - WWT 85/89

Only one sample of this variety was submitted.

		Site
		Cambridge
Dry Matter	(%)	88.3
Bulk Density	(kg/Hl)	69.5
Analysis of Dry Matter		
Crude Protein	(%)	12.3
Oil (Method B)	(%)	2.2
Crude Fibre	(%)	2.6
Ash	(%)	1.9
Neut Det Fibre	(%)	9.2
Starch	(%)	65.8
Sugars	(%)	2.7
NCGD (dig OM)	(%)	91.7
Calcium	(%)	0.04
Total Phosphorus	(%)	0.43
Phytate Phosphorus	(%)	0.37
Magnesium	(%)	0.14
Sodium	(%)	< 0.02
Histidine	(g/kg)	3.8
Arginine	(g/kg)	4.1
Aspartate	(g/kg)	8.2
Proline	(g/kg)	11.5
Alanine	(g/kg)	5.8
Cysteine	(g/kg)	2.7
Tyrosine	(g/kg)	4.1
Valine	(g/kg)	5.6
Leucine	(g/kg)	8.0
Glutamate	(g/kg)	32.5
Glycine	(g/kg)	6.6
Threonine	(g/kg)	4.6
iso-Leucine	(g/kg)	4.2
Lysine	(g/kg)	4.6
Methionine	(g/kg)	1.7
Serine	(g/kg)	9.0

APPENDIX II - Least Cost Feed Formulations

---------- RATIONALE : Copyright (C) 1990 A G Munford, Exeter U.K. ----------

**** ADAS Livestock Services ****

**** Nutrition Chemistry Dept ****

ADAS
Woodthorne
WOLVERHAMPTON
WV6 8TQ
Tel:0902 754190 Ext293

BROILER - Example
.....
.....
.....
.....

Ref: .....
Date: 28 May 1993
Time: 11:38

Adviser: Derek Kennedy

Broiler Finisher 5-8 — FEEDS USED — Cost of mix £143.94

Feedstuff	Quantity	Cost	Cost Range
Wheat	500.0	£110.00	(.00 - 115.81)
Soya Ext 48	228.3	£160.00	(135.82 - 165.64)
Barley	140.6	£105.00	(98.78 - 109.54)
Vegetable Oil	50.1	£300.00	(281.29 - 363.44)
Meat & Bone 48/10	33.6	£175.00	(169.47 - 202.16)
Fish 66	25.0	£350.00	(289.83 -99999.00)
Min/Vit	12.5	£300.00	(56.72 -99999.00)
Maize Gluten 60	8.7	£210.00	(.00 - 315.51)
Synth Methionine	1.0	£2400.00	(.00 -10296.25)
Limestone	.234	£80.00	(.00 - 101.39)
Total	1000.0 kg		

Broiler Finisher 5-8 — UNUSED RAW MATERIALS — Cost of mix £143.94

Raw Material	Cost	Value	Raw Material	Cost	Value
Triticale	£130.00	£114.32	Wheatfeed	£115.00	£88.40
Maize Germ & Bran Ml	£135.00	£121.89	Synth Lysine	£1900.00	£0.00
Pigment Premix	£700.00	£0.00	Dical Phosphate	£175.00	£67.20
Salt	£40.00	£0.00			

Comments:

Triticale would feature in this formulation if priced at £114 /tonne or less.

---------- RATIONALE : Copyright (C) 1990 A G Munford, Exeter U.K. ----------

**** ADAS Livestock Services ****

**** Nutrition Chemistry Dept ****

ADAS
Woodthorne
WOLVERHAMPTON
WV6 8TQ
Tel:0902 754190 Ext293

PIG GROWER - Example
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.....
.....
.....

Ref: .....
Date: 28 May 1993
Time: 11:06

Adviser: Derek Kennedy

Pig Grower 20-65kg — FEEDS USED — Cost of mix £118.81

Feedstuff	Quantity	Cost	Cost Range
Wheat	417.4	£110.00	(109.24 - 112.78)
Barley	382.3	£105.00	(102.50 - 105.68)
Soya Ext Hi Prot	142.2	£160.00	(144.77 - 163.57)
Meat & Bone 52/14	46.9	£171.00	(162.31 - 186.28)
Limestone	5.2	£80.00	(30.81 - 118.37)
Salt	3.4	£40.00	(31.41 - 434.11)
TE/Vit	2.5	£570.00	(31.42 -99999.00)
Total	1000.0 kg		

Pig Grower 20-65kg — UNUSED RAW MATERIALS — Cost of mix £118.81

Raw Material	Cost	Value	Raw Material	Cost	Value
Triticale	£130.00	£112.46	Wheatfeed	£115.00	£104.70
Maize Gluten 60	£210.00	£122.78	Maize Germ & Bran Ml	£130.00	£111.43
Molasses (cane)	£85.00	£67.32	Vegetable Oil	£300.00	£233.30
Fish 66	£350.00	£185.52	Synth Lysine	£1500.00	£1393.81
Synth Methionine	£2400.00	£31.42	Dical Phosphate	£175.00	£102.37

Comments:

Triticale would feature in this formulation if priced at £112 /tonne or less.

**** ADAS Livestock Services ****

**** Nutrition Chemistry Dept ****

ADAS
Woodthorne
WOLVERHAMPTON
WV6 8TQ
Tel:0902 754190 Ext293

DAIRY - Example
.....
.....
.....
.....

Ref: .....
Date: 28 May 1993
Time: 10:57

Adviser: Derek Kennedy

Dairy 18% **** FEEDS USED Cost of mix £106.48

Feedstuff	Quantity	Cost	Cost Range
Barley	284.0	£105.00	(103.94 - 105.21)
Maize Gluten Feed	250.0	£110.00	(.00 - 115.81)
Rice Bran	160.9	£85.00	(83.26 - 87.25)
Maize Distillers	100.0	£120.00	(.00 - 146.10)
Rapeseed Ext	100.0	£125.00	(.00 - 142.62)
Sunflower Ext	50.0	£90.00	(.00 - 101.99)
Linseed Meal	33.6	£148.00	(133.88 - 148.58)
Limestone	16.0	£80.00	(.00 - 206.72)
Salt	5.4	£40.00	(.00 - 1599.21)
Total	1000.0 kg		

Dairy 18% **** UNUSED RAW MATERIALS Cost of mix £106.48

Raw Material	Cost	Value	Raw Material	Cost	Value
Wheat	£110.00	£109.77	Triticale	£130.00	£116.09
Maize Germ	£125.00	£118.56	Molasses (cane)	£85.00	£79.91
Beet Pulp (dried)	£110.00	£97.17	Citrus Pulp (dried)	£102.00	£95.95
Wheatfeed	£115.00	£99.92	Soya Ext 44/7	£160.00	£159.18
Palm Kernel	£112.00	£103.38	Fish Meal 66	£370.00	£221.04
Dried Grass 4*18	£120.00	£100.05	Fat 100% Prills	£400.00	£366.32
Dicalcium Phosphate	£175.00	£33.89	Calcined Magnesite	£145.00	£0.00

Comments:

Triticale would feature in this formulation if priced at £116 /tonne or less. However it should be noted that the inclusion rate would only be around 1.5% .