HGCA

PROJECT REPORT No. 43

FACTORS AFFECTING THE NUTRITIVE VALUE OF WHEAT FOR POULTRY

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by

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Final report of a three year project which was carried out at the AFRC Institute of Animal Physiology and Genetics Research, Edinburgh Research Station, Roslin, Midlothian EH25 9PS. The work commenced in July, 1988 and was funded by a grant of £107,076 from the Home-Grown Cereals Authority (Project No. 0007/3/88).

Contents

Summary

In the United Kingdom the importance of wheat as an ingredient in diets for poultry, where it can supply up to 80% of the metabolisable energy and 40% of the amino acid requirements, cannot be understated. This study set out to examine the affects of agronomy on those components of wheat which make important contributions to the nutrition of poultry. Particular attention was directed at factors which were considered likely to affect metabolisable energy.

It was shown that neither the level of irrigation nor the location of the cultivation site had a significant effect on the nutrient content of wheat or its value to birds. Application of nitrogen fertilisers, however, increased the total nitrogen, true protein nitrogen and total amino acid contents. The concentrations of the essential amino acids, cysteine, methionine, lysine and threonine, were all significantly improved by levels of fertiliser addition up to 350 kg nitrogen/ha. The application of fungicide during growth reduced the ash content but decreased the total amino acid content, threonine being the essential amino acid most adversely affected.

The varieties Alexandria, Apollo, Avalon, Galahad, Mandate, Mercia, Mission, Sperber and Tonic were consistently shown to have the most desirable amino acid profiles. Sperber also tended to have a high gross energy which was well metabolised by adult birds. In contrast the varieties, Brock, Hornet, Rendezvous and Riband had rather poorer amino acid profiles, although Hornet's metabolisable energy content was relatively high, as was that of Slepjner. Amino acid digestibility coefficients appeared to be unaffected by wheat variety or site of growth, but these for the essential amino acids tended to be low, the value for lysine (81.1%) being particularly poor.

Dry matter was shown to be the single most important piece of information to use in adjusting the metabolisable energy value of wheat. Strong correlations were established between wheat density and metabolisable energy, but, because of differences between years of harvest, it was not possible to derive a prediction equation based on density for general use.

Introduction

In the UK poultry diets contain between 55 and 70% home-grown cereals which provide, on average, about 55% of the birds' metabolisable energy and 35% of their protein requirements. Currently, wheat is the predominant cereal in poultry feeds but barley, the usage of which has increased in the past 12 months, oats and triticale may play increasing roles if economic circumstances change.

Improved utilisation of cereals requires the following information:

1. Identification of variations in nutritional value brought about by differences in variety, agronomic conditions and, perhaps, season.
2. Description of any variation in terms of measurable chemical components, e.g. crude protein, true protein or amino acids.
3. The development of assays capable of predicting nutritional quality, e.g. metabolisable energy, amino acid digestibility.

This report covers three years work with wheat and is presented in two parts. Part 1 examines the effects of variety, the application of fungicide, the application of nitrogen and the level of irrigation on the composition of wheat (dry matter, oil, nitrogen, true protein nitrogen, amino acids and ash) and its gross and true metabolisable energy value to adult cockerels. Part 2 examines factors which influence the metabolisable energy value of wheat for poultry.

Part 1

The effects of variety, fungicide treatment, nitrogen fertilisation and irrigation on some nutritional characteristics of wheat.

Collection of samples

Wheat samples (102) were collected by ADAS from the 1988 harvest. The samples which were identified by number (1-102) were all analysed for nitrogen, oil, ash and amino acids and, on the basis of these values, 72 were selected for true metabolisable energy determination with adult cockerels. Descriptions of the samples are given in Tables 1 - 6 with an overall summary of the treatments imposed in Table 7.

Chemical and Biological Analyses

Dry matter (DM) contents were determined by drying for 4 h at 103°C. Oil was determined after 6 h extraction with petroleum spirit (40 - 60°C). Nitrogen (N) was determined by a standard Kjeldahl technique using a copper - selenium catalyst. True protein nitrogen (TPN) was determined after precipitation with uranyl acetate and application of the Kjeldahl procedure. Ash was determined after 16 h at 500°C. Gross energies (GE) of the wheats and excreta samples were determined in triplicate using a Parr Adiabatic bomb calorimeter.

Metabolisable energy values of wheat were determined by tube-feeding 50 g samples to adult cockerels which had been deprived of food for 48 h. The excreta voided during the 48 h subsequent to feeding were collected quantitatively, dried, weighed and analysed for gross energy and nitrogen. True metabolisable energy values corrected to zero nitrogen retention (TME_N) were derived from the determined energy balances and experimentally determined estimates of endogenous energy loss from similar birds given 50 g glucose.

Statistical Analyses

Each variable was analysed by the following two methods:

1. By analysis of variance, allowing for possible site differences and by examining the effects of variety, fungicide, nitrogen, irrigation and the interaction of variety with these last three treatments on the characteristics of wheat.

2. When significant effects were identified they were estimated and tested by a second method - Restricted Maximum Likelihood. The advantage of this approach is that the estimated differences between varieties are obtained by combining information from different sites and trials with the information available within trials, which was used in the first analysis. This approach has little effect on the estimated responses to fungicide, nitrogen application or irrigation, all of which are almost balanced within experiments and across varieties. In contrast to the first analysis, sites and varieties are fitted as random effects.

The variables examined (all on an "as received" basis) were oil, ash, gross energy, TME_N, TME_N/GE, cysteine, lysine, methionine, threonine, methionine + cysteine, the sum of the amino acids, total nitrogen, true protein nitrogen and true protein nitrogen/total nitrogen.

Results and Discussion

The results for all the proximate components and true protein nitrogen of the wheat samples are given in Tables 8 and 9. Dry matter, which ranged from 866 to 896 g/kg (mean 885 g/kg), was remarkably consistent across samples and was not examined further.

With one exception, there were no interactions between variety and any of the other treatments. Where significant varietal effects were detected, the variety estimates are presented in rank order (Table 10) together with an average standard error of a difference (SED) between two estimates. A similar procedure was adopted where significant effects of fungicides were detected (Table 11). Where responses to the application of nitrogen fertilisation were observed, these were found to be linear with dosage rate and their standard errors (SE) are presented in the text.

Oil

The oil content, which varied from 9.5 to 18.4 g/kg (mean 14.0 g/kg), was affected only by variety (χ_i^2=40.51). The average SED was 0.96 (Table 10), therefore varieties which differed by at least twice this value may differ significantly in oil content. However, because comparisons were made among 17 varieties which have been ranked according to data values, a much more stringent criterion is required to compensate for making post hoc comparisons. Using the Studentized Range test it was shown that only values separated by at least 3½ times the SED could be considered significantly different. This really says that only the two varieties at each extreme of the ranking list differ. Because the variety effect is more marked for oil than for any other of the variables examined, the data do not provide sufficient information to allow individual varietal differences to be detected. It may be more sensible to use the ranking list (Table 10) to suggest likely varieties to be used for a more controlled comparative set of trials in future.

Ash

The ash content, which varied from 12.0 to 32.5 g/kg (mean 14.7g/kg), was affected only by fungicide application (Table 11). The F2 treatment mean is more than twice x SED lower than the control (Control -F2 = 2.94, SED = 0.77) and, consequently, that particular treatment significantly reduced the ash content. Furthermore, if all four fungicide treatments applied are considered as one, then fungicide application reduced the ash content by 2.00 g/kg in general.

Total Nitrogen

Individual total nitrogen values varied from 12.90 to 23.70 g/kg (mean 17.95 g/kg) and were affected by wheat variety (Table 10), fungicide treatment (Table 11) and application of nitrogen. Despite the range of values observed (χ_i^2=19.4 and range/SED = 4.1) the only two varieties that could be categorically separated are Sperber (17.4 g/kg) and Riband (14.8 g/kg).

Fungicide treatments F2 and F3 (Table 11) decreased nitrogen (Control - F2 = 0.89, SED = 0.30 ; Control - F3 = 1.11, SED = 0.57) and, in general, fungicide decreased nitrogen content by 0.91 g/kg (SED = 0.22).

Perhaps not surprisingly the application of nitrogen to the growing sites increased the nitrogen content of the wheat. For every kg nitrogen applied per ha, wheat nitrogen increased by 0.019 g/kg (SE = 0.001)

True Protein Nitrogen

True protein nitrogen ranged from 10.37 to 20.66 g/kg (mean 15.64 g/kg) and was affected by variety (Table 10) and nitrogen application. Although the analysis suggested that the varieties differed (χ^2_i=4.35) the range/SED (3.0) was such that it was not possible to separate one from another.

The application of nitrogen increased the amount of true protein nitrogen in wheat by 0.018 g/kg (SE = 0.002) for every kg nitrogen/ha applied. None of the treatment variables affected the true protein nitrogen to total nitrogen ratio.

Energy

Neither variety nor treatment had any influence on the gross energy or TME_N (mean 16.24 kJ/g) of the wheats. Gross energy, which ranged from 15.48 to 16.84 kJ/g (mean 16.24 kJ/g) was relatively constant and TME_N, which varied from 12.87 to 14.41 kJ/g (mean 13.41 kJ/g), was only marginally less consistent (Tables 12 and 13). The proportion of the total energy metabolised (TME_N/GE) was only slightly affected by fungicide treatment (Table 11). Thus, although treatment F1 increased this ratio (F1 - control = 0.26, SED = 0.08), the combined effects of the 4 fungicide treatments evaluated suggests that, in general, TME_N/GE was unaffected by the application of fungicide.

Amino acids

The amino acid profiles of the 102 wheat samples are given in Tables 14, 15 and 16 and the data are summarised in Table 17.

Total amino acids

The total amino acid content of the wheat samples (Table 17) ranged from 72.5 to 143.7 g/kg (mean 97.1 g/kg), a relatively wide range. The content was affected by variety, fungicide treatment and the application of nitrogen. Although there appeared to be a difference between varieties (χ^2_i=9.7) the range/SED value (2.4) meant that individual varieties could not be distinguished. Fungicide application F2, reduced the total amount of amino acids recovered (Control - F2 = 8.81, SED = 2.40). In general the application of fungicide reduces the sum of the amino acids recovered from wheat by 7.08 g/kg (SED = 1.77). The application of fertiliser increased the total amino acid content of wheat by 0.11 g/kg for each kg nitrogen/ha applied (SE = 0.0107).

Cysteine

The concentration of cysteine in wheat ranged widely from 1.86 to 3.70 g/kg (mean 2.66 g/kg) and was affected by both variety (Table 10) and nitrogen fertilisation. However the varietal effect (χ_i^2=5.73) was not strong enough (range/SED = 2.8) to allow individual varieties to be separated. Application of nitrogen fertiliser increased the cysteine content of wheat by 0.0022 g/kg (SE = 0.0005) for each kg nitrogen/ha.

Methionine

The concentration of methionine in wheat varied from 1.32 to 2.25 g/kg (mean 1.67 g/kg) which, although less than cysteine, still covered a wide range. Although affected by variety (χ_i^2=9.29) the range/SED (2.9) was too small to allow varieties to be distinguished. As with cysteine, the application of 1 kg/ha nitrogen increased the methionine concentration by 0.0010 g/kg(SE = 0.0003).

Methionine + Cysteine

Taken together the concentrations of the two sulphur-containing amino acids ranged from 3.23 to 5.50 g/kg. Avalon (4.49 g/kg) had a significantly higher content than Riband (3.74 g/kg) and nitrogen fertilisation increased the methionine + cysteine content by 0.0033 g/kg (SE = 0.0005) for each kg/ha applied nitrogen.

Lysine

The concentration of lysine varied from 2.02 to 3.82 g/kg (mean 2.48 g/kg) and was only influenced by the application of nitrogen where 1 kg/ha nitrogen increased the lysine concentration by 0.0013 g/kg (SE = 0.0004).

Threonine

Threonine content ranged from 2.12 to 4.41 g/kg (mean 3.15 g/kg) and was affected by variety, the application of nitrogen and treatment with fungicide. Although varietal differences were detected (χ_1^2=7.05) the range/SED (2.50) was not large enough for them to be distinguished. Fungicide treatments F1 and F2 both reduced the amount of threonine in wheat and, overall, threonine was reduced by 0.27 g/kg (SED = 0.06). Nitrogen fertilisation increased threonine by 0.0031 g/kg (SE = 0.0003) per kg/ha of nitrogen applied.

Part 2

Factors affecting the Metabolisable Energy Value of Wheat

Experiments have been carried out to investigate factors which may influence the metabolisable energy value of wheat for poultry. Partly because of the difficulty in obtaining samples with authentic characteristics and partly because there are doubts about the relevance of such samples in commercial feeding practice, the experiments were mainly carried out on an ad hoc basis, when collections of appropriate samples were available. All analyses were carried out by standard laboratory techniques and metabolisable energy values were expressed in terms of true metabolisable energy (TME_N) corrected to zero nitrogen balance. Brief descriptions of the methods employed have been given in Part 1 of this report. Throughout emphasis was placed on simple measurements likely to predict wheat "quality".

Experiment 1

In this experiment 23 samples of wheat with a range of qualities were examined. No details are available on the origin or varieties of the samples other than all were grown in the UK and that 22 were taken from the 1984 harvest and 6 from 1985. The analyses carried out were as follows:-

DM	-	dry matter, % as received (ar)
OIL	-	oil, % ar or as dm
CPR	-	crude protein (nitrogen x 6.25), % ar or as dm
ASH	-	ash, % ar or as dm
DENS	-	density, kg/hl ar
TGW	-	thousand grain weight, g ar
DFM	-	dust and foreign material, g ar
GE	-	gross energy, kJ/g ar or as dm
TME_N	-	true metabolisable energy to zero nitrogen balance, kJ/g ar or as dm.

The mean values for the analytical data are given in Table 18 and for the energy parameters in Table 19. Table 20 shows the means for the separate years. Samples taken from the 1985 harvest were drier and more uniformly dry, than those from 1984. This was unexpected, because the 1985 harvest was generally wet. It may, however, reflect the tendency to dry the wetter samples. On a dry matter basis, the 1985 wheats contained 22% more oil, 10% more protein and 13% more ash and were generally less variable. They had much lower densities and 1000 grain weights and again were more consistent in these respects.

On a dry matter basis, the mean TME_N values for each year were virtually identical. In 1984, the range in TME_N values was from 12.44 to 13.25 kJ/g (ar) and from 12.90 to 13.51 kJ/g (ar) in 1985. However, as already noted, this year difference disappeared when differences in water content were eliminated, the range in TME_N, on a dry matter basis, being from 14.64 to 15.19 kJ/g over both years.

The within-year correlations amongst the analytical variables are shown in Table 21. Taken with the mean values (Tables 18 and 19) these correlations suggest several possible approaches to their interpretation, depending whether TME_N values are expressed on an as received, dry matter or organic matter basis.

Dry matter, gross energy and TME_N are highly correlated and dry matter and density are correlated, and therefore TME_N and density are correlated to a lesser extent. Consequently, a relationship would be expected between density and TME_N on an as received basis. There is also a significant correlation between ash and TME_N which may reflect variations in organic matter content. The gross energy contents of the wheat are very uniform on a dry matter basis and it is, therefore, not surprising that gross energy and dry matter are very highly correlated. It is interesting to note that the gross energy on an organic matter basis is even more uniform (range 18.57 to 18.97 kJ/g) and that these values are significantly correlated with oil on an organic matter basis (r = 0.51, rsd = 0.50%). This residual standard deviation is consistent with the error amongst duplicated determinations.

In Table 22, the ability of the different analytical variables in predicting the TME_N value of wheat on an as received basis is shown. It can be seen that dry matter is the most important single piece of information that should be used to adjust the TME_N value of wheat. In this particular experiment with wheats which had quite different chemical and physical characteristics between the different harvests, the between - year effect was virtually removed by taking dry matter into account. The relationships between TME_N and dry matter were similar for both years, the slopes being not significantly different. The overall equation is given as follows:

$$TME_N = 0.1539\ DM - 0.4630 \qquad (rsd = 0.134)$$

Because the constant in this equation is not significant, the prediction is not different from assuming a constant TME_N value for wheat on a dry matter basis as follows:

$$TME_N = 0.1486\ DM$$

Density is also a useful predictor within years but is not able to reconcile the differences observed between the 1984 and 1985 samples. Although the slopes of the regressions for the separate years do not differ significantly from each other, it is not possible to derive a prediction equation for general use. From the combined slopes TME_N increases by 0.049 kJ/g for each kg/hl increase in density. The combination of density and dry matter is statistically very effective but there is still a significant year effect.

The TME_N value of wheat on a dry matter basis can be predicted from either ash or density but the improvement in the residual standard deviation is not great (Table 22). If ash data are available it is probably simpler to assume a constant TME_N on an organic matter basis as follows:

$$TME_N = 0.151\ (DM - ASH)\ kJ/g$$

Experiment 2

In this experiment we examined wheats collected from the 1985 harvest and selected on the basis of their range of densities (57 to 80 kg/hl). The analytical values of the wheats are given in Table 23 ; all wheats were grown in the UK apart from sample 7 which was of French origin. On an as received basis the TME_N values ranged from 12.14 to 12.82 kJ/g, but, as in experiment 1, on a dry matter basis there was little variation (mean value = 14.81 kJ/g). The density was also significantly correlated with the TME_N of the wheats and could be used as a predictor of TME_N as follows:

$$TME_N = 10.430 + 0.0325DENS$$

This means that for every kg/hl increase in density the TME_N value of wheat increases by 0.032 kJ/g. This is somewhat less than the increase seen in experiment 1 of 0.049 kJ/g. An alternative interpretation of these data is that TME_N is fairly constant at densities above 70 kg/hl but declines below this value as follows:

$$TME_N = 8.938 + 0.056DENS$$

As in experiment 1, density and dry matter were highly correlated (r = 0.695**) and thus either variable can be used to describe the TME_N of wheats on an as received basis.

Experiment 3

In this experiment the TME_N of four wheats which had different Hagberg numbers was determined. The Hagberg number is a term used in the flour milling industry to give an indication of the α-amylase activity, the higher the number the lower the activity of the enzyme. The data from the experiment (Table 24) showed a high correlation between Hagberg number (H) and TME_N as follows:

$$TME_N = 13.01 + 0.002H \quad (r = 0.96^{***})$$

This means that for every increase of 10 in Hagberg number the TME_N of wheat (which was the variety Galahad) was increased by 0.02 kJ/g. Although this represents a relatively small effect, the size of the correlation coefficient suggests it may be worth examining further, with other wheat varieties and over a wider range of Hagberg numbers, the predictive power of the relationship.

Experiment 4

Throughout 1989 and 1990 many connected with the poultry industry expressed concern that the wheat variety Slejpner was resulting in poor performance when it was included in broiler diets. Provided that this was true, it was quite reasonably assumed that the variety did not provide the expected level of metabolisable energy to the birds. This hypothesis has been tested when 28 different samples of Slejpner wheat were analysed and evaluated for TME_N content (Table 25).

The derived values ranged from 13.03 to 13.50 kJ/g (as received) and that the mean value 13.22 ± 0.13 kJ/g did not differ significantly from the running mean (228 samples) determined in our laboratory during the preceding 9 years (13.15 kJ/g).

Experiment 5

A final study investigated the effect of wheat variety and its site of cultivation on its GE, TME_N and the digestibility of its amino acids by poultry. The varieties tested were Apollo, Apostle, Brock, Fortress, Galahad, Hornet, Riband, Slejpner, Sperber and Tonic. Gross energies (Table 26) varied from 18.39 (Hornet) to 18.64 kJ/g (Tonic), the mean value being 18.47 kJ/g. The values showed relatively little variation, although wheats grown on site 2 tended to have higher gross energy contents (18.49 kJ/g) than those grown on site 1 (18.45 kJ/g). This was most pronounced for Apostle (18.57 vs 18.42 kJ/g).

The TME_N values of the wheat varied from 14.83 (Apollo) to 15.34 kJ/g (Sperber), the mean value being 15.12 kJ/g (Table 27). Wheats grown on site 2 tended to have higher TME_N values (15.19 kJ/g) than those grown on site 1 (15.04 kJ/g). This was particularly noticeable for Galahad (15.31 vs 14.81 kJ/g), Slejpner (15.45 vs 15.06 kJ/g) and Apostle (15.09 vs 14.91 kJ/g).

Amino acid digestibility coefficients of the protein from the different wheats were not influenced by site or variety and the mean values are shown in Table 28.

Conclusions

Because the samples of wheat studied were grown and collected under different degrees of control, it is probably most advisable to use the results from this study as a means of suggesting varieties and treatments for further more defined experiments with poultry.

As far as the composition (principally the desirable amino acid concentrations) of the wheats is concerned, the varieties which consistently had the most valuable features were Alexandria, Apollo, Avalon, Galahad, Mandate, Mercia, Mission, Sperber and Tonic (Part 1). In addition Sperber contained a high gross energy content which was well metabolised by adult cockerels (experiment 5). Although Tonic contained the highest gross energy it was slightly less well metabolised. The varieties Brock, Hornet, Rendezvous and Riband had the poorest nitrogen and amino acid profiles, but Hornet had a relatively high metabolisable energy content. Poultry also consistently metabolised a high proportion of the energy from Slejpner (experiments 4 and 5).

The level of irrigation and the site of cultivation had little effect on the nutrient content of wheat and its value to birds. There also were no interactions between variety and any of the agronomic treatments imposed on the wheat during its growth.

The application of nitrogen affected some of the components examined and these were all linearly related to the dosage rate. Thus, the total nitrogen, true protein nitrogen and the total amino acid concentrations of wheat all increased with the application of nitrogen. Cysteine, methionine, lysine and threonine contents were all significantly improved by the levels of fertiliser addition studied (up to 350 kg nitrogen/ha).

The use of fungicide during growth also affected some of the components of wheat and, to some extent, these were dependent on the nature of the treatment. In general, the application of fungicide decreased the ash content (beneficial) but decreased the total amino acid content and, in, particular, threonine. However, the nutritionally important amino acids, cysteine, methionine and lysine, were unaffected. One of the treatments examined (F1) significantly improved the proportion of gross energy metabolised by the birds but this was not a general feature.

In the two experiments which examined simple predictors of the metabolisable energy of wheat, dry matter gave remarkably consistent results. In experiment 1 the TME_N of 23 wheats from the 1985 and 1986 harvests was 14.86 kJ/g dry matter and that for another set of 7 wheats from 1985 (experiment 2) was 14.81 kJ/g. The same experiments showed strong correlations between wheat density and TME_N. The regression coefficients, however, ranged from 0.032 to 0.049 and because of differences in the densities of the wheats harvested in different years it was not possible to derive a prediction equation for general use. It could be that different characteristics of the wheat (e.g. dry matter and starch) affect its density.

A strong negative correlation was shown to exist between the α-amylase activity (Hagberg number) of the wheat variety Galahad and its TME_N value. However, the small effect observed and the unexpected nature of the response warrant further investigation with other varieties.

The organic matter of wheat appears to have a constant TME_N value in spite of the wide range of purported qualities. It might have been expected that supposedly poor quality wheats would have had higher proportions of structural polysaccharides and lower starch contents than those of good quality. Analyses with starch and other carbohydrates are required to check the extent of the range of their concentration. There is also the possibility that the feeding value of wheat to young broilers is not fully exposed by tube-feeding small quantities to adult cockerels. This requires to be investigated in future experiments.

Finally because wheat can supply over one third of the protein required by broilers it is of some concern to observe its relatively low digestibility (experiment 5) and in particular the value derived for lysine (81.1%). Explanations need to be sought and efforts made to improve the digestible lysine content of wheat to poultry.

Acknowledgements

Many people contributed to this project and, although it is always slightly invidious to single out individuals, I would like to express my sincere thanks for the considerable help I have received from John Downie, Kim Henderson and David Waddington. In addition, Dorothy Meikle typed the report with considerable efficiency and aplomb while it was still being written and subject to innumerable last minute changes.

Table 1

Wheat samples (6) collected after different irrigation treatments (Trial 1)

Site : Gleadthorpe

Variety	Treatment*	Reference
Mission	1	1
Mission	2	2
Mission	3	3
Avalon	1	4
Avalon	2	5
Avalon	3	6

* irrigation treatments not specified

Table 2

Wheat samples (8) collected after different fungicide treatments (Trial 2)

Site: Surfleet

Variety	Treatment*	Reference
Slejpner	0	7
Hornet	0	8
Rendezvous	0	9
Mercia	0	10
Slejpner	1	11
Hornet	1	12
Rendezvous	1	13
Mercia	1	14

* Treatment 0 received no fungicide

Treatment 1 received fungicide as follows:

prochloraz (sportak) + fenpropimorph (corbel) at GS31

fenpropidin (patrol) + propiconazole (radar) at GS39

triadimenol and tridemorph (dorin) +

chlorothalonil (bravo) at GS59

Table 3

Wheat samples (21) collected after different fungicide treatments (Trial 3)

Site : Glympton

Variety	Treatment*	Reference	Treatment*	Reference
Avalon	0	65	2	80
Mandate	0	66	2	79
Galahad	0	67	2	81
Hornet	0	68		
Slejpner	0	69	2	82
Apollo	0	70	2	76
Fortress	0	71	2	78
Brock	0	72	2	84
Riband	0	73	2	83
Mercia	0	74	2	77
Rendezvous	0	75	2	85

* Treatment 0 received no fungicide

Treatment 2 received fungicide as follows:

prochloraz (sportak) + fenpropimorph (corbel) at GS 31

and fenpropidin (patrol) + propiconazole (radar) at GS 39

and ? (tilt) + carbendazim (bavistin) at GS 59

Table 4

Wheat samples (9) collected after different fungicide treatments (Trials 4,5 and 6)

Site	Variety	Treatment*	Reference
Dorchester	Mercia	0	86
	Mercia	3	87
	Mercia	4	88
Avebury	Slejpner	0	89
	Slejpner	3	90
	Slejpner	4	91
Adisham	Unknown (VI)	0	92
	Unknown (VI)	3	93
	Unknown (VI)	4	94

* Treatment 0 received no fungicide

Treatment 3 received prochloraz (sportak) at GS31

and fenpropidin (patrol) + propconazole (radar) at GS39

Treatment 4 received fenpropimorph (corbel) at GS31

and chlorothalonil (bravo) + carbendazim (bavistin) at GS39

Table 5

Wheat samples (14) collected after different rates of nitrogen fertilisation (Trials 7-12)

Site	Variety	Nitrogen Application (kg/ha)	Reference
Brampton	Unknown (V2)	0	15
Brampton	Unknown (V2)	170	16
Mears Ashby	Unknown (V3)	0	17
Mears Ashby	Unknown (V3)	330	18
Ardleigh	Unknown (V4)	0	19
Ardleigh	Unknown (V4)	240	20
Wereham	Unknown (V5)	0	95
Wereham	Unknown (V5)	240	96
Combs	Unknown (V6)	0	97
Combs	Unknown (V6)	240	98
Bridgets	Avalon	0	99
Bridgets	Avalon	350	100
Bridgets	Tonic	0	101
Bridgets	Tonic	350	102

Table 6

Wheat samples (44) collected from different sites (Trials 13-16)

		Site		
Site	Morley	Debenham	West Rudham	Boxworth
Variety				
Alexandria			43	
Apollo		31	44	55
Apostle		32		
Avalon	21	33	45	56
Brock	22	34	46	57
Fortress	23	35	47	58
Galahad	24	36	48	
Hornet	25	37	49	59
Mandate			51	60
Mercia	26	38	50	61
Parade		39		
Rendezvous	27	40		62
Riband			52	63
Slejpner	28	41	53	64
Sperber	29	42		
Tonic	30		54	

Table 7

Summary of Treatments

Trial	Site	Treatment	Table
1	Gleadthorpe	Irrigation x variety (2)	1
2	Surfleet	Fungicide (F1) x variety (8)	2
3	Glympton	Fungicide (F2) x variety (11)	3
4	Dorchester	Fungicide (F3,F4) on Mercia	4
5	Avebury	Fungicide (F3,F4) on Slejpner	4
6	Adisham	Fungicide (F3,F4) on unknown (VI)	4
7	Brampton	Nitrogen (170) on unknown (V2)	5
8	Mears Ashby	Nitrogen (330) on unknown (V3)	5
9	Ardleigh	Nitrogen (240) on unknown (V4)	5
10	Wereham	Nitrogen (240) on unknown (V5)	5
11	Combs	Nitrogen (240) on unknown (V6)	5
12	Bridgets	Nitrogen (350) x variety (2)	5
13	Morley	Variety (10)	6
14	Debenham	Variety (12)	6
15	West Rudham	Variety (12)	6
16	Boxworth	Variety (10)	6

Table 8

Proximate composition (g/kg as received) of wheat samples (102) : dry matter (DM), oil (O), nitrogen (N), ash (A) and true protein nitrogen (TPN).

SAMPLE	DM	O	N	A	TPN
1	*	18.2	20.4	17.9	*
2	*	18.1	19.9	15.8	*
3	*	15.2	20.1	15.3	*
4	*	15.6	20.3	16.7	*
5	*	15.5	20.6	15.3	*
6	*	16.5	19.7	15.8	*
7	888.9	14.8	17.8	15.3	15.12
8	888.7	15.1	17.2	14.8	14.10
9	*	11.3	17.6	16.8	*
10	*	13.5	17.8	14.7	*
11	881.0	16.1	16.1	13.2	13.52
12	882.4	14.1	15.9	12.3	13.38
13	*	10.6	16.8	12.1	*
14	*	14.9	17.5	13.3	*
15	881.3	13.4	13.6	13.8	10.37
16	886.6	14.0	16.7	14.3	13.87
17	879.3	16.9	15.4	12.9	14.14
18	883.6	15.9	21.7	12.9	19.12
19	880.3	14.4	14.2	14.9	12.10
20	882.8	15.1	18.5	15.2	16.34
21	873.4	12.3	21.1	13.2	18.06
22	877.6	12.9	19.9	12.3	17.86
23	877.4	11.0	20.4	13.6	19.32
24	876.0	13.2	20.7	13.4	17.86
25	872.6	11.9	20.1	12.2	19.33
26	877.0	13.9	19.9	14.0	17.86
27	870.3	11.0	19.2	13.0	18.90
28	874.1	13.7	18.6	13.6	16.45
29	878.6	15.1	23.5	13.0	20.45
30	*	16.1	22.4	12.8	*
31	*	9.5	17.3	13.0	*
32	*	11.4	17.0	13.7	*
33	876.9	14.2	18.2	13.5	16.66
34	872.5	13.1	16.2	13.6	14.50
35	868.0	12.0	17.0	14.0	14.91
36	875.9	13.5	16.5	13.4	14.91
37	875.2	12.5	15.1	13.3	12.82
38	868.8	13.6	18.1	14.0	15.97
39	*	14.6	17.3	13.3	*
40	870.0	10.2	16.2	13.2	14.98
41	866.4	13.9	16.4	14.5	14.70
42	872.8	13.2	17.5	14.2	16.18
43	*	15.2	17.3	14.8	*
44	*	12.5	16.6	14.4	*
45	882.9	14.4	17.3	15.0	14.64
46	879.4	14.6	16.5	14.1	14.64
47	884.7	11.5	17.1	14.9	14.85
48	*	13.3	17.1	14.1	*
49	*	12.6	15.9	13.9	*
50	*	12.0	17.1	15.8	*

Table 8 (Continued)

Proximate composition (g/kg as received) of wheat samples (102) : dry matter (DM), oil (O), nitrogen (N), ash (A) and true protein nitrogen (TPN)

SAMPLE	DM	O	N	A	TPN
51	884.8	14.3	17.5	14.8	15.26
52	882.2	14.9	15.2	13.5	12.67
53	886.2	14.8	16.6	14.3	14.78
54	*	17.7	17.3	13.9	*
55	*	10.3	15.4	14.7	*
56	889.8	16.6	17.6	15.5	15.82
57	*	16.6	16.6	14.9	14.10
58	893.0	14.8	16.8	14.9	14.42
59	*	13.4	16.2	14.6	*
60	*	12.8	16.8	15.3	*
61	887.6	15.6	16.9	15.6	14.69
62	*	12.4	16.4	14.6	*
63	893.7	17.0	15.7	15.8	13.22
64	890.9	14.5	16.4	15.6	14.50
65	888.7	15.9	20.8	17.6	18.14
66	*	17.2	20.8	18.0	*
67	889.2	13.7	19.7	17.6	17.65
68	*	15.8	19.4	16.5	*
69	891.6	12.5	19.0	15.5	16.30
70	886.0	12.0	19.0	15.4	16.24
71	890.7	11.9	19.1	15.5	15.70
72	889.2	14.4	19.6	14.6	16.93
73	889.2	13.4	18.6	16.2	16.46
74	892.8	13.1	18.2	32.5	17.02
75	892.0	12.5	19.5	14.7	15.74
76	889.4	11.4	18.8	15.7	16.46
77	889.4	14.2	19.5	15.3	17.71
78	885.7	11.7	19.7	14.1	15.82
79	*	14.0	18.3	14.0	*
80	890.5	12.5	20.1	13.8	17.06
81	891.2	13.7	19.6	13.9	17.63
82	890.9	15.9	17.8	13.5	15.46
83	888.5	14.3	16.2	13.6	14.27
84	896.3	16.7	17.6	14.8	15.54
85	890.6	13.1	18.1	12.8	15.76
86	896.4	15.3	16.9	15.6	13.23
87	893.0	18.4	16.5	15.0	14.70
88	*	13.5	16.9	14.8	*
89	894.1	12.2	16.5	16.5	14.29
90	890.0	13.6	14.7	16.3	13.09
91	*	11.8	15.9	15.0	*
92	889.8	14.2	18.7	14.0	16.46
93	891.3	13.9	17.4	13.5	14.85
94	*	13.4	17.2	13.6	*
95	892.6	12.0	12.9	15.4	10.58
96	892.7	13.4	18.4	15.4	15.41
97	890.4	12.5	15.6	14.3	12.67
98	892.2	14.2	21.5	14.0	18.77
99	891.4	15.1	17.6	14.6	14.85
100	893.4	14.8	22.3	13.6	19.46
101	895.0	17.6	16.3	14.6	13.86
102	896.0	16.1	23.7	12.0	20.66

Table 9

Summary of proximate composition of wheat samples (g/kg as received)

	DM	O	N	A	TPN
MEAN	885.0	14.0	18.0	14.7	15.64
MINIMUM	866.4	9.5	12.9	12.0	10.37
MAXIMUM	896.4	18.4	23.7	32.5	20.66
SD	7.96	1.89	2.04	2.18	2.13
SE	0.94	0.19	0.20	0.22	0.25

Table 10

Estimates of components of wheat - oil (O), nitrogen (N) and true protein nitrogen (TPN) - with significant variety effects.

Variety	O (g/kg)	Variety	N (g/kg)	Variety	TPN (g/kg)
Tonic	16.5	Sperber	17.4	Sperber	14.9
Mission	15.7	Tonic	16.9	Avalon	14.6
V3	15.4	Avalon	16.9	Mercia	14.4
Parade	14.9	Mission	16.6	Galahad	14.4
Brock	14.8	Alexandria	16.4	Mandate	14.3
Alexandria	14.8	Mandate	16.3	Tonic	14.2
Sperber	14.8	Parade	16.3	V1	14.2
Riband	14.6	Galahad	16.3	Alexandria	14.0
Avalon	14.6	V1	16.2	Parade	14.0
V4	14.5	Fortress	16.2	Apostle	14.0
Mandate	14.4	Mercia	16.2	Mission	14.0
Slejpner	14.3	Apostle	16.2	Fortress	14.0
Mercia	14.2	V6	16.0	V6	14.0
V1	14.0	Apollo	15.8	Apollo	14.0
V2	13.9	V4	15.8	Rendezvous	13.9
Galahad	13.9	V3	15.8	V3	13.9
Hornet	13.8	V2	15.7	V4	13.9
V6	13.7	V5	15.7	Brock	13.9
V5	13.3	Brock	15.7	V5	13.8
Apostle	13.1	Rendezvous	15.6	V2	13.8
Fortress	12.6	Slejpner	15.5	Slejpner	13.8
Rendezvous	11.9	Hornet	15.4	Hornet	13.7
Apollo	11.6	Riband	14.8	Riband	13.2
SED	0.96		0.64		0.57

Table 10 (Continued)

Estimates of components of wheat - total amino acids (TAA) and threonine (Thr) - with significant variety effects.

Variety	TAA (g/kg)	Variety	Thr(g/kg)
Mandate	91.14	Avalon	3.01
Avalon	90.87	Tonic	2.95
Mercia	90.69	Mandate	2.95
Alexandria	89.47	Fortress	2.94
Mission	89.04	Mercia	2.91
Sperber	88.16	Galahad	2.90
Tonic	87.57	Slejpner	2.90
V1	87.04	Apostle	2.90
Apostle	86.74	V6	2.90
Brock	86.55	Sperber	2.89
V6	86.45	Alexandria	2.88
Fortress	86.32	V4	2.88
Apollo	85.74	V1	2.87
V2	85.45	V5	2.87
V4	85.40	V2	2.87
V3	85.30	Mission	2.86
V5	85.27	V3	2.86
Parade	85.21	Apollo	2.86
Slejpner	84.92	Parade	2.86
Galahad	84.59	Riband	2.82
Rendezvous	84.46	Brock	2.81
Riband	83.18	Hornet	2.78
Hornet	82.53	Rendezvous	2.76
SED	3.65		0.101

Table 10 (Continued)

Estimates of components of wheat - cystine (Cys), methionine (Met) and Cys + Met - with significant variety effects.

Variety	Cys (g/kg)	Variety	Met (g/kg)	Variety	Met+Cys(g/kg)
Avalon	2.64	Avalon	1.79	Avalon	4.49
Sperber	2.56	Apostle	1.68	Apostle	4.33
Apostle	2.54	Galahad	1.66	Tonic	4.22
Mercia	2.53	Tonic	1.66	Mission	4.22
Tonic	2.52	Mission	1.65	Sperber	4.18
Apollo	2.51	Mandate	1.65	Galahad	4.18
Galahad	2.51	Apollo	1.65	Mandate	4.18
Mission	2.50	V1	1.63	Apollo	4.17
V6	2.49	Alexandria	1.63	Mercia	4.14
Mandate	2.49	V6	1.63	V6	4.13
Alexandria	2.48	Mercia	1.62	Alexandria	4.10
V1	2.47	Parade	1.62	V1	4.10
V4	2.45	V4	1.61	V4	4.04
Fortress	2.45	V3	1.61	V5	4.00
V5	2.45	Sperber	1.60	V3	3.99
V2	2.44	Rendezvous	1.60	Slejpner	3.98
V3	2.43	Slejpner	1.59	V2	3.98
Slejpner	2.42	Riband	1.59	Parade	3.95
Parade	2.40	V5	1.59	Fortress	3.95
Rendezvous	2.38	V2	1.58	Rendezvous	3.91
Brock	2.38	Hornet	1.56	Brock	3.87
Hornet	2.35	Brock	1.56	Hornet	3.84
Riband	2.26	Fortress	1.55	Riband	3.74
SED	0.137		0.083		0.207

Table 11

Estimates for components of wheat - ash (A), nitrogen (N), total amino acids (TAA), threonine (Thr) and the true metabolisable energy : gross energy ratio (TME_N/GE) - with significant fungicide effects.

Treatment	A(g/kg)	N(g/kg)	TAA(g/kg)	Thr(g/kg)	TME_N/GE
Separate control	14.80	16.80	91.46	3.09	0.820
F1	12.37	15.80	87.12	2.58	0.846
F2	11.86	15.91	82.65	2.88	0.822
F3	14.78	15.69	84.37	2.91	0.817
F4	14.31	16.16	87.47	2.94	-
SED[1]	1.36	0.57	4.50	0.14	0.088
SED[2]	0.77	0.30	2.40	0.08	0.044
Combined control	14.94	16.80	91.70	3.10	0.820
F1-F4	12.94	15.89	84.62	2.83	0.824
SED	0.56	0.22	1.77	0.06	0.033

SED[1] - Standard error of difference between control and F1 or F3 or F4

SED[2] - Standard error of difference between control and F2

Table 12

Gross and True Metabolisable Energy (GE and TME_N) contents of wheat samples

kJ/g
(as received)

SAMPLE	GE	TME_N	GE/TME_N
1	*	*	*
2	*	*	*
3	*	*	*
4	*	*	*
5	*	*	*
6	*	*	*
7	16.36	13.13	0.803
8	16.30	13.15	0.807
9	*	*	*
10	*	*	*
11	16.16	13.50	0.835
12	16.18	13.49	0.834
13	*	*	*
14	*	*	*
15	16.06	13.44	0.837
16	16.25	13.24	0.815
17	16.06	13.19	0.821
18	16.35	13.41	0.820
19	15.98	13.09	0.819
20	16.13	13.00	0.806
21	15.88	12.95	0.815
22	15.92	13.19	0.829
23	16.16	13.49	0.835
24	16.18	13.50	0.834
25	15.68	13.03	0.831
26	16.23	13.67	0.842
27	15.58	12.98	0.833
28	15.75	13.15	0.835
29	16.36	13.34	0.815
30	*	*	*
31	*	*	*
32	*	*	*
33	16.01	13.22	0.826
34	15.61	13.22	0.847
35	15.48	12.99	0.839
36	16.64	13.95	0.838
37	16.66	14.41	0.865
38	15.69	13.04	0.831
39	*	*	*
40	16.84	14.20	0.843
41	15.81	13.23	0.837
42	15.96	13.36	0.837
43	*	*	*
44	*	*	*
45	16.32	13.81	0.846
46	16.30	13.65	0.837
47	16.42	13.64	0.831
48	*	*	*
49	*	*	*
50	*	*	*

Table 12 (Continued)

Gross and True Metabolisable Energy (GE and TME_N) contents of wheat samples

kJ/g
(as received)

SAMPLE	GE	TME_N	GE/TME_N
51	16.41	13.56	0.826
52	16.40	13.74	0.838
53	16.31	13.41	0.822
54	*	*	*
55	*	*	*
56	16.60	13.68	0.824
57	16.50	13.82	0.838
58	16.28	13.39	0.822
59	*	*	*
60	*	*	*
61	16.19	13.37	0.826
62	*	*	*
63	16.48	13.60	0.825
64	16.32	13.32	0.816
65	16.42	13.67	0.833
66	*	*	*
67	16.39	13.51	0.824
68	*	*	*
69	16.37	13.59	0.830
70	16.25	13.57	0.835
71	16.46	13.51	0.821
72	16.37	13.59	0.830
73	16.38	13.58	0.829
74	16.04	13.31	0.830
75	16.11	13.31	0.826
76	16.12	13.21	0.819
77	16.24	13.35	0.822
78	15.95	13.17	0.826
79	*	*	*
80	16.23	13.58	0.837
81	16.18	13.56	0.838
82	16.43	13.33	0.811
83	16.16	13.60	0.842
84	16.22	13.75	0.848
85	16.30	13.48	0.827
86	16.22	13.21	0.814
87	16.24	13.18	0.812
88	*	*	*
89	16.32	13.22	0.810
90	16.11	13.07	0.811
91	*	*	*
92	16.40	13.15	0.802
93	16.43	13.26	0.807
94	*	*	*
95	15.86	12.87	0.811
96	16.59	13.54	0.816
97	16.44	13.41	0.816
98	16.66	13.51	0.811
99	16.45	13.48	0.819
100	16.66	13.54	0.813
101	16.60	13.37	0.805
102	16.77	13.44	0.801

Table 13

Summary of Gross and True Metabolisable Energy (kJ/g as received) of wheat samples

	GE	TME_N	GE/TME_N
MEAN	16.24	13.41	0.826
MINIMUM	15.48	12.87	0.801
MAXIMUM	16.84	14.41	0.865
SD	0.28	0.28	0.013
SE	0.03	0.03	0.002

Table 14

Amino acid compositions of wheat samples

g/kg
(as received)

SAMPLE	ALA	ARG	ASP	CYS	GLU	GLY
1	5.03	4.08	6.54	2.62	33.74	4.51
2	4.79	4.84	5.27	2.56	29.75	3.98
3	4.82	4.23	6.00	2.47	32.06	3.78
4	4.72	5.18	6.06	2.67	29.36	4.24
5	5.17	5.91	6.66	2.64	32.77	4.31
6	5.06	5.46	6.17	2.49	31.60	4.73
7	4.83	4.81	6.22	2.65	25.72	4.06
8	4.73	5.06	5.40	2.46	23.42	3.65
9	4.78	4.27	5.57	2.34	26.95	3.53
10	5.23	5.39	6.19	2.51	29.43	3.96
11	4.58	4.65	5.77	2.36	21.52	3.60
12	4.50	4.06	5.61	2.16	20.44	3.48
13	5.08	2.36	5.43	2.43	25.19	3.48
14	4.50	3.39	5.08	2.54	28.49	3.45
15	3.71	3.21	5.12	2.20	21.77	2.94
16	4.10	3.24	5.65	2.77	29.36	3.88
17	4.11	3.33	5.25	2.44	26.46	3.29
18	5.47	4.82	6.84	3.02	33.72	4.56
19	3.81	4.03	5.13	2.34	23.27	3.09
20	4.93	4.25	6.29	2.99	27.94	4.01
21	5.32	3.36	5.77	2.92	36.99	4.00
22	5.22	2.74	6.29	2.34	39.73	3.75
23	5.93	2.93	6.10	2.61	29.68	3.71
24	6.20	3.47	6.10	2.68	30.29	3.34
25	6.80	2.18	6.10	2.41	28.00	3.33
26	6.88	3.57	6.13	2.73	33.93	3.67
27	6.42	1.25	5.54	2.82	26.36	3.02
28	6.54	2.78	5.54	2.55	25.84	3.18
29	7.52	2.32	6.77	2.94	33.62	3.58
30	7.62	3.00	6.36	3.06	31.92	3.79
31	6.29	2.33	5.54	2.54	22.38	2.90
32	4.44	3.40	5.45	2.71	27.44	3.52
33	4.37	3.00	5.42	2.91	31.71	3.85
34	4.45	2.90	5.05	2.17	28.91	4.45
35	4.64	3.24	5.15	2.17	31.10	3.90
36	4.55	3.16	5.16	2.20	27.50	3.65
37	4.02	2.69	4.72	2.00	24.37	3.11
38	4.59	3.74	4.94	2.42	32.13	3.56
39	6.52	2.20	5.49	2.07	24.87	3.04
40	4.51	3.08	5.10	2.16	29.72	3.52
41	4.19	3.12	5.14	2.17	28.18	3.66
42	6.39	3.82	4.78	2.60	25.14	3.09
43	4.57	3.35	5.17	2.50	33.37	3.69
44	4.38	4.28	5.21	2.42	28.18	3.44
45	6.03	3.90	5.22	2.66	23.96	3.14
45	5.81	3.24	5.12	2.49	23.51	2.82
47	6.01	3.68	5.00	2.39	24.52	3.18
48	6.12	3.75	4.97	2.51	22.82	2.87
49	4.27	2.76	4.76	2.16	28.02	3.56
50	4.31	2.98	5.30	2.16	30.83	3.54

Table 14 (Continued)

Amino acid compositions of wheat samples

g/kg
(as received)

SAMPLE	ALA	ARG	ASP	CYS	GLU	GLY
51	4.98	3.27	5.81	2.42	30.73	3.54
52	4.90	2.94	4.90	2.10	26.41	3.27
53	4.41	3.41	5.31	2.32	30.45	3.53
54	6.34	3.52	5.01	2.43	23.22	2.99
55	5.75	2.79	5.12	2.27	21.42	2.59
56	6.22	3.31	5.24	2.52	26.31	2.93
57	5.93	3.26	5.20	2.22	22.02	2.73
58	5.96	3.33	5.19	2.25	20.40	2.86
59	5.97	3.78	5.45	2.19	20.33	2.80
60	6.29	3.31	5.52	2.20	21.57	2.77
61	6.46	3.36	5.36	2.99	21.64	2.89
62	5.93	3.59	4.95	2.25	19.86	2.74
63	6.05	3.42	5.17	2.34	19.50	2.65
64	6.09	3.10	5.31	2.98	20.73	2.72
65	7.19	4.01	6.01	3.50	30.41	3.44
66	7.50	3.55	6.70	3.53	28.20	3.54
67	7.10	2.78	6.09	3.36	28.35	3.18
68	7.27	3.27	6.27	3.47	24.53	3.31
69	6.65	2.49	6.22	3.50	33.28	3.46
70	7.15	3.38	6.90	3.47	31.28	3.62
71	6.22	4.06	6.41	3.39	35.28	3.71
72	6.81	2.24	5.95	3.22	34.84	3.34
73	6.79	3.03	6.02	3.29	32.41	3.23
74	5.01	3.34	6.56	3.43	34.66	3.38
75	6.51	2.28	5.74	3.53	33.44	3.40
76	5.58	3.33	6.59	3.47	25.56	3.21
77	7.02	3.52	5.76	3.49	26.61	3.21
78	6.52	2.56	5.63	3.47	24.27	3.32
79	7.26	3.04	6.86	3.42	35.10	3.50
80	6.95	2.52	6.29	3.70	37.12	3.70
81	6.91	2.96	5.73	3.63	26.18	3.29
82	6.82	3.49	6.03	2.58	23.25	3.14
83	6.20	3.16	5.47	2.16	21.72	2.94
84	6.25	3.75	5.38	3.14	25.51	2.99
85	6.48	3.69	5.28	2.54	24.68	3.10
86	5.99	3.32	5.08	2.30	21.13	2.87
87	5.85	3.87	4.82	2.11	22.17	2.90
88	5.70	3.73	5.04	2.31	22.94	3.03
89	6.07	3.71	5.17	2.10	22.37	2.95
90	5.62	2.94	4.61	1.86	19.94	2.73
91	5.77	3.51	4.95	2.18	20.86	2.79
92	6.49	3.93	5.72	2.68	26.92	3.29
93	6.15	3.49	5.29	2.46	21.59	3.24
94	6.50	3.55	5.35	2.43	23.54	3.12
95	3.74	3.54	4.41	2.26	16.96	2.80
96	4.86	3.09	6.89	2.94	31.40	4.02
97	4.01	4.57	5.39	2.53	25.61	3.46
98	5.10	6.33	6.77	3.34	30.15	4.34
99	4.22	3.11	5.66	2.71	30.22	3.73
100	5.30	4.56	7.21	3.26	41.52	4.82
101	3.99	3.23	5.43	2.42	28.39	3.57
102	5.31	5.18	7.57	3.13	44.62	4.81

Table 15

Amino acid compositions of wheat samples

g/kg
(as received)

SAMPLE	HIS	ILE	LEU	LYS	MET	CYS+MET
1	3.28	4.02	8.16	2.89	1.86	4.48
2	2.93	3.50	7.35	2.61	1.72	4.28
3	3.14	3.74	7.48	2.79	1.81	4.28
4	3.00	3.69	7.48	2.88	1.80	4.47
5	2.13	3.75	7.99	2.57	1.98	4.62
6	2.41	4.17	7.58	2.77	1.92	4.41
7	2.40	3.34	6.89	3.12	1.80	4.45
8	2.26	2.78	6.23	2.52	1.71	4.17
9	2.34	3.23	6.57	2.41	1.58	3.92
10	2.44	3.38	7.07	2.70	1.96	4.47
11	2.23	2.96	6.21	2.60	1.72	4.08
12	2.48	3.18	6.40	2.48	1.83	3.99
13	2.58	2.73	6.53	2.50	1.68	4.11
14	2.61	2.56	6.31	2.26	1.76	4.30
15	1.76	2.62	5.26	2.15	1.34	3.54
16	2.02	2.87	6.62	2.54	1.59	4.36
17	2.01	2.64	5.92	2.06	1.75	4.19
18	2.76	4.11	8.49	2.77	1.79	4.81
19	1.67	2.52	5.32	2.38	1.51	3.85
20	2.44	3.50	7.11	2.62	1.86	4.85
21	3.06	3.59	7.87	2.38	2.20	5.12
22	3.10	3.32	7.64	2.62	1.72	4.06
23	2.58	3.58	7.35	2.45	1.98	4.59
24	2.81	3.41	7.47	2.42	2.22	4.90
25	2.74	3.28	7.01	2.60	1.85	4.26
26	2.46	3.19	7.42	2.32	2.16	4.89
27	2.33	3.06	6.68	2.27	1.95	4.77
28	2.30	2.96	6.76	2.35	1.71	4.26
29	3.10	3.70	8.27	2.62	1.73	4.67
30	2.59	3.54	7.94	2.24	2.20	5.26
31	2.32	2.85	6.26	2.32	1.74	4.28
32	2.41	2.75	6.41	2.49	1.86	4.57
33	2.70	3.32	7.11	2.48	1.76	4.67
34	2.58	2.77	6.36	2.09	1.40	3.57
35	2.61	3.04	6.60	2.40	1.60	3.77
36	2.52	2.70	6.48	2.45	1.63	3.83
37	2.36	2.54	5.76	2.02	1.35	3.35
38	2.74	2.90	6.95	2.03	1.62	4.04
39	2.25	2.86	6.47	2.57	1.58	3.65
40	2.71	3.19	6.67	2.35	1.44	3.60
41	2.46	3.00	6.31	2.25	1.51	3.68
42	2.18	2.98	6.66	2.56	1.69	4.29
43	2.35	3.10	6.68	2.38	1.80	4.30
44	2.46	3.08	6.22	2.27	1.92	4.34
45	2.05	3.08	6.35	2.50	2.25	4.91
46	2.01	2.98	6.11	2.31	1.72	4.21
47	2.03	2.72	6.15	2.28	1.49	3.88
48	2.06	2.69	6.12	2.36	1.68	4.19
49	2.46	2.73	5.93	3.30	1.42	3.58
50	2.41	3.00	6.70	3.05	1.40	3.56

Table 15 (Continued)

Amino acid compositions of wheat samples

g/kg
(as received)

SAMPLE	HIS	ILE	LEU	LYS	MET	CYS+MET
51	2.41	3.47	7.31	3.82	1.68	4.10
52	2.29	2.80	5.98	2.04	1.43	3.53
53	2.70	2.73	6.63	2.35	1.55	3.87
54	2.13	2.67	6.25	2.30	1.69	4.12
55	1.83	2.62	5.53	2.26	1.48	3.75
56	1.94	3.09	6.39	2.15	1.84	4.36
57	1.84	1.80	5.98	2.24	1.61	3.83
58	1.84	2.84	5.90	2.39	1.44	3.69
59	1.88	2.55	5.68	2.44	1.58	3.77
60	2.02	2.52	5.92	2.32	1.52	3.72
61	2.00	2.68	6.23	2.37	1.46	4.45
62	1.89	2.93	6.02	2.31	1.49	3.74
63	1.88	2.81	5.82	2.62	1.83	4.17
64	1.82	2.87	5.97	2.42	1.37	4.35
65	2.48	3.27	7.58	2.27	1.62	5.12
66	2.41	3.13	7.44	2.59	1.60	5.13
67	2.32	3.12	7.23	2.57	1.54	4.90
68	2.52	3.46	7.24	2.81	1.54	5.01
69	2.45	3.46	7.32	2.52	1.65	5.15
70	2.35	3.58	7.42	2.76	1.58	5.05
71	2.49	3.23	7.43	2.65	1.32	4.71
72	2.34	2.94	7.09	2.19	1.45	4.67
73	2.44	3.26	7.04	2.47	1.41	4.70
74	1.98	3.58	7.21	2.41	1.60	5.03
75	2.35	3.49	7.24	2.47	1.59	5.12
76	2.38	3.62	7.11	2.81	1.50	4.97
77	2.26	3.25	7.12	2.50	1.52	5.01
78	2.02	2.86	6.64	2.24	1.40	4.87
79	2.35	3.40	7.48	2.69	1.63	5.05
80	2.44	3.64	7.74	2.46	1.80	5.50
81	2.28	3.43	7.29	2.32	1.60	5.23
82	2.20	3.18	6.72	2.39	1.92	4.50
83	2.06	2.68	6.11	2.24	1.47	3.63
84	2.19	2.84	6.54	2.43	1.42	4.56
85	2.21	3.00	6.66	2.32	1.79	4.33
86	1.96	2.92	6.07	2.44	1.51	3.81
87	1.93	2.90	6.11	2.31	1.48	3.59
88	2.00	2.92	6.14	2.43	1.70	4.01
89	2.00	2.60	6.10	2.52	1.38	3.48
90	1.83	2.29	5.27	2.23	1.37	3.23
91	1.93	2.54	5.75	2.33	1.56	3.74
92	2.21	3.31	7.10	2.49	1.79	4.47
93	2.12	3.07	6.61	2.40	1.68	4.14
94	2.01	3.07	6.58	2.38	1.51	3.94
95	1.58	2.48	4.81	2.20	1.38	3.64
96	2.48	3.38	7.24	2.93	1.72	4.66
97	1.93	3.02	6.01	2.38	1.54	4.07
98	2.63	3.93	7.94	3.21	1.99	5.33
99	2.06	3.00	6.39	2.30	1.73	4.44
100	2.81	4.15	8.54	2.74	2.06	5.32
101	2.05	2.99	5.97	2.30	1.51	3.93
102	2.85	3.88	8.58	3.08	1.93	5.06

Table 16

Amino acid compositions of wheat samples

g/kg
(as received)

SAMPLE	PHE	PRO	SER	THR	TYR	VAL	TAA
1	4.81	14.63	6.60	4.15	2.33	5.55	114.80
2	4.73	12.82	6.18	3.51	2.09	4.73	103.36
3	4.78	14.32	5.95	3.63	2.37	4.81	108.18
4	4.39	9.61	6.12	3.69	2.60	3.69	101.18
5	4.65	13.63	6.70	3.94	2.65	5.11	112.56
6	4.42	12.63	6.37	4.37	2.56	5.59	110.30
7	4.06	11.16	5.56	3.87	2.59	4.97	98.05
8	3.65	10.08	5.18	3.62	2.53	4.12	89.40
9	3.86	10.43	5.48	3.63	2.35	4.79	94.11
10	4.21	11.10	5.92	4.08	2.48	4.77	102.82
11	3.43	10.58	5.25	3.47	2.51	4.33	87.77
12	3.50	10.92	4.96	3.58	2.92	4.54	87.04
13	4.23	14.48	5.28	2.91	3.33	4.38	94.60
14	3.80	13.78	5.20	3.02	2.94	4.30	95.99
15	2.66	11.98	4.30	2.92	2.11	3.94	79.99
16	3.53	14.72	5.42	3.28	2.61	4.21	98.41
17	3.21	14.37	5.01	3.09	2.33	4.04	91.31
18	5.14	14.87	6.68	3.94	3.72	5.65	118.35
19	2.90	12.36	4.42	2.86	2.39	3.69	83.69
20	4.21	11.28	5.83	3.97	2.91	5.27	101.41
21	5.18	14.85	6.64	3.65	2.82	4.99	115.59
22	4.94	19.39	6.15	3.26	3.81	3.16	119.18
23	4.04	13.42	6.31	3.54	3.24	4.93	104.38
24	4.72	11.85	6.43	3.36	3.24	5.79	105.80
25	4.63	13.63	5.76	3.00	3.50	5.38	102.20
26	4.33	16.17	6.08	3.27	3.24	5.20	112.75
27	4.11	11.38	5.56	2.95	3.12	5.28	94.10
28	4.10	11.22	5.04	3.13	3.15	4.70	93.85
29	5.49	13.61	6.99	3.30	3.98	5.87	115.41
30	5.00	13.52	6.74	3.64	3.88	5.74	112.78
31	3.88	9.50	5.29	2.81	2.97	4.72	86.64
32	3.84	11.41	5.50	3.12	3.25	4.19	94.19
33	4.20	11.83	5.90	3.18	3.27	4.88	101.89
34	3.54	11.77	5.12	3.01	3.02	4.32	93.91
35	3.58	12.77	5.52	3.28	3.29	4.32	99.21
36	3.62	10.65	5.25	3.09	2.99	4.55	92.15
37	3.51	10.85	4.54	2.65	2.86	3.68	83.03
38	4.03	13.08	5.58	3.14	3.22	4.15	100.82
39	3.64	8.89	5.42	2.94	2.98	5.12	88.91
40	3.73	11.61	5.22	3.07	3.02	4.90	96.00
41	3.85	12.78	5.13	3.04	3.02	4.24	94.05
42	3.87	9.86	5.81	3.08	3.00	4.75	92.26
43	4.00	14.16	5.24	2.84	3.29	4.54	103.03
44	4.03	11.65	4.93	3.10	3.07	4.31	94.95
45	3.68	10.56	5.18	2.95	3.03	4.96	91.50
46	3.54	8.85	4.86	2.53	2.89	4.82	85.61
47	3.43	11.19	5.32	2.90	2.94	4.45	89.68
48	3.66	8.59	5.24	2.87	2.62	4.59	85.52
49	3.72	13.00	4.68	2.65	3.22	4.03	92.67
50	4.22	13.96	4.57	2.64	3.24	4.46	98.77

Table 16 (Continued)

Amino acid compositions of wheat samples

g/kg
(as received)

SAMPLE	PHE	PRO	SER	THR	TYR	VAL	TAA
51	4.81	14.62	5.44	3.07	3.68	5.33	106.39
52	3.81	12.07	4.57	2.65	2.93	4.38	89.47
53	5.13	11.87	5.24	3.04	3.20	4.08	97.95
54	3.51	9.51	5.51	2.91	2.89	4.44	87.32
55	2.98	7.89	4.59	2.57	2.46	4.33	78.48
56	3.45	10.02	5.20	2.81	2.77	4.99	91.18
57	3.29	8.65	4.89	2.71	2.66	4.64	81.67
58	3.23	8.71	4.73	2.72	2.77	4.66	81.22
59	3.06	8.52	4.80	2.68	2.47	4.35	80.53
60	3.30	8.81	5.01	2.72	2.61	4.82	83.23
61	3.42	9.31	5.26	2.95	2.61	4.82	85.81
62	3.32	8.24	4.78	2.60	2.77	4.74	80.41
63	3.27	7.29	4.75	2.75	2.52	4.69	79.36
64	3.20	8.28	4.71	2.60	2.58	4.93	81.68
65	4.33	12.77	6.47	3.27	3.33	5.19	107.14
66	4.46	12.60	6.23	3.33	3.34	5.13	105.28
67	4.14	10.93	6.07	3.15	3.32	5.15	100.40
68	4.27	10.64	5.53	3.01	3.43	5.79	98.36
69	4.33	12.10	5.83	3.45	3.24	5.28	107.23
70	4.41	12.20	5.83	3.23	3.46	5.47	108.09
71	4.22	13.45	6.07	3.35	3.78	5.14	112.20
72	4.01	13.32	6.12	3.11	3.01	4.71	106.69
73	3.94	11.87	5.74	3.19	3.16	5.07	104.36
74	3.70	23.06	5.69	3.43	2.77	5.55	117.36
75	4.14	11.93	5.63	2.12	3.38	5.30	104.54
76	4.76	10.85	5.63	2.98	3.57	5.58	98.53
77	4.23	11.58	5.89	3.12	3.28	5.23	99.59
78	3.92	10.78	5.52	2.96	2.50	4.52	91.13
79	4.60	14.75	5.64	3.23	3.80	5.02	113.77
80	4.20	12.58	6.18	3.31	3.41	5.37	113.41
81	4.23	11.10	5.75	3.14	3.32	5.58	98.74
82	3.85	10.53	5.30	2.94	3.00	5.42	92.76
83	3.69	9.13	4.96	2.74	2.82	4.59	84.14
84	3.91	10.46	5.48	2.88	2.97	4.54	92.68
85	3.97	10.05	5.28	2.97	3.09	4.82	91.93
86	3.62	9.13	4.71	2.67	2.94	4.86	83.52
87	3.46	9.38	4.79	2.68	2.82	4.92	84.50
88	3.60	8.91	4.75	2.59	2.84	4.70	85.33
89	3.63	9.07	4.85	2.60	2.75	4.17	84.04
90	2.90	7.78	4.24	2.47	2.48	4.08	74.64
91	3.41	8.88	4.70	2.57	2.72	4.12	80.57
92	4.07	10.81	5.64	2.98	3.12	5.12	97.67
93	3.81	9.38	5.21	2.74	3.18	5.27	87.69
94	3.68	10.26	5.22	2.83	2.99	5.22	90.24
95	2.79	10.95	3.96	2.84	2.20	3.61	72.51
96	4.34	17.48	5.83	3.69	2.98	4.85	110.12
97	3.22	13.57	4.98	3.37	2.47	4.25	92.31
98	4.62	13.68	6.56	4.21	3.35	5.68	113.74
99	3.58	16.66	5.43	3.61	2.79	4.37	101.57
100	4.89	23.79	7.13	4.36	3.99	6.06	137.19
101	3.47	15.19	4.88	3.39	2.60	4.10	95.48
102	5.73	25.43	7.50	4.41	4.13	5.54	143.68

Table 17

Summary of the amino acid compositions of wheat samples

	ALA	ARG	ASP	CYS	GLU	GLY	HIS	ILE	LEU	LYS
MEAN	5.59	3.50	5.65	2.66	27.55	3.43	2.32	3.10	6.73	2.48
MINIMUM	3.71	1.25	4.41	1.86	16.96	2.59	1.58	1.80	4.81	2.02
MAXIMUM	7.62	6.33	7.57	3.70	44.62	4.82	3.28	4.17	8.58	3.82
SD	1.02	0.83	0.64	0.46	5.23	0.50	0.35	0.43	0.76	0.28
SE	0.10	0.08	0.06	0.05	0.52	0.05	0.04	0.04	0.08	0.03

	MET	CYS+MET	PHE	PRO	SER	THR	TYR	VAL	TAA
MEAN	1.67	4.32	3.96	12.03	5.48	3.15	2.99	4.79	97.09
MINIMUM	1.32	3.23	2.66	7.29	3.96	2.12	2.09	3.16	72.51
MAXIMUM	2.25	5.50	5.73	25.43	7.50	4.41	4.13	6.06	143.68
SD	0.21	0.54	0.60	3.10	0.68	0.46	0.43	0.57	12.58
SE	0.02	0.05	0.06	0.31	0.07	0.05	0.04	0.06	1.25

Table 18

Mean analytical results for individual wheat samples (experiment 1)

YEAR	%DM	OIL (%)		CPR (%)		ASH (%)		DENS	TGW	DFM
		ar	dm	ar	dm	ar	dm	(kg/hl)	(g)	(%)
84	86.6	1.4	1.6	11.9	13.7	1.5	1.7	68.0	37.0	3.2
84	84.4	1.2	1.4	11.4	13.6	1.4	1.7	67.3	37.2	12.7
84	85.8	1.4	1.6	12.7	14.8	1.5	1.8	67.6	42.9	0.5
84	84.3	1.3	1.5	12.1	14.3	1.4	1.7	67.6	43.3	2.7
84	85.6	1.3	1.5	11.1	13.0	1.2	1.4	71.8	53.3	0.6
84	87.4	1.1	1.3	11.1	12.7	1.4	1.6	72.4	49.6	0.8
84	85.3	1.2	1.4	10.8	12.7	1.3	1.5	72.9	45.8	4.2
84	85.4	1.2	1.4	11.3	13.2	1.2	1.4	73.3	45.2	1.2
84	85.9	1.3	1.5	10.6	12.4	1.3	1.5	76.7	46.1	1.9
84	85.8	1.3	1.5	10.8	12.6	1.3	1.5	78.2	47.5	3.1
84	86.1	1.3	1.5	9.7	11.3	1.2	1.4	77.0	46.8	5.8
84	87.8	1.2	1.4	12.3	14.0	1.2	1.4	78.5	47.7	1.8
84	88.5	1.5	1.7	10.7	12.1	1.2	1.4	76.5	53.7	3.2
84	88.5	1.7	1.9	13.1	14.8	1.3	1.5	75.6	43.4	4.4
84	87.7	1.6	1.8	10.5	12.0	1.4	1.6	77.6	52.1	1.8
85	88.1	1.7	1.9	11.9	13.5	1.5	1.7	67.1	39.3	4.5
85	89.2	1.6	1.8	13.8	15.5	1.4	1.6	68.2	36.0	2.8
85	88.0	1.6	1.8	13.3	15.1	1.7	1.9	64.2	35.6	1.3
85	88.4	1.8	2.0	11.1	12.5	1.5	1.7	66.3	39.1	3.5
85	89.1	1.7	1.9	13.0	14.6	1.7	1.9	64.7	35.4	5.8
85	89.6	1.6	1.8	13.4	15.0	1.4	1.5	69.7	36.7	2.1

Table 19

Mean energy values for individual wheat samples

YEAR	GE (kJ/g)		TME_N (kJ/g)	
	ar	dm	ar	dm
84	15.99	18.46	12.68	14.64
84	15.56	18.44	12.44	14.74
84	15.84	18.46	12.70	14.80
84	15.51	18.40	12.51	14.84
84	15.74	18.39	12.59	14.71
84	16.02	18.33	12.85	14.70
84	15.75	18.46	12.78	14.98
84	15.76	18.45	12.78	14.96
84	15.80	18.39	12.85	14.96
84	15.82	18.43	12.73	14.84
84	15.83	18.39	13.08	15.19
84	16.26	18.52	13.21	15.05
84	16.21	18.32	13.25	14.97
84	16.43	18.56	13.00	14.69
84	16.05	18.30	13.06	14.89
85	16.43	18.65	13.10	14.87
85	16.60	18.61	13.30	14.91
85	16.30	18.52	12.90	14.66
85	16.31	18.45	13.01	14.72
85	16.46	18.48	13.25	15.08
85	16.64	18.58	13.51	15.08

Table 20

Mean values for wheat samples from separate years

		1984	1985	BOTH
DM (%)		86.3	88.7	87.0
OIL (%)	ar	1.3	1.7	1.4
	dm	1.5	1.9	1.6
CPR (%)	ar	11.3	12.8	11.7
	dm	13.1	14.4	13.5
ASH (%)	ar	1.1	1.4	1.5
	dm	1.5	1.7	1.6
DENS (kg/hl)		73.4	66.7	71.5
TGW (g)		46.1	37.0	43.5
DFM (%)		3.2	3.3	3.2
GE (kJ/g)	ar	15.90	16.46	16.06
	dm	18.42	18.55	
TME_N (kJ/g)	ar	12.83	13.18	12.93
	dm	14.86	14.86	14.86

Table 21

Within-year correlations amongst analytical and predictive variables for wheat (*,,*** significance, usual convention)**

	DM	OIL	CPR	ASH	DENS	TGW	DFM	GE	TME_N
DM	x	0.48*	0.17	-0.22	0.58**	0.39	-0.26	0.96***	0.83***
OIL		x	0.04	0.11	0.17	0.14	0	0.45*	0.25
CPR			x	0.23	-0.30	-0.47	-0.14	0.33	0
ASH				x	-0.66**	-0.49*	-0.09	-0.27	-0.51
DENS					x	0.60**	-0.22	0.56**	0.77***
TGW						x	-0.48*	0.25	0.44*
DFM							x	-0.22	0.19
GE								x	0.80***
TME_N									x

Table 22

Prediction of TME_N of wheat from different variables

All variables on "as received" basis

Independent variable	r(significance)	rsd[1/]	Regression Coefficients
0	0	0.238	-
DM,%	0.83***	0.136	0.163
GE,MJ/kg	0.80***	0.145	0.828
DENS,kg/hl	0.77***	0.155	0.049
ASH, %	-0.51*	0.211	-1.033
TGW,g	0.44*	0.219	0.024
DM + DENS	0.90***	0.108	0.113 , 0.028
DENS + GE	0.89***	0.114	0.030 , 0.555
DM + ASH	0.89***	0.113	0.148 ,-0.694

[1/] rsd - residual standard deviation calculated within-years irrespective of the significance of year effect

Table 23

Composition and energy values (as received) of wheats of different density (experiment 2)

Sample	1	2	3	4	5	6	7
DENS (kg/hl)	57	66	70	74	77	79	80
TGW (g)	44.1	36.4	43.6	42.3	45.6	40.0	44.2
DM (g/kg)	810	864	875	872	870	872	873
OIL (g/kg)	16	15	16	15	15	16	14
CPR (g/kg)	123.8	93.1	119.4	116.9	123.1	98.1	135.6
ASH (g/kg)	15	14	15	15	14	15	14
GE (kJ/g)	15.08	15.80	16.08	16.05	16.01	15.97	16.05
TME_N(kJ/g)	12.14	12.69	12.86	12.95	12.87	12.86	13.02

Table 24

Analytical values (%), GE and TME_N (kJ/g) contents (as received) of wheats having different Hagberg numbers (experiment 3)

Hagberg Number	DM	O	A	N	GE	TME_N
163	87.8	1.9	1.6	1.80	16.33	13.34
235	87.9	1.8	1.5	1.78	16.46	13.48
262	87.5	1.7	1.4	1.82	16.39	13.51
292	87.6	1.9	1.3	1.87	16.40	13.61

Table 25

Analytical values (%), GE and TME_N (kJ/g) values (as received) of different samples of Slejpner Wheat (experiment 4)

Sample	DM	OIL	ASH	N	GE	TME_N
1	86.8	1.4	1.1	1.86	16.00	13.33
2	87.1	1.4	1.5	1.75	16.04	13.33
3	86.9	1.4	1.5	1.90	15.99	13.28
4	87.3	1.4	1.4	2.16	16.04	13.38
5	88.0	1.6	1.7	1.76	16.30	13.50
6	87.2	1.6	1.5	1.69	16.02	13.44
7	87.0	1.5	1.4	1.97	16.01	13.40
8	87.6	1.3	1.4	1.80	16.15	13.35
9	86.8	1.4	1.4	1.84	15.98	13.15
10	87.4	1.3	1.4	1.78	16.14	13.20
11	87.2	1.5	1.5	1.87	16.05	13.16
12	87.3	1.4	1.0	1.80	16.07	13.17
13	87.8	1.2	1.3	1.97	16.26	13.25
14	88.5	1.5	1.2	1.71	16.21	13.23
15	88.5	1.7	1.3	2.09	16.42	13.14
16	88.7	1.6	1.4	2.10	16.30	13.07
17	88.2	1.2	1.2	2.01	16.30	13.11
18	88.4	1.8	1.5	1.77	16.31	13.03
19	88.9	1.6	1.6	2.08	16.46	13.28
20	88.1	1.7	1.5	1.76	16.43	13.11
21	87.7	1.6	1.4	1.68	16.05	13.07
22	87.0	1.7	1.4	1.82	16.10	13.09
23	87.5	1.6	1.5	1.91	16.07	13.16
24	86.9	1.4	1.4	1.88	16.07	13.34
25	86.8	1.4	1.4	1.90	16.13	13.13
26	87.7	1.3	1.3	1.61	16.20	13.35
27	86.7	1.5	1.4	1.89	16.21	13.09
28	86.5	1.3	1.5	1.86	16.27	13.15

Table 26

Gross energy values (kJ/g, dry matter) of different wheat varieties grown at two sites (experiment 5)

	Site 1	Site 2	Mean
Apollo	18.42	18.45	18.44
Apostle	18.42	18.57	18.50
Brock	18.47	18.46	18.46
Fortress	18.40	18.46	18.43
Galahad	18.43	18.48	18.46
Hornet	18.37	18.41	18.39
Riband	18.48	18.46	18.47
Slejpner	18.41	18.40	18.40
Sperber	18.51	18.58	18.54
Tonic	18.61	18.67	18.64
Mean	18.45±0.07	18.49±0.08	18.47±0.07

Table 27

True metabolisable energy (TME_N) values (kJ/g dry matter) of different wheat varieties grown at two sites (experiment 5)

		Site 2	Mean
Apollo	14.75	14.91	14.83
Apostle	14.91	15.09	15.00
Brock	15.22	15.08	15.15
Fortress	15.08	15.17	15.12
Galahad	14.81	15.31	15.06
Hornet	15.26	15.23	15.24
Riband	15.04	15.19	15.12
Slejpner	15.06	15.45	15.26
Sperber	15.29	15.38	15.34
Tonic	14.97	15.10	15.04
Mean	15.04±0.18	15.19±0.16	15.12±0.14

Table 28

Mean Amino Acid Compositions and Digestibilities of 10 different Wheat varieties

	Amino Acid (g/kg dry matter)	Digestibility (%)
Ala	3.7	83.3
Arg	4.4	87.5
Asp	5.4	80.1
Cys	2.2	87.0
Glu	29.7	95.6
Gly	4.1	N.D.
His	2.5	88.7
iso-Leu	3.4	90.4
Leu	6.7	90.8
Lys	2.8	81.1
Met	1.6	88.9
Phe	4.6	91.3
Pro	10.0	94.9
Ser	4.6	88.4
Thr	2.9	82.2
Tyr	2.7	88.7
Val	4.4	88.1
Try	1.2	N.D.