

# Proposal for modification of predicted ME of whole crop cereal (WCC) forages for dairy cows

## Summary:

a) It is suggested that no adjustment is made to the predicted ME content of fermented WCC when the DM is below 550g/kg.

b) It is suggested that the predicted ME content (MJ/kg DM) of unprocessed, WCC with a DM above 550g/kg and either fermented or urea-treated is adjusted downwards by:

$$(0.26 \times \text{starch content in forage (g/kg DM)} \times 14.4 \text{MJ/kg DM}) / 1000$$

c) It is suggested that no adjustment is made to the predicted ME content of well processed WCC with a DM above 550g/kg and either fermented or urea-treated WCC.

d) It is suggested that for poorly processed WCC with a DM above 550g/kg, either fermented or urea-treated and where 50% or more of the grains appear to not have been chipped or broken, that the predicted ME content (MJ/kg DM) is adjusted by the following:

$$((0.26 \times \text{starch content in forage (g/kg DM)} \times 14.4 \text{MJ/kg DM}) \times 0.5) / 1000$$

e) If none of the grains in processed WCC with a DM above 550g/kg and either fermented or urea-treated appear to have been chipped or broken then the adjustment to ME content for unprocessed WCC should be made as in (b) above.

## Introduction:

Previous studies have identified that the metabolisable energy (ME) content of mature whole crop cereal forages when measured in dairy cows is low (approximately 8.0MJ/kg DM; Sutton *et al.*, 1998). This has been attributed to the low digestibility of the grains, with many whole grains passing through the cow intact (Sutton *et al.*, 1997). Studies in dairy cows have reported that the digestibility of starch in mature whole crop cereal forages that had not been processed varied from 0.63 to 0.81kg/kg (Sutton *et al.*, 1997). When the forage was harvested at a lower DM (below 550g/kg) and fermented, a whole tract apparent digestibility in the region of 0.97kg/kg was reported (Sutton *et al.*, 2002). Recently, a processor has been developed that cracks the grains in WCC at harvest. Studies with dairy cows have shown that the use of a processor increased the calculated digestibility of the starch component in WCC to approximately 0.97kg/kg (Jackson *et al.*, 2004; Bond *et al.*, 2005), a value similar to that for lower DM WCC forages.

The current DEFRA-Link project has used digestibility values determined in sheep to estimate the ME content of whole crop forages to be fed to dairy cows. It is well established that the digestibility of whole grains is higher in sheep than dairy cows (see review of Theurer, 1986) and this has been confirmed for the digestibility of starch in whole crop cereals (Sutton *et al.* 2002). Therefore, some form of adjustment, either chemical (e.g. through an *in vitro* digestibility determination) or mathematical is required. A suggested mathematical adjustment is outlined.

## **Proposal:**

### **a) Fermented whole crop cereals (<550gDM/kg)**

From Sutton *et al.*, (2002) the apparent whole tract digestibility of the starch component in fermented whole crop wheat (n=7) when determined in dairy cows was approximately 0.96-0.97kg/kg. When the apparent digestibility of the same forages were measured in sheep the values ranged from 0.98 to 1.0kg/kg (Sutton *et al.* 2002), although other studies have reported lower starch digestibilities for fermented whole crop wheat (0.90-1.0kg/kg, Adesogan *et al.* 1998; 0.95-0.96kg/kg; Sinclair *et al.* 2003), with a mean value of 0.97kg/kg from 19 published values.

*It is suggested that no adjustment is made to the predicted ME content of fermented WCC when the DM is below 550g/kg.*

### **b) Unprocessed, whole crop cereals with a DM between 550-900g/kg and either fermented or urea-treated.**

From Sutton *et al.*, (1997) the average digestibility of the starch component in mature, unprocessed and urea-treated whole crop wheat was 0.74: this results in 0.26 of the starch being undigested. Determination of the digestibility of unprocessed, urea-treated whole crop wheat in sheep has produced values ranging from 1.0kg/kg (Sutton *et al.* 2002) and 0.95-1.0kg/kg (Adesogan *et al.* 1998), with a mean value of 0.98kg/kg from 11 published values.

Three assumptions are made:

- i) That the gross energy of starch is assumed at 17.8 MJ/kg DM (McDonald *et al.*, 2002).
- ii) That all the starch is potentially digestible, and therefore the digestible energy (DE) is equivalent to the GE.
- iii) That ME is 0.81 of DE (AFRC, 1995).

This results in cereal starch having an ME content of 14.4MJ/kg DM. This compares with tabulated values of 15.0MJ/kgDM for tapioca flour and 14.1MJ/kg DM for maize starch.

If the estimated ME for the unprocessed whole crop forage is adjusted down by the average digestibility values published by Sutton *et al.*, (1997) and the ME content of the starch, then a reasonable correction factor can be obtained. This is outlined in Tables 1 and 2 in Appendix 1 for whole crop forages with varying starch contents.

*It is suggested that the predicted ME content of unprocessed, WCC with a DM above 550g/kg and either fermented or urea-treated is adjusted downwards by:*

$$(0.26 \times \text{starch content in forage (g/kg DM)} \times 14.4\text{MJ/kg DM})/1000$$

### **c) Well processed, whole crop wheat with a DM between 550-900g/kg and either fermented or urea-treated.**

Using the values of Jackson *et al.*, (2004) and Bond *et al.*, (2005), the digestibility of starch in processed whole crop wheat was approximately 0.97kg/kg.

*It is suggested that no adjustment to the ME content of well processed WCC with a DM above 550g/kg and either fermented or urea-treated WCC is made.*

**d) Poorly processed, whole crop wheat with a DM between 550-900g/kg and either urea-treated or fermented.**

Because a processor is fitted to the forager does not guarantee that the forage has been well processed. Processors may be poorly adjusted, worn or damaged. A subjective decision needs to be made regarding the degree of processing of the sample. In the study of Jackson *et al.*, (2004), visual assessment revealed that in a well processed sample, approximately 10-15% of the grains appeared to be intact, yet the whole tract digestibility of the starch determined in dairy cows approached 0.97. It is recommended that if less than 50% of the grains appear to have been visually cracked or chipped then the sample should be assumed to be poorly processed and the following adjustment made:

*It is suggested that for poorly processed WCC with a DM above 550g/kg, either fermented or urea-treated and where 50% or more of the grains appear to not have been chipped or broken, that the predicted ME content is adjusted by:*

$$((0.26 \times \text{starch content in forage (g/kg DM)} \times 14.4\text{MJ/kg DM}) \times 0.5)/1000$$

**e) Very poorly processed whole crop cereals with a DM between 550-900g/kg and where very few or none of the grains appear chipped or damaged.**

*It is recommended that if none of the grains appear to have been chipped or broken then the adjustment for unprocessed WCC should be made.*

## **Appendix**

**Table 1:** Adjustment factor to ME for WCC forages with varying starch content

|                                             | Starch content (g/kg DM) |      |      |
|---------------------------------------------|--------------------------|------|------|
|                                             | 200                      | 300  | 400  |
| a) Ferm (DM <550g/kg)                       | 0.0                      | 0.0  | 0.0  |
| b) Unprocessed, DM between 550-900g/kg      | -0.8                     | -1.1 | -1.5 |
| c) Well processed, DM between 550-900g/kg   | 0.0                      | 0.0  | 0.0  |
| d) Poorly processed, DM between 550-900g/kg | -0.4                     | -0.6 | -0.7 |

**Table 2:** Adjustment factor to ME for WCC forages with varying starch content and assuming the predicted ME content was 10.5MJ/kg DM.

|                                             | Starch content (g/kg DM) |      |      |
|---------------------------------------------|--------------------------|------|------|
|                                             | 200                      | 300  | 400  |
| a) Ferm (DM <550g/kg)                       | 10.5                     | 10.5 | 10.5 |
| b) Unprocessed, DM between 550-900g/kg      | 9.7                      | 9.4  | 9.0  |
| c) Well processed, DM between 550-900g/kg   | 10.5                     | 10.5 | 10.5 |
| d) Poorly processed, DM between 550-900g/kg | 10.1                     | 9.9  | 9.8  |

## References:

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