



# Alimentation à base de concentrés pour les bovins en croissance et en finition

## Quelle complémentation alimentaire en concentrés chez les bovins en croissance et en finition pour maximiser le revenu des éleveurs ?

**Mots-clés :** bovins à viande, sous-produits alimentaires, céréales, concentrés, supplémentation, ensilage d'herbe

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Le niveau optimum d'une complémentation alimentaire en concentrés pour les bovins à viande pendant les périodes hivernales à l'intérieur dépend de la réponse animale (kg de gain / kg de concentré), du taux de substitution des fourrages et du prix relatif des produits animaux et des aliments pour les bovins. La valeur alimentaire (et économique) des ingrédients alimentaires dérivés des sous-produits dépend des pratiques alimentaires, notamment des apports de concentrés.

### Résumé

De petites améliorations de l'efficacité alimentaire, notamment pendant les périodes d'alimentation hivernales à l'intérieur, peuvent avoir une influence relativement importante sur la rentabilité des exploitations. L'augmentation du niveau de concentrés dans l'alimentation réduit l'apport en fourrage et augmente les gains de poids vif et de poids de la carcasse, bien que de façon dégressive. La croissance compensatrice subséquente au pâturage réduit l'avantage de la supplémentation en concentrés des jeunes bovins. Un ensilage d'herbe de haute digestibilité avec une supplémentation en concentrés modérée peut permettre de s'approcher en grande partie des performances de croissance obtenues avec des régimes riches en concentrés. La gestion de l'alimentation est plus importante lors de l'alimentation avec des concentrés *ad libitum* par rapport aux concentrés en compléments. La valeur nutritive (et économique) relative des ingrédients alimentaires dérivés des sous-produits dépend de leur niveau d'inclusion dans la ration et de la quantité de concentrés distribués.

### Abstract: Concentrate feeding and feed ingredients for growing-finishing.

Small improvements in feed efficiency, especially during indoor 'winter' feeding periods, can have a relatively large influence on farm profitability. Increasing the level of concentrates in the diet reduces forage intake and increases live weight and carcass weight gains, although at a decreasing rate. Subsequent compensatory growth at pasture diminishes the advantage of concentrate supplementation of young cattle. High digestibility grass silage with moderate concentrate supplementation can sustain a large proportion of the cattle performance achieved on high-concentrate diets. Feeding management is more important when feeding concentrates *ad libitum* than as a supplement. The relative nutritive (and economic) value of by-product feed ingredients depends on their inclusion level in the ration, and the amount of concentrates fed.

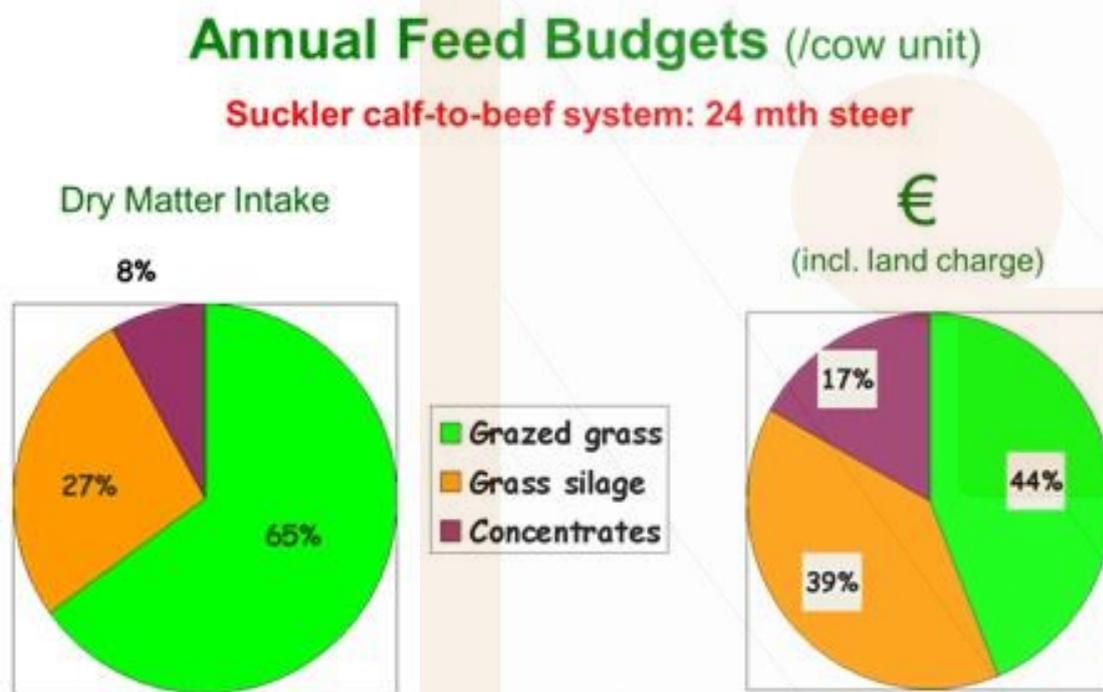
## INTRODUCTION

In beef production systems, feed provision is the single largest direct cost incurred, accounting for approximately 75% of total costs of production; therefore, small improvements in feed efficiency can have a relatively large influence on farm profitability. Additionally, feed efficient cattle excrete fewer nutrients, and produce less gaseous emissions, to the environment (Kenny *et al.*, 2018).

Due to the considerably lower comparative cost of grazed grass as a feedstuff, beef production systems should aim to increase animal output from grazed pasture. However, the seasonality of grass growth and inclement grazing conditions means that an indoor 'winter' period, of varying duration, is inevitable on all Irish farms and the main feed costs on beef farms relate to this period, and especially when feeding finishing cattle. For example, even in grass-based, suckler calf-to-steer beef systems on research farms, grazed grass,

grass silage and concentrate account for 65%, 27% and 8%, respectively, of feed Dry Matter (DM) intake annually. Yet when this feed consumption is expressed in terms of cost (land charge included), the outcome is very different: grazed grass, silage and concentrate account for 44%, 39% and 17% of the total annual feed costs, respectively (see Figure 1).

Clearly, in other production systems, such as weanling-to-finish and 'winter-finishing', the proportional cost associated with concentrate feeding will be even higher. Consequently, enhanced feed-cost efficiency during the more expensive indoor feeding periods has a comparatively greater financial impact than during the grazing season. Economic and environmental sustainability of beef production systems therefore depends on optimising the contribution of grazed grass to the lifetime intake of feed, and on providing silage and concentrate as efficiently and at as low a cost as feasible.



**Figure 1.** Annual feed budget for a grass-based suckler calf-to-beef steer system expressed on a DM intake and cost-basis.

## I. FEEDING CONCENTRATES: KEY PRINCIPLES

The role of concentrates is to make up the deficit in nutrient supply from forages in order for cattle to reach performance targets (McGee, 2005). Indeed, in situations where there is a shortage in winter supplies of forage, it may be better to buy concentrates and feed less forage than to purchase expensive low-quality forage.

- Energy is the most important nutrient required by growing-finishing cattle. Comparisons of feedstuffs should always be based on their 'net' energy (and protein) values on a DM basis. It is important to ensure that an adequate level of an appropriate mineral/vitamin mix is included in the ration.

- Dry matter digestibility (DMD) is the primary measure influencing the nutritive value of forage and consequently, the performance of forage-cattle. Low DMD forage means that higher levels of concentrate supplementation have to be used to achieve the same growth rate or performance (Table 1).

- Increasing the level of concentrates in the diet reduces forage intake ("substitution") and increases live and carcass weight gains, although at a diminishing rate.

- Animal production response to concentrate

supplementation is higher with forages of lower DMD.

- Growth response to concentrate feeding is higher in high-growth potential animals. For example, a recent Teagasc Grange study comparing suckler-bred Charolais with Holstein-Friesian steers offered a high-concentrate diet, found that the older, lighter, slower-growing Holstein-Friesian steers consumed 10% more feed DM resulting in a 20% inferior feed conversion efficiency. Similarly, bulls are inherently more feed efficient - 10 to 20% better - than comparable steers.

- Animal response to concentrate supplementation at pasture primarily depends on the availability and quality of pasture and level of supplementation.

- Increasing the level of concentrate supplementation reduces the importance of forage nutritional value, especially when feeding concentrates *ad libitum* (to appetite).

- The optimum level of concentrate supplementation primarily depends on animal production response (kg gain/kg concentrate), forage substitution rate and the relative prices of animal product and feedstuffs (McGee, 2015).

## II. CONCENTRATE FEEDING: INDOORS

### Weanling Cattle:

To minimise feed costs and exploit subsequent compensatory (“catch-up”) growth at pasture during the following grazing season, a live weight gain of 0.5-0.6 kg/day through the first winter is acceptable for steers, heifers (and suckler bulls) (McGee *et al.*, 2014). Due to compensatory growth, there is little point in over-feeding weanlings during the first winter. However, cattle growing too slowly (<0.5kg/day) during winter will not reach target weights. This target animal performance level can be achieved on grass silage supplemented with concentrates as outlined in Table 1.

### Finishing Cattle:

Efficiency of feed utilisation by finishing cattle primarily depends on weight of animal (decreases as live weight increases), potential for carcass growth (e.g. breed type, gender, compensatory growth potential) and duration (decreases as length increases) of finishing period (McGee, 2015). Even high-quality grass silage is incapable of sustaining adequate growth rates to exploit the growth

potential of most cattle so concentrate supplementation is required. Each 1 unit decline in DMD of grass silage requires an additional ~0.33 kg concentrate daily to sustain performance in finishing cattle. Concentrate supplementation rates for finishing steers to achieve ~1.0 kg live weight/day with grass silage varying in DMD are shown in Table 1. Correspondingly, for finishing heifers (lower growth potential) daily supplementation is reduced by about 1.5 to 2.0 kg and for finishing bulls (higher growth potential) rates should be increased by 1.5 to 2.0 kg to achieve 1 kg live weight.

Where silage DMD is poor (e.g. 60%) and/or in short supply, and animal growth potential is high, feeding concentrates *ad libitum* should be considered. However, when feeding concentrates *ad libitum*, particularly cereals, there is a risk of acidosis. Therefore, it is critical to ensure; (i) gradual adaptation to concentrates (over ~3 weeks), (ii) minimum roughage inclusion (~10% of total DM intake) for rumen function, (iii) meal supply never runs out and, (iv) a constant supply of fresh water is provided.

**Table 1.** Concentrate supplementation (kg/day) necessary for weanlings to grow at ~0.5 kg and for finishing steers (600 kg) to grow at ~1.0 kg live weight/day, when offered grass silage of varying Dry Matter Digestibility (DMD) to appetite.

Grass silage DMD (%)	~60	~65	~70	~75
Weanlings	2.0-3.0	1.5-2.0	1.0-1.5	0-1.0
Finishing steers	-	7.0-8.0	5.5-6.5	4.0-5.0

## III. CONCENTRATE FEED INGREDIENTS

Although cereals (barley, maize, wheat and to a much less extent, oats) usually predominate, by-product feeds, also known as co-products, are widely available and used extensively in beef rations. They are secondary products mainly from the food processing industry and the biofuel/ethanol industry. Key by-products include soya hulls, corn gluten feed, maize dried distillers grains, wheat dried distillers grains, palm kernel expeller meal and citrus pulp. By-products generally have little value as a foodstuff for humans, but many are suitable as a feed for cattle due to the ability of cattle to digest fibrous, plant cell-wall material. Indoor feed costs could be reduced through utilisation of alternative, ‘cheaper’ concentrate feed ingredients in beef rations. However, a potential limitation of feeding by-products to cattle is that significant variation can exist in their chemical composition and nutrient content, and this is liable to change over time as the primary manufacturing processes evolve and become more efficient. This means that periodic re-evaluation of the nutritive value of by-products is required for accurate formulation of rations for beef cattle.

In this context, a series of recent DAFM-funded experiments carried out at Teagasc Grange, has evaluated a number of key cereal and by-product feed ingredients in beef cattle diets. The ‘control’ concentrate offered in all these studies was a barley/soyabean meal-based ration (ca. 862g rolled barley, 60g soya bean meal, 50g molasses, 28g minerals and vitamins/kg); all other rations were compared against this. The optimum inclusion level of a number of by-product feeds was evaluated by replacing rolled barley (and some, or all, of the soyabean meal depending on the protein content of the test feed ingredient) in the ration. All

concentrates were prepared as coarse mixtures.

Key findings are as follows:

- Carcass weight was heavier and feed efficiency was better in bulls offered a high-concentrate diet where half of the rolled barley in the control ration was replaced with maize meal, but not flaked-toasted maize; maize inclusion in the ration did not enhance carcass fat deposition (Lenehan *et al.*, 2015a).
- Rolled oats can replace rolled barley in a concentrate supplement (ca. 5.0 kg/day) to high-digestibility grass silage without negatively affecting performance of finishing beef cattle; feeding oats had no effect on carcass fat score (McGee *et al.*, 2018).
- For growing ‘weanling’ cattle, soya hulls and citrus pulp can replace rolled barley in concentrate rations offered at relatively low levels (ca. 2 kg/day), as a supplement to high digestibility grass silage, without negatively affecting performance (Lenehan *et al.*, 2015b; 2017b).
- For finishing cattle diets, citrus pulp can replace rolled barley in the ration at inclusion rates up to 400g/kg without negatively affecting performance when offered ca. 5.0 kg concentrate/day as a supplement to high-digestibility (ca. 75% DMD) grass silage (Kelly *et al.*, 2017).
- For growing cattle offered ca. 3.5 kg/day of concentrate as a supplement to moderate digestibility grass (ca. 65% DMD) silage, and finishing cattle offered *ad libitum* concentrates, the optimum inclusion level of soya hulls in a barley-based concentrate was ca. 200g/kg (Magee *et al.*, 2015c).
- Dried corn gluten feed had a feeding value comparable to that of rolled barley/soya bean meal when offered as a

supplement (ca. 5.0 kg/day) to high-digestibility grass silage (Kelly *et al.*, 2018).

- Maize dried distillers grains had a superior feeding value (based on dietary feed conversion ratio) to wheat dried distillers grains when the ration was offered as a supplement (3.5 kg/day) to grass silage or *ad libitum*. The optimal inclusion level of maize and wheat dried distillers grains in the concentrate was about 800g/kg when the concentrate ration was offered as a supplement to moderate-digestibility grass silage and, about 400g/kg for maize, and 200g/kg for wheat, dried distillers when the ration was offered *ad libitum* (Magee *et al.*, 2015a; 2015b).

- Palm kernel expeller meal can be included in a barley-based concentrate at up to 400 g/kg when offered as a supplement to moderate digestibility grass silage and up to 100 g/kg when offered *ad libitum* (Magee *et al.*, 2016).

## CONCLUSION

Studies at Teagasc, Grange have shown that at adequate (ca. 20 g DM/kg live weight) grass allowances in autumn, feeding ca. 0.50 to 0.75 kg of concentrate ration per 100 kg live weight resulted in carcass growth responses in steers between 30 and 110 g carcass per kg concentrate. The low growth response to supplementation was associated with

Overall it is concluded that, due to ‘associative effects’, the relative nutritive (and economic) value of by-product feed ingredients depends on concentrate feeding practices; i.e. inclusion level in the ration; whether the ration is offered as a supplement to grass silage or to appetite with restricted grass silage.

Weanling and finishing, steers and heifers, generally do not require protein supplementation when fed barley-based concentrates and high DMD grass silage (McGee, 2005), but for suckler bull weanlings, recent research at Grange showed a significant, but small, response to protein supplementation (Lenehan *et al.*, 2015b). However, all cattle are likely to respond to supplementary protein in barley-based concentrates when grass silage has moderate to low DMD and/or low protein content, especially weanling cattle.

grazing very high nutritive value grass herbage. Recent Grange research has shown that concentrate supplementation is a strategy for ‘pasture-finishing’ (achieving adequate carcass fat score) of cattle in autumn, especially late-maturing breed types (Lenehan *et al.*, 2017a; Regan *et al.*, 2018).

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## References:

- Kelly M.J., Moloney A.P., Kelly A., McGee M. (2017). Replacement of rolled barley with citrus pulp in a concentrate supplement for finishing beef cattle offered grass silage. *Journal of Animal Science* 95, Suppl. 4, 295.
- Kelly M., Moloney A.P., Kelly A., McGee M. (2018). Intake, growth, carcass and selected meat quality traits of steers offered grass silage and supplementary concentrates with increasing levels of dried corn gluten feed. *Advances in Animal Biosciences*, 9, (1) 150.
- Kenny D.A., Fitzsimons C., Waters S.M., McGee M. (2018). Invited Review: Improving feed efficiency of beef cattle – the current state of the art and future challenges. *Animal*, 12, 1815–1826.
- Lenehan C., Moloney A.P., O’Riordan E.G., Kelly A., McGee M. (2015a). Effect of substituting barley with maize on the performance of suckler-bred bulls offered a high concentrate diet. *Agricultural Research Forum*, Tullamore, Ireland, p82.
- Lenehan C., Moloney A.P., O’Riordan E.G., Kelly, A., McGee M. (2015b). Effects of supplementary concentrate type and protein level on growth of suckler-bred weanling bulls offered grass silage. *Agricultural Research Forum*, Tullamore, Ireland, p74.
- Lenehan C., Moloney A.P., O’Riordan E.G., Kelly A., McGee M. (2017a). Pasture-based finishing of early-maturing sired suckler beef bulls at 15 or 19 months of age. *Advances in Animal Biosciences* 8, s1, 28-32.
- Lenehan C., Moloney A.P., O’Riordan E.G., Kelly A., McGee M. (2017b). Comparison of rolled barley with citrus pulp as a supplement for growing cattle offered grass silage. *Advances in Animal Biosciences* 8, s1, 33-37.
- Magee D., Moloney A.P., Kelly A., O’Riordan, E.G., McGee M. (2015a). Replacement of barley with increasing levels of maize dried distillers grains: intake, growth and carcass characteristics of beef cattle. *Agricultural Research Forum*, Tullamore, Ireland, p80.
- Magee D., Moloney A.P., Kelly A., O’Riordan E.G., McGee M. (2015b). Effect of replacing barley with increasing levels of wheat dried distillers grains on intake, growth and carcass traits of beef cattle. *Agricultural Research Forum*, Tullamore, Ireland, p75.
- Magee D., Moloney A.P., Kelly A., O’Riordan E.G., McGee M. (2015c). Intake and performance of beef cattle offered barley-based concentrates with increasing inclusion levels of soya hulls. *Agricultural Research Forum*, Tullamore, Ireland, p81.
- Magee D., Moloney A.P., Kelly A., O’Riordan E.G., McGee M. (2016). Inclusion of palm kernel expeller meal in barley-based concentrates for beef cattle. *Book of Abstracts, 67th Annual Meeting of European Federation for Animal Science (EAAP)*, Belfast UK, p669.
- McGee M. (2005). Recent developments in feeding beef cattle on grass silage-based diets. In: “Silage production and utilisation”. (ed. R.S. Park and M.D. Stronge). Wageningen Academic Publishers, 51–64.
- McGee M. (2015). Feed efficiency in beef finishing systems. *Irish Grassland Association Journal*, 49, 97-105.
- McGee M., Drennan M.J., Crosson P. (2014). Effect of concentrate feeding level in winter and turnout date to pasture in spring on biological and economical performance of weanling cattle in suckler beef production systems. *Irish Journal of Agricultural and Food Research*, 53, 1-19.
- McGee M., Kelly M., Kelly A., Moloney A.P. (2018). Comparison of rolled barley and oats as supplements to grass silage for finishing beef cattle. *Advances in Animal Biosciences* 9, (1), 226.
- Regan M., Lenehan C., Moloney A.P., O’Riordan E.G., Kelly A.K., McGee M. (2018). Finishing late-maturing suckler steers and bulls from pasture: Effect of concentrate supplementation. *Grassland Science in Europe*, 23, 485-487.