

Balanced Intake Programming, Implant and β -Adrenergic Agonist Schedules to Enhance Feedlot Feed Efficiency

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Summary

According to USDA data cattle are being fed to heavier weights. Because of the increased maintenance requirements of heavier cattle, the use of available technologies consisting of feed intake management programs, anabolic steroidal implants, and β -adrenergic agonists can be used in combination to improve cattle growth performance.

Introduction

A Current trend in the U.S. feedlot industry is that cattle are being harvested at heavier weights (USDA). This is supported by the fact that according to USDA data cattle live weight at time of harvest has increased from an average of 549 kg in May 2003 to 586 kg in May 2013. Over the same ten year period carcass weights have increased from 333 kg to 355 kg per head. As cattle become heavier their maintenance requirements are increased (NRC, 1996) leaving less metabolizable energy for gain. In order to improve feed efficiency in cattle fed to heavier body weights technologies consisting of feed intake management such as programmed feeding, β -adrenergic agonists and implants may be utilized.

Feed Intake Management

Feed intake management consists of managing the amount of feed delivered to cattle in such a manner that cattle growth performance is maintained or improved. Feed intake management programs generally consist of either restricted or programmed feeding (Peters, 1995, Galyean, 1999) with restricted feeding consisting of limiting the amount of feed consumed while programmed feeding utilizes net energy equations and delivering a prescribed amount of feed in order to achieve a targeted rate of gain (Galyean, 1999).

Restricted and programmed feeding have been used successfully for growing cattle (Loerch, 1990; Sainz, 1995; Gunter, 1996) by feeding a lesser amount of a higher energy diet compared to offering a lower energy growing diet ad libitum. Because average daily gain can be maintained with less feed using restricted or programmed feeding in cattle growing programs over all feed efficiency can be improved (Loerch, 1990; Sainz, 1995). Compared to offering cattle a finishing diet ad libitum restricted feeding during the finishing period decreased cattle average daily gain but improved feed efficiency (Hicks, 1990; Murphy and Loerch, 1994) while programmed feeding has been shown to maintain cattle average daily gain while improving feed efficiency (Hicks, 1990; Loerch and Fluharty, 1998). While feed efficiency was reported to be improved with restricted or programmed feeding, quality grade can be negatively affected (Hicks, 1990; Murphy and Loerch, 1994), which might be a result of restricting energy intake because the degree of feed restriction is too great. According to Peters (1995) the goal of

programmed feeding is to maximize feed intake over the entire feeding period which differs from the goal of maximizing feed intake on a daily basis when offering feed ad libitum. Programmed feeding also prevents the over feeding of cattle by providing for more consistent feed deliveries over the course of the entire feeding period compared to cattle that are offered feed ad libitum (Peters, 1995). While data regarding the effects of inconsistent feed deliveries on cattle growth performance have been mixed (Galyean, 1992; Zinn, 1994; Schwartzkopf, 2003) it appears that a system in which the variability of feed deliveries is decreased would be beneficial in improving cattle feed efficiency. Decreasing the incidence of overfeeding can decrease the opportunity for cattle to overeat thereby decreasing the potential for digestive upset, as well as decrease the amount of feed sorting and waste by cattle (Pritchard, 2003).

Implants

The effects of anabolic steroid implants on improving cattle growth performance are well documented (NRC, 1996). Implants approved for cattle contain either estrogenic hormones, androgenic hormones, or both and it has been demonstrated that implants containing both estrogenic and androgenic hormones improve cattle growth performance over implanting with estrogenic or androgenic hormones alone (Duckett and Andrae, 2001). The combination of estrogenic and androgenic hormones in implants approved for cattle has been shown to increase satellite cell numbers in muscle (Johnson et al. 1998), increase muscle IGF-1 mRNA (Pampusch et al., 2003), and increase circulating IGF-1 concentrations (Johnson et al. 1996). The net effect of the combination of both estrogenic and androgenic hormones is increased muscle growth in cattle compared to non-implanted cattle or cattle implanted with either anabolic or estrogenic hormones alone.

Implanting cattle decreased marbling in cattle (Duckett and Andrae, 2001). The reported decreases in marbling as a result of implanting cattle might be the result of one or more proposed theories which are the dilution effect, nutrient or energy repartitioning, or implants negatively affecting adipogenic gene expression. The dilution effect as described by Duckett and Andrae (2001) suggests that the amount of intramuscular fat remains the same between non implanted and implanted cattle but because implanted cattle exhibit increased muscle growth it is diluted and therefore not as visible. As discussed previously it is well documented that muscle growth is greater in cattle that are implanted which might provide for the repartitioning of nutrients and or energy to lean tissue growth at the expense of growing adipose tissue thereby decreasing marbling (Tokach et al., 2010). Implants have also been shown to decrease mRNA concentrations for adipogenic genes consisting of C/EBP β , PPAR γ , and SCD (Chung et al., 2012) which could also contribute to decreased marbling in implanted cattle. Implanted cattle grow faster and deposit protein in a greater proportion relative to lipid and are therefore typically leaner compared to non-implanted cattle fed the same number of days. Therefore, according to Preston (1990) the problem of decreased marbling in implanted cattle can be alleviated by feeding implanted cattle longer. Preston (1990) concluded that in order to have marbling scores similar to non-implanted cattle steers and heifers implanted with both estrogen and trenbolone acetate need to be fed an additional 16 and 5 days, respectively.

β -adrenergic Agonists

β -adrenergic agonists are compounds similar in structure to a class of naturally occurring compounds known as catecholamines which consist of dopamine, norepinephrine, and epinephrine (Bell et al., 1998). When β -adrenergic agonists bind to β -adrenergic receptors located on the cell surface they can initiate a cascade of reactions resulting in increased protein synthesis, decreased protein degradation, and increased lipolysis which can improve the

growth performance of livestock (Mersmann, 1998). Currently there are two approved β -adrenergic agonists approved to be fed to for cattle in the United States and consist of ractopamine hydrochloride and zilpaterol hydrochloride. Ractopamine hydrochloride is a category 1 β -adrenergic agonist shown to improve growth performance of livestock by increasing protein synthesis (Moody, et al. 2000). Zilpaterol hydrochloride is category 2 β -adrenergic agonist and improves growth performance of cattle by increasing protein synthesis while decreasing protein degradation (Moody, et al. 2000). Feeding ractopamine hydrochloride or zilpaterol hydrochloride improved growth performance of steers (Elam et al., 2009; Bryant et al., 2010; Scramlin et al., 2010) and heifers (Montgomery et al., 2009; Bryant et al., 2010; Rathmann et al., 2012). Feeding ractopamine hydrochloride was reported to have little or no effect on marbling (Winterholler, 2007; Quinn, 2008; Bryant, 2010) in feedlot cattle. Feeding zilpaterol hydrochloride was reported to decrease marbling in feedlot cattle (Elam et al., 2009; Montgomery et al., 2009; Baxa et al., 2010) potentially through a dilution effect as proposed by Kellermeier et al. (2009). However, Rathman et al. (2012) reported no differences in marbling score or choice quality grade in heifers fed zilpaterol hydrochloride when the feeding period was extended by 21 days compared to heifers not fed zilpaterol hydrochloride.

A Combined Approach

The modes of action for implants and β -adrenergic agonists on improving cattle growth performance differ as discussed previously and therefore have been shown to be additive (Baxa et al., 2010; Bryant et al., 2010; Parr et al., 2011) in improving cattle growth performance.

An example of an actual feed intake management program is illustrated in Figure 1 and depicts a programmed feeding schedule for yearling cattle based upon feed intake equations and number of cattle in the pen.

Figure 1. Actual programmed feeding schedule for yearling steers showing predicted feed intake as well as percent of predicted feed intake.

FILE: 130724NWI						DAILY BATCH AMOUNTS					In Date: 07/25/2013
ALLBF05vC		100%				95%	100%	105%	110%	115%	120%
Activity	Date	DOF	#DM	#AF/Hd	RATION						
	09/13	51	23.4	38.5	Finisher	3650	3850	4050	4250	4450	4600
	09/14	52	23.4	38.5	Finisher	3650	3850	4050	4250	4450	4600
	09/15	53	23.5	38.5	Finisher	3650	3850	4050	4250	4450	4600
	09/16	54	23.5	38.6	Finisher	3650	3850	4050	4250	4450	4650

The cattle feeder simply allows the cattle to “seek” a line and is cognoscente of what the actual feed intake is compared to the predicted feed intake. Such a program allows for consistent feed deliveries and feed intake management. The graph showing predicted feed intake across days on feed for the same yearling steers in Figure 1 is shown in Figure 2.

Similar feed intake management programs can be generated for calf feds as well. Obviously the effectiveness of such a program is directly related to the accuracy of the feed intake equations being used. Therefore analysis of actual feed intake data and cattle growth performance is warranted in order to make any necessary adjustments for improving accuracy of any equations used in a feed intake management program.

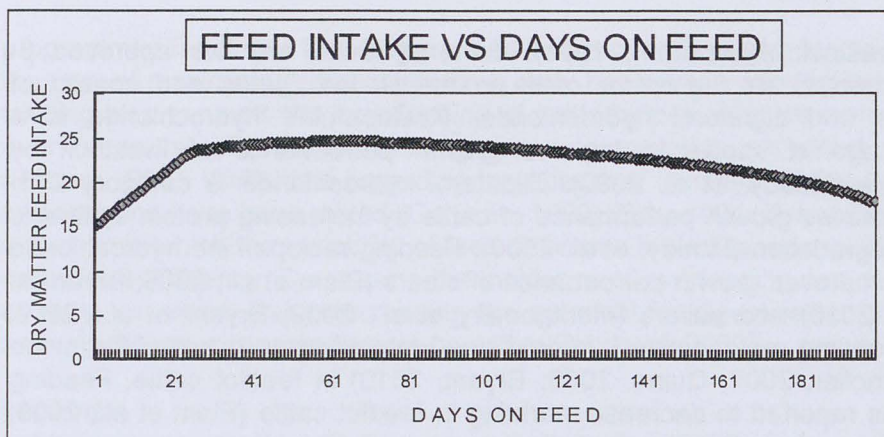


Figure 2. Actual predicted feed intake across days on feed using feed intake equations for yearling steers depicted in Figure 1.

Combining the technologies of feed intake management such as programmed feeding, a terminal implant containing both estrogenic and androgenic hormones, as well as β -adrenergic agonists should help to improve growth performance of feedlot cattle during the finishing period.

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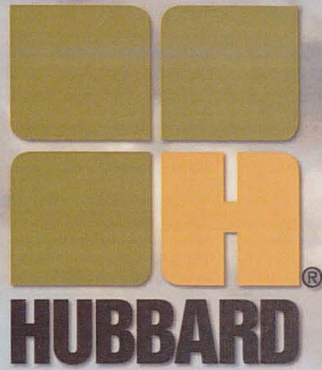
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