INCREASE FEEDLOT PROFITABLITY BY DIFFERENTIATING BETWEEN BEEF BREEDS

Sub theme: Knowledge & Information

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Abstract:

Feedlots currently feed animals according to a pre-determined feeding period that will result in market acceptable carcass weights. However, feedlots are price takers on the input and output side and the only way they can increase their profitability is to increase the productivity of their inputs. Precision agriculture in the feedlot, through incorporating the unique genetic growth potential of a breed, was identified to increase feedlot profitability and sustainability. This was done through applying production economic theory and calculating the point in time where the value of the marginal product is equal to the marginal factor cost and profit is thus maximized for each breed. The additional gross profit that can be generated through applying the PMFP is 6% according to the specific case study. The study indicates that the differences in the genetic growth potential of breeds can be used as a management tool in order to generate additional profit from any breed.

1. Introduction and background

Cattle feedlots operate on the principle that they buy weaned calves and feed them with rations containing energy, protein, fibre, minerals, vitamins, and antibiotics, while also administering growth hormones which will result in the highest possible weight increase during the shortest period of time (Spies, 2011). The current objective of feedlots is to resell the animals when they reach their target slaughter weight and carcass classification.

The profitability of feedlots is however unstable due to fluctuations in various factors, such as input and output prices. Due to the fact that feedlots are price takers on the input and output side, the only way they can increase their profitability is to increase the productivity of their inputs. There is a wide array of different beef cattle breeds in South Africa, each with its own genetically determined growth capability, that are fed in commercial feedlots. In order for a feedlot to increase the productivity of its largest variable input (feed), each type of beef breed must be fed according to its genetic growth potential (Fox, Tedeschi & Baker, 2004).

Different breeds of beef cattle differ significantly in terms of their growth rate of fat, lean meat, and bone (Koch *et al*., 1976). Strydom, Frylinck, Van der Westhuizen and Burrow (2008) stated that weight gain, feed intake, feed conversion, and dressing percentage differ significantly between feeding periods, as well as between breed types. Mason (1971) added that different breeds have different growth potential and thus have to be managed according to their genetic potential. Amer, Kemp, Buchanan-Smith, Fox and Smith (1994) showed that profit maximisation was a more appropriate slaughter criterion for comparing beef genotypes than constant age, weight, or composition feeding periods. Spies (2011) suggested that economic and management factors, which include genetic differences, should be integrated to make decisions that will enhance the profit potential of a feedlot.

Various studies have been conducted to determine optimal feeding periods by using different variable factors. Oltjen, Bywater and Baldwin (1986) developed the Davis Growth Model (DGM), which can predict the growth and feed intake of feedlot cattle by taking nutrition, initial condition, frame size, and use of growth promoters into account. Amer *et al. (*1994), on the other hand, focused on body size, fat deposition, and carcass fatness as a function of the energy content of the diet. Pre-generated growth and feed intake data were used by Williams and Bennett (1995), in combination with different sets of input and output prices in order to maximise profit per day. The study indicated which breed must be chosen to feed under certain price conditions. Guiroy, Fox, Tedeschi, Baker and Cravey (2001), Fox, Tedeschi and Baker (2004), and Tedesci, Fox and Guiroy (2004*)* based their calculations on individual cattle and predicted growth and feed intake. Barioni, De Leon, Oltjen and Sainz (2009) used an algorithm to determine the optimal feeding period using a least-cost diet formulation in combination with the DGM.

In light of the literature provided, it is clear that unique genetic potential has to be used in order to differentiate each breed in order to determine the feeding period where maximum profit can be generated. The various studies that were cited indicate different methods to determine the optimal feeding period. Some of the reviewed models did not differentiate between breeds at all or treated different animals of the same breed as individual units. Most of the studies used the predicted growth and feed intake of individual animals, while some used different price scenarios, and others utilised nutrient requirements.

This study will, however, focus on differentiating between breeds in terms of each specific breed's unique growth curve and feed intake level. Each breed group will be treated as an individual unit by using existing and on-going generated data as an average of the group. Since the growth and feed consumption curves of the breeds are not know the on-going generated data refers to growth and feed intake data collected each week. The nutritional content of the feed will be constant in this study and will not be seen as a variable.

2. Procedures

A feedlot experiment was used to generate data to use as the foundation of the model in order to determine the Profit Maximising Feeding Period (PMFP). The experiment was conducted at the Liebenbergstroom commercial feedlot in the Free State province of South Africa. The cattle used in the feedlot experiment were classified by breed type. One representative breed in each breed type was nominated in terms of the availability of cattle in the area. The breed types and representative breeds are as follows:

- *Bos indicus* - Brahman
- Sanga - Afrikaner
- Sanga synthetic derived - Bonsmara
- *Indicus* synthetic derived - Simbra
- *Bos taurus* British - Angus
- *Bos taurus* dual purpose - Simmentaler
- *Bos taurus* lean meat - Limousin

A total of 35 bull weaners of each of the seven breeds were selected. Five weaners were collected from 49 stud breeders, total of 245 weaners, in order to minimise the management and genetic effects. The weaners were collected in a 150 km radius around the Liebenbergstroom feedlot in order to minimise the climate, grazing, and adjustment effects. The average age of the weaners was seven months, while the average weight for each breed was as follow: Brahman: 223 kg; Afrikaner: 210 kg; Simbra: 231 kg; Bonsmara: 250 kg; Angus: 227 kg; Simmentaler: 222 kg, and Limousin: 243 kg. Calves with a weight variation of 25 kg above and below the average were allowed in the study.

All animals were treated homogeneously in terms of vaccinations, growth stimulants, and handling. The weaners entered an adjustment period with the applicable feed for rumen adjustment. After this period, the weaners were fed the same high-energy feedlot diet in their separate pens. Each breed of cattle was fed separately in their own pen for the duration of the experiment. In order to determine the feed intake as accurately as possible, the feed was fed by using 50 kg bags from the Sernick feed factory. Feed intake was determined daily for each group. The weaners were weighed individually every week on Tuesday mornings at 07:00. The weigh facility consists of an electronic scale and air pressure operating system (Faasen, 2016).

The production economic theory that can be use to determine the PMFP, is based on the law of diminishing marginal returns. The law of diminishing marginal returns states "as a unit of a variable input is added to units of one or more fixed inputs, after a point, each incremental unit of the variable input produces less and less additional output" (Debertin, 2012). The Total Product (TP) that is produced in a feedlot scenario is the total weight gain of the calf. Marginal product (MP) can be defined as the additional weight gained by the calf due to a unit increase in feed intake (Drummond & Goodwin, 2011). At the beginning of the feeding period weight gain increases at an increasing rate and is referred to as increasing marginal returns. Beyond a certain feeding period, weight gain will increase at a decreasing rate and is referred to as decreasing marginal returns. Then, eventually, the weight gain reaches a maximum point and begins to decrease, which is referred to as negative marginal returns. These marginal return stages are referred to as the law of diminishing marginal returns (Drummond & Goodwin, 2011). The negative marginal return phase is assumed not to apply to feedlot cattle due to the assumption that cattle will not lose weight in the feeding period with appropriate feed intake.

In order to determine the profit maximising feeding period for the different breeds Microsoft Excel® 2010 was used. The calculations is based on the growth and feed intake data of a specific breed, which form the foundation of the model. The feed and carcass prices are also incorporate, as well as the dressing percentage. By incorporating values for each week's weight gain and feed intake, the Value of the Marginal Product (VMP) and Marginal Factor Cost (MFC) are calculated. The Marginal Profit (Mrr) and Gross Profit (Grr) are calculated for each week by using the VMP and MFC (Drummond & Goodwin, 2011).

The results layout from the PMFP calculations is shown in Table 1. The feeding period is indicated in weeks. The physical and economic influence on the PMFP includes changes in dressing percentage, feed price, and carcass price. These are the only values that are adjustable in the model. The feedlot manager can change these factors according to the market-related value in order determine the PMFP and to see what effect it has on the PMFP.

The PMFP is indicated by the grey coloured row in Table 1 and the black crosses in Figure 1 and is reached when the VMP is equal to the MFC, the marginal profit is zero, and the gross profit is at a maximum. The model can determine alternative feeding periods when changes in dressing percentage, feed price, and carcass price occur for different breed types. In the case of the example in Table 1 and Figure 1 the data for the Brahman was used, while the PMFP of the other breeds are also indicated. The Brahman, for example, thus reached its PMFP at 16 weeks while the Simbra and Limousin reached their respective PMFP's at week 21 and 26.

3. Results

The PMFP was calculated in the experiment by making use of the relevant market prices at the time. All the carcasses, when slaughtered, were classified as A2/3 (age and fat content) according to the South African Meat Classification System and thus, regardless of weight, received the same price of R35.00/kg. The total variable cost was included in the feed price and prices of R2.55/kg feed, R2.80/kg feed, and R2.90/kg feed for Week 1-5, 6-14, and 15-30 were used respectively. These prices and each breed's unique growth and feed intake data were incorporated into the model to generate a figure that graphically indicates the gross margin, marginal profit, VMP, MFC, as well as the PMFP.

It is evident from Figure 1 that for the Brahman, the VMP equals the MFC, marginal profit is zero, and the gross profit is maximised between Week 16 and Week 17. It thus seems as if the PMFP in Figure 1 is reached at Week 17 but it is actually not the case. As the two curves meet before Week 17, Week 16 should be used for the PMFP as the production economics theory states that maximum profit shall be realised at the point where the VMP is equal to the MFC or the point in the time series just before that.

Table 1: Presentation of the results from the PMFP model for the Brahman

PMFP Model Results

Feeding Period: Week	Feeding Period: Days	Output & Input Price: Carcass Price R/kg	Output & Input Price: Feed Price R/kg	Profit: Marginal Profit R/week	Profit: Gross Profit R/week
1	7	35	2.55	92.61	92.61
2	14	35	2.55	103.30	195.91
3	21	35	2.55	108.24	304.14
4	28	35	2.55	109.58	413.73
5	35	35	2.55	93.45	507.18
6	42	35	2.80	90.28	597.45
7	49	35	2.80	86.59	684.04
8	56	35	2.80	82.41	766.45
9	63	35	2.80	77.55	844.00
10	70	35	2.80	71.70	915.70
11	77	35	2.80	64.61	980.32
12	84	35	2.80	56.15	1036.47
13	91	35	2.80	46.35	1082.82
14	98	35	2.80	35.47	1118.29
15	105	35	2.80	18.07	1136.36
16	112	35	2.90	6.40	1142.76
17	119	35	2.90	-4.54	1138.22
18	126	35	2.90	-13.93	1124.29
19	133	35	2.90	-21.14	1103.15
20	140	35	2.90	-25.81	1077.34
21	147	35	2.90	-28.13	1049.21
22	154	35	2.90	-27.42	1021.78
23	161	35	2.90	-29.44	992.35
24	168	35	2.90	-35.22	957.13

Breed Type	Breed	Profit Maximizing Feeding Period: Week	Profit Maximizing Feeding Period: Day
Bos indicus	Brahman	16	112
Sanga	Afrikaner	15	105
Bos indicus synthetic derived	Simbra	21	147
Sanga synthetic derived	Bosnmara	16	112
Bos taurus British	Angus	22	154
Bos taurus dual purpose	Simmentaler	27	189
Bos taurus lean meat	Limousin	26	182

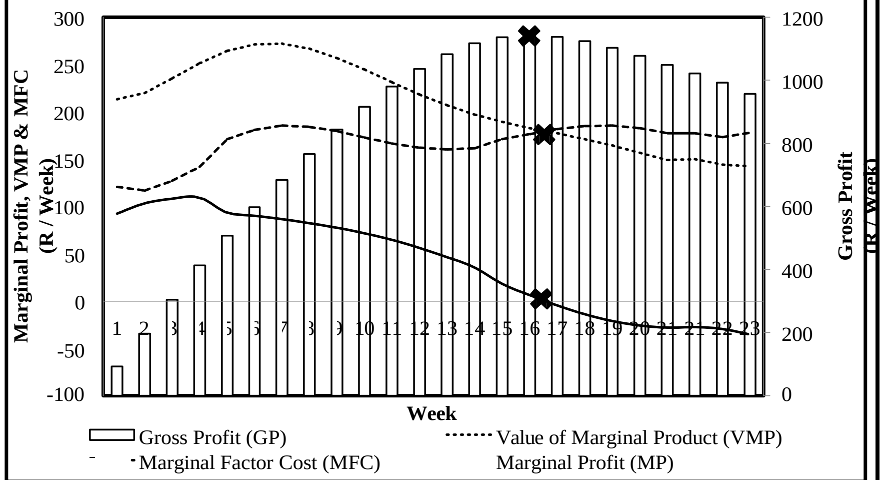

Figure 1: PMFP output for the Brahman

The gross profit margin in the case of the Brahman will be lower in Week 17 than in Week 16 as Week 17 is actually past the point where the VMP and MFC curves are equal. This principle also applies to the PMFP of the other breeds where the VMP and the MFC are equal to each other between two weeks in time.

The usual feeding period for any breed used by Liebenbergstroom feedlot is 133 days or 19 weeks. The Brahman thus has to be fed three weeks shorter than the average feeding period in order to maximise the gross profit returns. A shorter feeding period results in a higher number of rotation cycles per year that can further enhance feedlot profitability. The additional gross profit due to the shorter feeding period is R31.06 per animal for the Brahman per cycle. The average rotation at Liebenbergstroom is 2.7 cycles per year with a feeding period of 19 weeks. Feeding the Brahman for only 16 weeks will result in 3.2 cycles per year. The increase in cycles per year will provide an additional yearly gross profit as the feedlot can now feed 0.7 more cycles per year for the Brahman. The total additional gross profit generated per year in the event where only one animal is fed in a rotation is R99.39, for the Brahman. This figure only represent the difference between the normal gross margin when fed for 19 weeks and the PMFP gross margin, and indicates that all the breeds can be fed more profitably when the PMFP is used[1].

4. Discussion

A case study was conducted in order to determine what effect the application of the PMFP model might have on the profitability of a large feedlot. The objective of the case study was to calculate the difference in Gπ between the average feeding period of 19 weeks and the PMFP for each breed. The difference in Grr is the additional Gπ that can be generated by the feedlot by using the PMFP model to determine the PMFP of each breed.

The case study was conducted for the Liebenbergstroom commercial feedlot. The feedlot has a capacity of 5 000 cattle and uses an average feeding period of 19 weeks, which provides 2.7 cycles per year. The percentage of the feedlot capacity allocated for each

[1] The PMFP for the other six breeds that was used in the study is available on request from the author.

breed is indicated in Table 2. The same data, in terms of prices, growth and feed intake, that was used in the study was also used for the case study. Table 2 gives an indication of the *Grr* between the current average feeding period of 19 weeks for any breed and the Gπ of feeding each breed according to the PMFP. The table is divided into *Grr*/animal/cycle and the Gπ/year for feeding one animal in a cycle. The Gπ/breed/cycle and *Grr*/breed/year are calculated by multiplying the *Grr* by the number of animals/breed (N) in this case study.

Table 2: Additional gross profit (rand) for feeding the breeds according to their PMFP and not according to the traditional 19 weeks

Breed	%	N	Gπ / animal / cycle	Gπ / year with one animal / cycle	Gπ / breed / cycle	Gπ / breed / year
Brahman	8	400	R31.06	R99.39	R12 424.00	R39 756.00
Afrikaner	5	250	R80.61	R274.07	R20 152.00	R68 517.00
Simbra	13	650	R61.26	R147.02	R39 819.00	R95 563.00
Bonsmara	35	1750	R48.79	R156.13	R85 382.00	R273 227.00
Angus	15	750	R41.62	R95.73	R31 215.00	R71 797.00
Simmentaler	12	600	R265.21	R503.91	R159 126.00	R302 346.00
Limousin	12	600	R231.34	R462.68	R138 804.00	R277 608.00
Total	**100**	**5 000**	**R759.89**	**R1 738.93**	**R486 923.00**	**R1 128 807.00**

According to Table 2, there are major differences between the Gπ of the current feeding period and the PMFP. The Gπ of the Simmentaler and Limousin is higher compared to all the other breeds due to the larger increase from the average feeding period to the PMFP. The PMFPs and the different cycles per year for each breed can generate a total additional Gπ of R1 128 807.00 per year for this feedlot with a standing capacity of 5 000 cattle. This is an additional 6% Gπ per year by using the breed classification and PMFP for each breed generated by this study and the PMFP model. In the case of larger feedlots with standing capacities of 30 000, 70 000, and 100 000, an additional 6% Gπ will generate R6 772 840.00, R15 803 295.00, and R22 576 136.00 per year additional Gπ respectively, which will have a great influence on feedlot profitability.

5. Conclusion

The PMFPs that were generated by using the production data, economic values, and production economic theory calculated realistic feeding periods that ensured maximum profit and acceptable carcass weight and grading. Each breed can generate additional Gπ

by feeding them according to their unique PMFP. All of the breeds' PMFPs varied from the average standard feeding period used in feedlot, which implies that PMFPs have to be used due to the additional Gπ generation, which will realise maximum Gπ. The PMFP model can determine the PMFP for any price scenario. An additional 6% Gπ can be generated by firstly grouping weaners according to breed in a feedlot; secondly, by determining their production data and incorporating the relevant economic prices into the PMFP model; and lastly, by using the production economic formula in the PMFP model. The study indicated in conclusion that the difference between breeds can be used as a management tool in order to generate profit from any breed.

6. References

Amer, P.R., Kemp, R.A., Buchanan-Smith, J.G., Fox, G.C. & Smith, C. 1994. A bioeconomic model for comparing beef cattle genotypes at their optimal economic slaughter endpoint. *Journal of Animal Science* 72: 38-50.

Barioni, L.G., De Leon, V.A.T., Oltjen, J.W. & Sainz, R.D. 2009. *A hybrid algorithm to optimize beef feedlot operations*. 7th international workshop modelling nutrient digestion and utilization in farm animals, Paris, France. 10-12 September.

Bosman, D.J. 2002. Cattle breeds and types for the feedlot. In *Feedlot management,* edited by K-J. Leeuw. Irene: Agricultural Research Council Animal Production Institute. pp. 84-90.

Debertin, D.L. 2012. *Agricultural Production Economics.* (2nd ed.). USA: MacMillan Publishing Company.

Drummond, H.E. & Goodwin, J.W. 2011. *Agricultural economics.* (3rd ed.). USA: Pearson Publishers.

Faasen, C. 2016. *Personal communication.* CEO of Sernick and Liebenbergstroom Feedlot.

Fox, D.G., Tedeschi, L.O. & Baker, M.J. 2004. *Identifying differences in efficiency in beef cattle*. Ithaca, NY: Animal Science Department, Cornell University.

Guiroy, P.J., Fox, D.G., Tedeschi, L.O., Baker, M.J. & Cravey, M.D. 2001. Predicting individual feed requirements of cattle fed in groups. *Journal of Animal Science* 79: 1983-1995.

Koch, R.M., Dikeman, M.E., Allen, D.M., May, M., Crouse, J.D. & Campion, D.R. 1976. Characterization of biological types of cattle III. Carcass comparison, quality and palatability. *Journal of Animal Science* 43: 48-62**.**

Mason, I.L. 1971. Comparative beef performance on the large cattle breeds of Western Europe. *Animal Breeding Abstracts* 39: 1.29

Oltjen, J.W. 2012. Bioeconomical model for best slaughter endpoint for maximum profit. *Revista Argentina de Produccion Animal* 32(1): 63-68.

South African Feedlot Association (SAFA). 2016. South African Feedlot Association. [Online]. *Available at: http://www.safeedlot.co.za. [Accessed on 20 May 2016]*.

Spies, D.S. 2011. Analysis and quantification of the South African red meat value chain. (Doctoral dissertation). Department of Agricultural Economics, University of the Free State, Bloemfontein.

Strydom, P.E. 2008. Do indigenous Southern African cattle breeds have the right genetics for commercial production of quality meat? *Meat Science* 80: 86-93.

Tedeschi, L.O., Fox, D.G. & Guiroy, P.J. 2004. A decision support system to improve individual cattle management. 1. A mechanistic, dynamic model for animal growth. *Agricultural Systems* 79: 171-204.