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## A STOCKER CATTLE GROWTH SIMULATION MODEL

**B. Wade Brorsen, Odell L. Walker, Gerald W. Horn, and Ted R. Nelson**

Stocker cattle operations are an important part of the nation's cattle industry. Many producers do not realize the profit potential in new technological advances, and some feed their cattle on uneconomic planes of nutrition. Stocker cattle producers can benefit from results of animal science and agronomic research if they are presented in a framework suited to use in decision-making. Analyses prepared by agricultural economists often ignore many of the factors determining gain because of lack of data and complexity of the relationships. Thus, a system for economic analysis that accounts for more factors and improves growth predictions would be highly useful. The purpose of this study is to develop and provide computerized analytical procedures to estimate physical and economic results of alternative stocker production systems.

Researchers have developed several models to aid in analyzing stocker cattle production choices. Oklahoma State University (OSU) has enterprise budgets that model specific stocker cattle production choices. But more technical information needs to be incorporated into the budgets, and analytical flexibility is needed to analyze more production alternatives.

Oklahoma State University's Beef Projection Program designed by Nelson uses continuous functions to analyze beef production in feedlot situations. However, the Nelson model is not designed for forage situations, and additional variables should be included to improve the flexibility of the model. Fox and Black developed a model that included adjustments for additional variables in cattle growth and used continuous growth functions. However, it was designed specifically for feedlot situations in the Corn Belt and is not applicable to stocker cattle because of differences in the relationship between intake and digestibility, differences in the impacts of feed additives and growth stimulants, and the relationship between digestibility and net energy for forages. Fox and Black, Nelson, and enterprise budgets have all made important contributions. The model described in this work is designed to address additional problems. It is specifically designed to provide a framework for analyzing stocker cattle production. It offers the flexibility needed to stimulate individual animal performance for a specific operation, yet provides accuracy in analyzing general stocker-pasture situations.

### MODEL CAPABILITIES

Given information about a specific stocker cattle system, growth patterns and economic outcomes are estimated. Outcomes are projected on the basis of one animal, but this projection is applicable to any number of animals subject to reasonable enterprise size relationships.

The economic analysis accounts for costs such as veterinary supplies, trucking, commissions, interest, death loss, labor, truck equipment, minerals, and pest control. The model accounts for shrinkage from buying and selling activities. Also, a factor is included to adjust for performance of cattle transferred to a new environment. Pasture is valued in dollars per unit of TDN.

The model assumes there are 30 days in each month and 360 days in a year. Cattle are started on the first day of any of the 12 months. However, the results derived can be applied to cattle started on a different day. Gains are calculated at 15-day intervals, except that near the selling weight the printing interval is changed to 5 days. For print-out purposes, the average daily gain at the beginning of the interval is assumed to be the gain for each day of the interval.

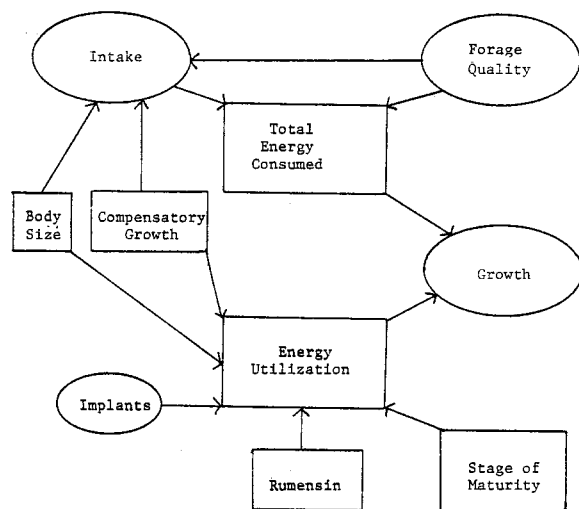
### FACTORS AFFECTING GROWTH OF STOCKER CATTLE

Many factors affect stocker cattle growth. Those considered in this work and the direction of the relationships between them are shown in Figure 1. The reasons for selecting these variables and the way in which their relationships were quantified are explained in following paragraphs.

#### Energy Requirements for Growth and Maintenance

The California Net Energy System (CNES) is the most widely used energy system for ration formulation and gain projection for feedlot cattle in the United States (Fox and Black, p. 141). The CNES is also used as the base for National Research Council (NRC) nutrient requirements for beef cattle (National Academy of Sci-

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**Figure 1.** Diagram of the Factors Affecting Stocker Cattle Growth.

ences). CNES was developed primarily using high-quality grain rations. After comparing actual gains of stocker cattle with gains predicted by the net energy system, CNES was determined to be the best method of measuring energy requirements of stocker cattle (Brorsen). CNES separates net energy into net energy for maintenance ( $NE_m$ ) and net energy for gain ( $NE_g$ ). The requirements are<sup>1</sup>

$$(1) \quad NE_m^r = .043W^{.75}$$

where

$NE_m^r$  = net energy required for energy balance (Mcal/day)

$W$  = empty body weight of the animal (lb)

The net energy available for gain ( $NE_g^a$ ) can then be calculated as follows

$$(2) \quad NE_g^a = [\text{Intake} - (NE_m^r/NE_m)] (NE_g)$$

where

$NE_g^a$  = net energy available for gain (Mcal/day)

Intake = daily dry matter intake (lb/day)

$NE_m$  = net energy for maintenance value of the feedstuff (Mcal/lb)

$NE_g$  = net energy for gain value of the feedstuff (Mcal/lb)

The average daily gain (ADG) for steers can then be defined as,

$$(3) \quad \text{ADG}(\text{lb/day}) =$$

$$\frac{\sqrt{.0001748 + (.003112)(NE_g^a/W^{.75})} - .01322}{.001556}$$

<sup>1</sup> Weight is measured in pounds as opposed to the NRC manual where weight is measured in kilograms. The adjustment factor for the coefficient is  $(2.2)^{.75}$  or 1.8.

and for heifers,

$$(4) \quad \text{ADG}(\text{lb/day}) =$$

$$\frac{\sqrt{.0001974 + (.005756)(NE_g^a/W^{.75})} - .01405}{.002878}$$

The CNES framework was developed using average-frame-size British breed cattle that were given a growth stimulant in a controlled environment. Several adjustments to these functions are made later for cattle that differ from those used to develop the CNES.

### Voluntary Intake

Agricultural economists often assume intake to be a constant percentage of body weight. This assumption creates problems when the quality of the forage varies greatly, as it is allowed to do in the model developed here. Animal science experiments indicate that intake at low digestibility is affected by capacity of the rumen and rate of passage, which causes intake to increase with increases in digestibility. At high digestibilities, intake is a function of the animal's energy requirements, and intake decreases with digestibility. Rumen capacity is directly correlated with body weight. However, energy requirements are more closely related to metabolic weight ( $W^{.75}$ ).

The primary intake equation is one developed by Conrad et al. using rations between 52- and 66-percent digestibility. Conrad et al. developed their equation using lactating dairy cows. It has been shown that there is no significant difference between the results of Conrad et al. and the results obtained by estimating the same equation using results from experiments of stocker cattle on diets ranging from 37- to 67-percent digestibility (Lake, Clanton, and Karn; Mader; Rider and Boyer; Wilson).

The intake equation used for diets with a TDN greater than 66 percent is derived from one estimated by Dinius et al. using diets with high digestibilities and using metabolic weight. In order to avoid a discontinuous intake function, the Dinius et al. equation is converted to a function of body size (Brorsen). This should not be a critical approximation, since most forages have a TDN value below 66 percent, but it does mean that the resulting intake function would not be appropriate in a feedlot situation.

The intake function combining these two equations is

$$(5) \quad I = \begin{cases} \frac{.0107 W}{(1 - \text{TDN}/100)} & \text{if TDN} \leq 66 \\ (.061742 - .00045866\text{TDN})W & \text{if TDN} > 66 \end{cases}$$

where

$I$  = Daily voluntary intake of dry matter (lb/day),

$W$  = Animal body weight (lb), and

TDN = Total digestible nutrient content of the diet (%).

Additional factors that influence voluntary intake are not accounted for by these equations, but they represent an improvement over the assumption that intake is a constant percentage of body weight.

### Compensatory Growth

Compensatory growth is the ability of an animal, previously restricted in growth, to resume growth at a rate greater than normal for animals of the same chronological age (Wilson and Osbourn, p. 324). Compensatory growth has been attributed to both increased intake (Wilson and Osbourn) and increased energy utilization (Meyer et al.). On the basis of a review of the literature by Brorsen, half the increase in gain from compensatory growth is assumed to be due to increased intake and half is assumed to be due to increased digestibility of the feedstuff (increases in  $NE_m$  and  $NE_g$  values).

Compensatory growth responses are highly variable, but in general, during realimentation animals will recover 50 percent of the difference in gain acquired during the restriction period when compared to a higher-gaining group (Winchester and Howe; Horton and Holmes). Also, experiments indicate that maximum compensatory growth will occur only with a high-energy diet (Fox et al.). An ADG of one pound per day is assumed to be the previous ADG of the cattle in the CNES study. The multipliers for intake,  $NE_m$  and  $NE_g$  are obtained from the following equations

$$(6) \quad IMULT = \frac{1.042 - .0429 (PREVADG)}{.947 + .05362 (PREVADG)}$$

$$(7) \quad GMULT = \frac{1.0516 - .0524 (PREVADG)}{.9356 + .0655 (PREVADG)}$$

$$(8) \quad PREVADG = \begin{cases} PG & \text{if } D \leq 60 \\ PG(1 - \frac{D-60}{180}) + AG(\frac{D-60}{180}) & \text{if } 60 < D < 180 \\ MG & \text{if } D \geq 180 \end{cases}$$

where

IMULT = Multiplier for intake; intake = predicted intake  $\times$  IMULT

GMULT = Multiplier for  $NE_g$  and  $NE_m$

PG = ADG last 120 days before start on the present pasture system.

AG = ADG since start

D = Days since start

MG = ADG last 180 days.

These equations incorporate more information for estimating compensatory gain than the method used by Fox and Black, who used one multiplier for the whole feeding period. In the model developed here, past growth restrictions are phased out and compensatory growth potential develops within the model. Restricted animals placed on wheat pasture recover half of the weight difference between them and their non-restricted counterparts. Slightly less response is obtained on lower-quality forages. Compensatory growth from feed restriction within the model is slightly less

than from previous restriction. This fault of the model is introduced to eliminate an unrealistic "cobweb effect" in which gain is reduced due to past compensatory growth, then gain is increased due to this reduction and a continuous cycle develops. Even with its faults, the compensatory growth and adjustment contributes greatly to the predictive ability of the model.

### Protein Requirements

In order for the CNES equation to be valid, the protein needs of the animal must be met. Digestible protein is used as the measure of protein requirements. The equations to determine protein requirements are obtained by regressing weight and gain upon the protein requirements exhibited in the tables in the NRC manual (National Academy of Sciences). The equations obtained are

$$(9) \quad \text{Steers: } TPR = .14989 + .0005749W + .2387ADG$$

$$(10) \quad \text{Heifers: } TPR = .1764 + .000576W + .2225ADG$$

where

TPR = Digestible protein requirements (lb/day)

W = Empty body weight (lb)

ADG = Average daily gain (lb)

### Adjustment for Cattle of Different Mature Sizes

Certain breeds of cattle are known to gain weight faster than others. Fox and Black assumed that this was because of a difference in mature weight rather than breed per se. Research results suggest that differences in energetic efficiency between British breeds and larger-framed European breeds are small when animals are compared at the same stage of growth (Klosterman; Crickenberger et al.; Harpster et al.).

In CNES, net energy required per pound of gain increases as weight increases. Thus, CNES should depend on stage of maturity instead of body weight. Fox and Black introduced the concept of equivalent weights. An animal's equivalent weight can be predicted from the following equations

$$(11) \quad \text{Steers: } EW_t = \frac{1050}{CW} (AW_t)$$

$$(12) \quad \text{Heifers: } EW_t = \frac{840}{CW} (AW_t)$$

where

1050 lb. and 840 lb. are assumed to be average market weights for steers and heifers respectively

$AW_t$  = the animal's actual body weight in pounds at time t

CW = the animal's expected weight at low choice or equivalent market weight for lower quality cattle

$EW_t$  = the animal's equivalent weight at time  $t$  (the weight of an average animal at the same stage of maturity)

The equivalent weight is used in the gain equation instead of actual weight. The gain for steers becomes

$$(13) \quad \text{Gain} = \frac{\sqrt{.0001748 + (.003112) (NE_g^a/EW^{.75})} - .01322}{.001556}$$

One particular advantage of the equivalent weight adjustment is that it can be used in conjunction with the frame-size category in the new feeder grade system. For example, large-frame feeder steers have an expected weight at U.S. Choice of at least 1,200 pounds. This is the information that is needed by the model to compute the adjustment of different mature sizes.

### Growth Stimulants

Growth stimulants have been proven to increase average daily gain and feed efficiency in cattle. The major implants used are diethylstilbestrol (DES), Synovex-S (for steers), Synovex-H (for heifers) and Ralgro (zeranone). The feeding experiment for which CNES was developed used a growth promotant (DES), (Lofgreen and Garrett). Since use of DES is no longer legal, the CNES must be adjusted.

The effects of growth stimulants are accounted for by using a multiplier for net energy available for gain. Fox and Black assumed that the effects of DES and Synovex-S are equal. In this analysis, DES, Synovex-S, and Synovex-H are also assumed to have equal effects on gain. Brorsen used data from research experiments to obtain the multipliers. The ratios of the amount of  $NE_g^a$  required to give the differences in gains reported are computed using this data. Each trial is given an equal weight. The multipliers used are the mean of the multipliers implied by the experiments. The results are contained in Table 1.

The implant multiplier (IMP) is used directly upon  $NE_g^a$ . The equation for steers becomes:

$$(14) \quad \text{Gain} = \frac{\sqrt{.0001748 + (.003112) (IMP) (NE_g^a/EW^{.75})} - .01322}{.001556}$$

**Table 1.**  $NE_g^a$  Multipliers for Implants on Stocker Cattle.

Implant	Multiplier (IMP)
DES	1.00
Synovex-S	1.00
Synovex-H	1.00
Ralgro	.91
No Implant	.76

Source: Brorsen

### Rumensin

Monensin (Rumensin) is a biologically active compound produced by a strain of *Streptomyces cinnamonensis* and increases rumen fermentation and feed efficiency in feedlot studies. Although research is still incomplete, Rumensin appears to increase gain in stocker cattle with no change in intake (Brorsen). Therefore the effect of feeding Rumensin is shown in the model by increasing the TDN value of the feedstuff, which leads to higher  $NE_m$  and  $NE_g$  values.

Results of 14 experiments were used by Brorsen to compile the Rumensin multiplier. All trials where Rumensin intake was between 50 and 200 mg per day were included in the analysis. Experiments with both grain and mineral as a carrier were included. The value of the Rumensin multiplier was obtained by dividing the TDN necessary for the gain recorded with Rumensin by the TDN necessary for the gain recorded without Rumensin. The multiplier used in the model is the average of the multiplier implied from all trials included in the analysis. The multiplier for TDN estimated by this method was 1.05. Therefore, Rumensin was found to increase the digestibility of the forage by 5 percent.

### DEVELOPMENT OF DATA USED IN THE ANALYSIS

#### Forage Data

One of the major reasons agricultural economists have not used the net energy system extensively is a lack of adequate forage data. Inadequate data is also a problem in this analysis. To predict the performance of stockers, measures of pasture quality, protein, and quantity available are required. To reflect seasonal changes in pastures, time is discretized into 12 monthly periods. Thus, monthly estimates for major Oklahoma forages are developed to be used in the model. These values can be changed readily if a user desires to substitute his own pasture estimates.

The pasture data compiled are expected values for a given month. Quality and protein values are estimates for what the cattle consume. Cattle tend to eat the best forage and leave the rest. Thus, the values estimated for quality (TDN) and protein may be higher than the values obtained from forage samples. The quantity figures refer to how much forage a top manager's cattle would be allowed to consume in a given month. Thus, the quantity figures may be different than actual dry matter growth or total dry matter available for a specific month.

Eight different pastures were selected to be included directly in the model. Others may be added if the user chooses. The pastures selected as being typical for Oklahoma are overseeded bermudagrass, bermudagrass, short native grass (primarily buffalograss), tall native grass (primarily bluestem), lovegrass, sudangrass, fescue, and wheat pasture.

Data are not available to estimate net energy values directly. Data are available to estimate TDN values of

the forage, so TDN is selected as the measure of forage quality. The TDN values are converted to  $NE_m$  and  $NE_g$  values by the method developed by Van Soest where

$$(15) \quad NE_g (\text{Mcal./CWT.}) = 1.32 \text{ TDN} - 45.9$$

$$(16) \quad NE_m (\text{Mcal./CWT.}) = 1.32 \text{ TDN} - 13.2$$

Many of the experiments used to compile the pasture data reported the *in vitro* digestible dry matter (IVDMD) of the forage from the method of Tilley and Terry. The IVDMD values were converted to TDN by the equation from Oh, Baumgardt, and Scholl

$$(17) \quad \text{TDN} = \text{In Vivo DDM} = 16.7 + 0.74 \text{ IVDMD}$$

Monthly estimates of digestible protein for Oklahoma forages could not be obtained directly, due to insufficient data. Crude protein values for each of the forages are estimated. The crude protein values are converted to digestible protein by KJELDAHL laboratory process

$$(18) \quad \text{Percent digestible protein} = 0.929 (\text{percent crude protein}) - 3.48$$

This equation can yield digestible protein values less than zero. If digestible protein from the equation is negative, it is given a value of zero.

The quantity of forage to be consumed is expressed as pounds of dry matter per month. This quantity is used only in valuing forages and estimating stocking rates. Vavra et al. argued that forage quality and actual gains

are inversely related to stocking rates. The quantity of forage does not affect gain in the model, since stocking rates and quality of the forage are assumed to be constant in the interval.

Examples of data for Oklahoma pastures are in Table 2. The general seasonal pattern of forage nutritional values is shown. New growth of forage is the highest quality, and quality drops rapidly as the forage matures. Dormant pasture values decrease slowly as weather deteriorates the forage.

The forage values used in the model are only estimates of long-run expected values. If more information is available about a specific operation, different values may be used. The pasture data stored in the model could be improved through increased research on monthly nutrient values of pastures, but are good estimates of expected values for Oklahoma forages. As will be shown later, they are adequate in predicting gains when forage quality is not known.

The model allows for concentrates and hay to be fed while cattle are grazing the forage. The NRC bulletin is used to obtain the data for the feedstuffs. Values are obtained for  $NE_g$ ,  $NE_m$ , digestible protein, and percent moisture for corn, milo, wheat, soybean meal, cottonseed meal, alfalfa hay, and wheat straw. Other supplemental feeds may be substituted.

If protein is in short supply from pasture, the model balances the ration for protein by adding supplement through an iterative process. The model will not allow protein to be the limiting nutrient for growth. The model will not run if protein needs are not being met because it is assumed that it will never pay to restrict protein below the minimum requirement. Supplement can also be fed at any specified level up to the entire diet.

**Table 2.** Expected Values of TDN, Crude Protein, and Dry Matter Available for Selected Pastures.

Pasture	MONTH											
	J	F	M	A	M	J	J	A	S	O	N	D
<b>Overseeded Bermudagrass</b> (200 lb. of N Used/Acre)												
TDN (Percent)	35.6	37.6	68.0	66.7	63.7	56.9	55.2	52.1	54.9	50.9	42.8	41.9
C.P. (Percent)	5.6	6.6	25.0	24.2	20.6	16.9	10.0	9.8	10.0	12.1	8.2	7.1
Production (lbs. DM/A)	0	0	265	1,000	810	925	1,030	970	950	220	0	0
<b>Bermudagrass</b> (200 lb. of N Used/Acre)												
TDN (Percent)	35.6	35.0	37.2	43.1	60.0	58.0	56.0	52.0	55.0	51.0	43.5	42.5
C.P. (percent)	5.8	5.7	5.9	7.0	13.7	11.9	10.0	9.8	10.0	7.5	6.2	6.0
Production (lbs. DM/A)	65	65	65	0	330	1,330	1,330	1,330	1,330	330	65	65
<b>Wheat Pasture</b> (100 lb. of N Used/Acre)												
TDN (Percent)	68.0	68.0	67.0	65.0	60.0	55.0	0	0	0	68.0	68.0	68.0
C.P. (Percent)	25.0	25.0	23.0	20.0	18.0	10.0	0	0	0	25.0	25.0	25.0
Production (lbs. DM/A)	440	440	440	660	660	0	0	0	0	0	0	440

Source: Mader; Dinus, et al.; Lofgreen and Garrett; McMurphy and Tucker (1972a); McMurphy and Tucker (1972b); Wagner; and Wilson.

## Cattle Prices

The user specifies expected buying and selling prices of the cattle. The model calculates prices over time by linearly interpolating between these two prices. The temporal relationship of cattle prices is not linear. Therefore, if desired, the input cattle prices can be internally adjusted using seasonal price indexes. Thus, the returns calculated by the model for each interval can take into account seasonal price movements.

## COMPARISON WITH ACTUAL EXPERIMENTS

Lehman argued that a model is valid if it can predict reality. The animal growth predictions of the model outlined in this study are compared to the results of 10 actual experiments. The results of this comparison appear in Table 3. The differences between average daily gain results of actual experiments and projections of the model are not significant using a paired differences test. Reasonable results are obtained in each simulation of actual experiments. This indicates that the model is valid, since it predicts reality adequately.

## APPLICATION OF THE MODEL

The model has potential for extension, researcher, and producer use. The model can be used to compare performance of steers and heifers. It can be used to determine the most profitable supplement to use for winter feeding. It can also be used to determine whether it would pay to feed Rumensin or how much extra to pay for cattle that will exhibit compensatory growth.

Coupled with other techniques, such as mathematical programming, the model can be used to determine the profit-maximizing enterprise mix for a given or endogenously determined pasture program. Researchers could use the model to estimate the potential impact of research on breeds, growth stimulants, additives, and pastures. The procedure outlined gives accurate estimates of stocker cattle gains under alternative production conditions.

The computer output gives sufficient information for most production decisions. Table 4 is the output from a simulation of stocker cattle on overseeded bermudagrass. The first row of the table gives the sex, purchase weight, purchase price, Rumensin multiplier, implant multiplier, previous average daily gain, and the animal's estimated weight when fed to low Choice or equivalent. The second set of values gives commissions per head, trucking cost per hundredweight, medical costs per head, miscellaneous costs per day, interest rate, and the dollars of equity per head. These values only tell the user what he has inputted. The model is capable of performing an economic analysis and gain projection on a daily basis; however, in this example a 15-day interval is selected.

The title applied to the particular run precedes the printout of the 15-day analysis. The cattle performance data printed by 15-day periods are current weight in pounds, daily intake of dry matter in pounds, daily gain per day, optimum stocking rate in head per acre, and pounds of supplement fed per day on an as-is basis. Marginal revenue minus marginal cost is the profit per day during the interval. Since marginal revenue minus marginal cost is assumed to be constant in the interval, it is the same as average profit in the interval. Profit per day is simply total profit to date, divided by days. The data given in each line are the same for that

**Table 3.** Simulation Results Compared to Results of Actual Experiments.

Source	Forage	Actual ADG (lb/day)	Predicted ADG (lb/day)	Difference
Wilson	Bermudagrass	.76	.77	-.01
Mader	Small Grains	1.87	1.98	-.11
Mader	Small Grains	1.16	1.49	-.33
Mader	Bermudagrass Hay	.00	.01	-.01
Mader	Bermudagrass Hay	.40	.19	.21
McMurphy and Tucker (1972b)	Small Grains	1.71	1.70	.01
McMurphy and Tucker (1974)	Small Grains	2.24	2.07	.17
Smith	Bermudagrass	1.48	1.11	.37
Horn et al.	Bermudagrass	.30	.45	-.15
McMurphy and Tucker (1972a)	Overseeded Bermudagrass	1.33	1.30	.03

**Table 4.** Computer Output From Simulation of Stocker Cattle Performance on Overseeded Bermuda-grass.

OVERSEEDED BERMUDA												
TEN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CP	35.6	37.6	68.0	66.7	63.9	56.9	55.2	52.1	54.9	50.1	42.8	41.9
DM	5.6	6.6	25.0	24.2	20.6	16.9	10.0	9.8	10.0	12.1	8.2	7.1
	0	0	265	1000	810	925	1030	970	950	220	0	0
			SK BUYWT	BUYPR	RUM	IMPLANT	PADG	CHMT				
			\$ 400.00	95.01	1.00	1.00	1.00	1050				
			COMM	TRKRT	VETMED	OTH/DY	INTRT	SEQUIY				
			3.50	0.34	4.85	0.07	0.12	0.00				
			STOCKERS ON OVERSEEDED BERMUDAGRASS									
DATE	WEIGHT	FD/DY	GAIN/DY	HD/AC	LB.SUP	MR-MC	PROF/DY					
3 0	400.00											
3 15	435.03	12.21	2.34	0.72	0.00	0.30	0.30					
3 30	471.18	13.28	2.41	0.67	0.00	1.11	0.70					
4 15	507.67	14.66	2.43	2.27	0.00	1.00	0.80					
4 30	545.17	15.80	2.50	2.11	0.00	.090	0.83					
5 15	577.10	16.14	2.13	1.67	0.00	0.61	0.78					
5 30	607.92	16.81	2.06	1.61	0.00	0.48	0.73					
6 15	622.10	14.61	0.94	2.11	0.00	-0.01	0.63					
6 30	635.80	14.82	0.91	2.08	0.00	-0.04	0.54					
7 5	639.31	14.48	0.70	2.37	0.00	-0.13	0.52					
7 10	642.80	14.54	0.70	2.36	0.00	-0.14	0.49					
7 15	646.29	14.61	0.70	2.35	0.00	-0.14	0.47					
7 20	649.76	14.67	0.70	2.34	0.00	-0.15	0.45					
7 25	653.24	14.74	0.69	2.33	0.00	-0.15	0.43					
7 30	656.71	14.81	0.69	2.32	0.00	-0.15	0.41					
STEER CLOSEOUT AFTER 150 DAYS.												
ADG = 1.71 LB/DAY INTAKE = 14.76 LB/DAY												
AVG HD/AC = 1.79 MIN HD/AC = 0.67												
CATTLE AT \$95.01/CWT..... 400.00												
MISC. COSTS AT 90.07/DAY... (LABOR = 0												
EQU = 1.5 PICK-UP = 3 MIN = 4 PEST = 1.5)												
INTEREST @ 12 PERCENT..... 10.00												
COST OF SUPPLEMENT AT \$12.10/CWT..... 0.00												
PASTURE COST AT \$1.43/CWT D.M..... 2,213.98												
D.M. = 7.10 *MED = 4.85 *COW = 3.50 *TRK = 1.36												
TOTAL SPECIFIED COSTS												
SALE VALUE @ \$79.25/CWT..... 656.71												
NET RETURNS TO 90 EQUITY, MGMT, RISK, & UNPAID LAND & LABOR												
BREAK-EVEN SALE PRICE..... 61.02												
NUTRIENT REQUIREMENTS												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TEN	0.0	0.0	68.0	66.7	63.9	56.9	55.2	0.0	0.0	0.0	0.0	0.0
DP	0.0	0.0	7.4	6.6	5.9	5.0	4.8	0.0	0.0	0.0	0.0	0.0
DM	0	0	382	457	494	441	439	0	0	0	0	0

day and the previous 14 days, except weight and profit per day, which are values for the last day of the interval.

The second section of the printout gives a summary of cattle performance. All costs are itemized, and the net return to the resources for which no charge was made and the break-even sale price are calculated.

The computer program also provides a printout of the forage and supplement data being used. Also, a monthly summary of the nutrient requirements of the animal is available. This printout gives the average TDN value of the total ration, minimum percent of digestible protein, and pounds of dry matter consumed for each month.

The projected gains for the steers grazing the overseeded bermudagrass are higher during the early grazing due to higher-quality forage. No protein supplement is required. Net return to management, risk, land, and

labor is \$61.02. The net return would have been higher if the cattle had been marketed earlier. This can be seen by examining marginal revenue minus marginal cost. When this figure is negative, the producer is losing money by keeping the cattle. If the pasture is a fixed cost, the model should be run with no charge for pasture in order to determine when to sell the cattle.

There are many additional applications of the model. Brorsen's analysis indicates that seasonal price fluctuations and forage quality are very important in determining net returns. Synovex increased gains from 25 to 30 percent. Ralgro increased gains 16 to 19 percent. The effect of compensatory growth potential was evaluated using 1979 price data. In the specific case studied, it was more profitable to keep cattle gaining rapidly during the winter, in spite of less compensatory growth during summer grazing (Brorsen).

The model is specifically developed for Oklahoma. To adapt the model for use in other locations in the southern U.S., the only adjustment needed is to the forage data. Cold, wet, windy weather, which exists in the northern U.S., would result in cold stress on animals and increased maintenance requirements (Webster et al.).

## SUMMARY

The model outlined in this study is designed to simulate the growth of stocker cattle and study the economic significance of different stocker cattle production alternatives. The model calculates energy requirements for growth and maintenance, estimates dry matter intake for pasture of specified qualities by months, projects gains and weights by 5-to 15-day periods, and provides an economic summary of projected results of the stocker system. Gains are adjusted internally for compensatory growth, different mature sizes, use of implants, and use of Rumensin. Monthly estimates of quality, protein, and dry matter available are obtained for various forages. These, along with data for hay and concentrates, are used to calculate the nutrient content of the diet to use in estimating stocker gains. The model is flexible and can simulate specific stocker cattle systems and is highly available to stocker producers via a micro-computer program.

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