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The Use of Urea and Stilbestrol in Fattening Rations for Beef Cattle

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To the Graduate Council:

I am submitting herewith a thesis written by Samuel French Wolfe entitled "The Use of Urea and Stilbestrol in Fattening Rations for Beef Cattle." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

M.C. Bell, Major Professor

We have read this thesis and recommend its acceptance:

Charles S. Hobbs, Horace C. Smith, Jr.

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Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

June 4, 1956

To the Graduate Council:

I am submitting herewith a thesis written by Samuel French Wolfe entitled "The Use of Urea and Stilbestrol in Fattening Rations for Beef Cattle." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

M. C. Bell
Major Professor

We have read this thesis
and recommend its acceptance:

Charles S. Hobbs

Horace C. Smith Jr.

Accepted for the Council:

E. G. Walters
Dean of the Graduate School

THE USE OF UREA AND STILBESTROL IN FATTENING RATIONS FOR BEEF CATTLE

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

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by

Samuel French Wolfe

June 1956

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Samuel French Wolfe

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CHAPTER I

INTRODUCTION

Protein supplements are necessary for fattening cattle fed large amounts of grain and molasses with mixed hay. In times of shortages of natural protein supplements there is a definite need for protein substitutes. Urea feed is a protein substitute that has been successfully used to replace a part of natural protein supplement for cattle and sheep. Most results have indicated that urea is of value in limited amounts, but does not adequately replace all of the natural protein supplement. Rupel et al. (1943) state that 5,000,000 tons of protein supplements are required per year for dairy cattle, beef cattle, and sheep. The replacement value of urea is estimated by these workers to be $113 per ton when linseed meal, corn, and oats are valued at 45, 35, and 35 dollars per ton, respectively. Green (1955) states that hundreds of thousands of tons of ruminant feeds containing urea are being fed successfully each year in the United States, and that this practice may be expected to increase in the future.

Urea is of no value to swine and poultry, but the practice of feeding urea to ruminants makes more natural protein available for swine and poultry at lower costs.

Chemically, urea is a diamide of carbonic acid and is the principal end product of protein metabolism in mammals, being thus found in the urine of all four-legged farm animals and also man. Urea is manufactured commercially from coal, air, and water, and for feeding purposes, is normally standardized to forty-two percent nitrogen.

This is equivalent to 262 percent crude protein since protein is commonly calculated by multiplying the nitrogen content of a feedstuff by the factor 6.25.

Stilbestrol is a synthetic compound with estrogenic properties which is capable of producing many of the effects brought on by the female hormone estradiol. Small amounts of stilbestrol administered either orally or as subcutaneous implants have been shown to increase both rate of gain and feed efficiency in cattle and sheep. The incorporation of stilbestrol in ruminant feeding would seem especially important in times of feed shortages since its use, under proper conditions, is a means of producing more pounds of meat per unit of feed. The cost of stilbestrol is small; however, there is additional labor required for mixing it with feeds or for making subcutaneous implants. Due to the possible ill effects from improper mixing, stilbestrol is currently being distributed to the farmer after incorporation in supplements by commercial feed companies. Stilbestrol, like urea, has not been shown to increase rate of gain in swine and poultry, but when used extensively in ruminant feeding, it may increase the supply of feed and lower the cost of these feeds to swine and poultry.

This investigation was conducted to study the substitution of urea and corn, on a nitrogen basis, for part or all of the protein supplement needed to balance a low protein fattening ration for steers, and also to study the effect of adding ten milligrams of stilbestrol per steer daily to a ration in which urea was used as the sole protein supplement in balancing the ration.

CHAPTER II

REVIEW OF LITERATURE

Investigation of simple nitrogen compounds as feedstuffs for ruminants began during the 1880's in Germany. Armsby (1911) showed that ruminants could utilize non-protein nitrogen to a limited extent; however, it was not until 1937 that it was first realized (Reid 1953) that the nitrogen from urea could be efficiently converted to protein by ruminants, and during recent years, urea has come into rather widespread use as a protein substitute. This has been brought about as a result of extensive experimental work along with the needs of protein substitutes to relieve shortages.

Green (1955), Swenson (1954), Dowe (1953), and Agrawala et al. (1953) agree that the protein substituting value of urea is due to the biosynthetic activity of rumen microorganisms. Urea is rapidly hydrolyzed to ammonia, and its nitrogen along with carbohydrates is utilized by the bacteria and protozoa of the rumen and reticulum as nutrients for their growth and reproduction. These microorganisms are in turn digested, thus furnishing protein constituents for the host animal. Brinegar (1951), Hunt et al. (1954), and Jordon (1953) have generally shown that for microorganisms to make efficient conversion of urea to protein, the ration fed must contain readily available carbohydrates and some protein as such. These workers found that poor conversion of urea occurs when added to hay rations when no concentrates are fed. Starch seems to be the preferred carbohydrate since free sugars are absorbed too rapidly and celluloses are digested too slowly to be

efficiently used by the microorganisms. Since the ammonia from urea, if not rapidly used, is readily absorbed and eliminated, the carbohydrates must be simultaneously available for most efficient utilization. Therefore it would seem and has been generally borne out by Gallup et al. (1952, 1953a) and Hunt (1954) that urea is most effective in a protein sparing capacity when it is fed with a ration which is low in protein and high in starch.

Gallup et al. (1953a) made an eight year study on the use of urea in rations for fattening calves. A total of 210 calves were full fed on grain for approximately 165 days. They were fed urea in pelleted protein supplements in amounts ranging from one-half to two pounds per day. Results from these trials showed that pellets in which urea supplied the equivalent of either twenty-five or fifty percent of the protein produced gains equal to those produced by the common plant protein supplements. Pellets with eighty-five percent of the nitrogen supplied by urea were, in general, unsatisfactory. Culberson et al. (1950, 1952), Bell et al. (1955), Tillman et al. (1951), Weber and Hughes (1942), working with beef steers, and Briggs et al. (1948), working with lambs, also found urea to be equal to common protein supplements when substituted on a fifty percent basis. Weber and Hughes (1942) fed four groups of three steers each for a period of 168 days to compare the value of urea to cottonseed meal. One animal in each group was fed cottonseed meal as the protein supplement; a second animal, urea; and the third, urea plus cottonseed meal ash. The energy level of the rations for steers receiving urea was maintained with corn starch. Average daily gains were 1.59, 1.59, and 1.63 pounds for the

treatments, respectively. There was no significant advantage gained by adding the cottonseed meal ash to the ration. Culbertson et al. (1951) found urea to be equal to soybean oil meal in replacing all the soybean oil meal needed to balance a fattening ration made up of shelled corn and mixed hay for yearling steers.

In metabolism tests, low protein roughages such as grass hay and cottonseed hulls were not found to be efficiently supplemented with urea alone by Gallup et al. (1953a) and Brinegar (1951). Much of the urea was wasted unless some carbohydrate such as a cereal grain was added. Goode (1955) found no significant advantage from treating silage with urea when gains of pregnant cows were compared. Weber and Hughes (1942), Briggs et al. (1950), and Gallup et al. (1953a) have collectively shown that urea has no effect on the normal metabolism of calcium, phosphorus, and vitamin A in cattle and sheep. Hunt (1954) found that inorganic sulfur as sodium sulfate and sulfur in methionine stimulated the activity of rumen microorganisms with the result that more urea was utilized than when the source of sulfur was cystine or elemental sulfur. However, Starks (1953) showed that elemental sulfur can be used by sheep to partially supply the dietary needs of sulfur when added to a low-sulfur ration where the major source of nitrogen is urea. He found that lambs receiving elemental sulfur retained significantly more nitrogen and sulfur than controls.

Thomas et al. (1951), feeding purified diets to lambs, noted that in the absence of dietary sulfur, urea nitrogen was apparently not utilized since the deficient lambs were consistently in negative nitrogen and sulfur balance.

Burroughs et al. (1951) noted, from in vitro studies, differences in urea utilization between flasks containing good, intermediate, and poor quality proteins favoring the higher quality proteins. Hunt (1954) also noted the innoculum from a fistulated steer fed good quality alfalfa hay to be more effective in urea utilization than the innoculum from one fed poor quality timothy hay. Bell et al. (1951) made a series of digestion and nitrogen balance studies on the utilization by steers of urea nitrogen in rations containing different carbohydrate feeds. Corn, dehydrated sweet potatoes, milo, barley, cane molasses, and combinations of cane molasses and corn were used in combination with prairie hay and sufficient protein supplement to make basal rations containing eight percent crude protein. Urea was added to each ration to provide a total of eleven percent protein equivalent. The addition of urea was found to have very little effect on apparent digestibility of nutrients with the exception of protein which was increased in all rations. The addition of urea also was found to improve nitrogen retention significantly in all cases. These findings were in agreement with Briggs et al. (1948), Dinning et al. (1949), Tillman and Swift (1953), and Gallup et al. (1952).

Dinning et al. (1948), in studying the toxicity of urea, administered orally forty-two grams of urea in a water solution to a sheep under light anesthesia. A rapid rise of the ammonia in the portal blood was found which continued to increase during the two-hour observation period. A level of eight and four-tenths milligrams per one hundred milliliters of blood was ultimately reached indicating hydrolysis of urea in the rumen and absorption of large quantities of

ammonia. When steers were administered urea as a drench in amounts exceeding one hundred grams, a rapid rise of both urea nitrogen and ammonia nitrogen occurred in the blood. Ataxia appeared in steers when the ammonia nitrogen of the systemic blood reached a level of approximately two and one-half milligrams per one hundred milliliters of blood and symptoms of alkalosis followed by death occurred at a level of approximately four milligrams. When urea was mixed with other concentrates, one steer was induced to eat up to four hundred grams of urea daily without producing ill effects. These workers suggested that lethal blood ammonia nitrogen levels may be between two and four milligrams per one hundred milliliters. Gallup et al. (1953b) suggest that urea may produce harmful effects under certain conditions such as rapid consumption of feeds containing urea by starved animals or to animals not having previously been fed feeds containing urea; however, urea toxicity would not be expected in animals that are accustomed to properly mixed rations containing urea at the recommended levels. Dowe (1953) stated that since urea can be toxic, it is recommended to limit urea to one percent by weight of the total dry matter. The Association of American Feed Control Officials (Dowe, 1953) has recommended that mixtures carrying more than three percent urea be labeled with appropriate feeding instructions.

Estrogens occur in variable amounts in the natural feeds of livestock, particularly in growing legumes. The editors of American Veterinary Medical Association Journal state in the May 1955 issue that several years ago sheep breeders in Australia were besieged with dead and weak lambs due to the excessive estrogen content of subterranean

clover. Although estrogens have been identified in many plants including even Spanish moss, it is believed that no plant grown on the North American Continent approaches the danger point.

Clegg and Cole (1954), in comparing the growth response of heifers implanted with twenty-four milligrams of stilbestrol, untreated heifers, and implanted steers on fattening rations, found the treated heifers to give less response than the steers. These workers also found that implanted heifers on pasture made no more gain than controls.

Jordon (1950), O'Mary et al. (1956), and Andrews et al. (1954) have demonstrated increased rate of gain and feed efficiency by implanting pellets containing twelve to thirty-six milligrams of stilbestrol subcutaneously in feeder steers. Perry et al. (1955), Murphree (1955), and Burroughs et al. (1955) have found increased rate of gain and feed efficiency by oral administration of stilbestrol at levels of five and ten milligrams per day to fattening steers. Clegg and Cole (1954) and Goetsch (1955) agree that the mode of action of stilbestrol is still vague, but suggest that it may increase weight gains and feed efficiency by its effect on the pituitary and adrenal glands since these glands were found to be significantly larger in treated animals. In treated heifers the thyroids were found to be significantly depressed; whereas, the thyroids of treated steers were found to be larger, but not significantly. An increase in nitrogen retention, which was also found by these workers, was suggested due to an increased production of growth hormone and adrenal androgens. Murphree (1955) suggests the length of beneficial use to be approximately one hundred days for oral administration of stilbestrol in the case of fattening steers, and O'Mary et al.

(1956) have shown significant benefit from pellet implantation in beef steers for a similar period. Burroughs et al. (1954) state that pellet administration has not been widely practiced by farmers because a potential health hazard is involved if substantial residues remain in the tissues of treated animals at the time of slaughter, and also, because implanted animals may exhibit undue restlessness or abnormal sexual activity. He lists advantages of oral administration over pellet implantation as being indicative of producing the desirable effects without the undesirable side effects. These advantages were listed as: reduction of labor and technology required for the restraint of animals for pellet implantation and better control of the levels administered.

CHAPTER III

EXPERIMENTAL PROCEDURE

This experiment included two separate trials which were conducted under similar conditions with identical objectives. In the initial study thirty-two Hereford and Angus steers averaging 696 pounds were alloted into four lots of eight steers each on a basis of weight, grade, and breeding. Prior to this study, all steers had been on pasture. All lots were used in an eighty-four day feeding study (May 8 through July 31, 1954) after a period of twenty-one days to get them "on feed". The basal ration consisted of grass hay, ground yellow corn, cane molasses, cottonseed meal, and minerals. Average daily rations per steer are shown in Table I; average percentage composition of feed ingredients, in Table II; and average percentage crude protein of rations, in Table III. Protein supplements were as follows: Lot I, cottonseed meal; Lot II, fifty percent cottonseed meal and fifty percent urea (nitrogen basis); Lot III, urea; Lot IV, urea plus ten milligrams of stilbestrol per steer per day. Additional corn was fed the lots receiving urea to give equivalent total digestible nutrients and crude protein. The mineral mixture was fed in a partitioned box with loose salt in one side and dicalcium phosphate in the other. The molasses was fed by pouring it over the grain with the urea being stirred in for lots receiving urea. Number two coarsely ground yellow corn was used. The stilbestrol was dissolved in vegetable oil and mixed with such an amount of ground corn that one pound of the mixture contained the daily desired amount of stilbestrol for the lot receiving stilbestrol. This mixture was sprinkled

TABLE I

AVERAGE DAILY RATION PER STEER (POUNDS)

Lot No.	Hay	Corn	Molasses	CSM	Urea	Total
			Trial I			
1	9.6	6.1	5.0	2.4	----	23.10
2	9.6	7.1	5.0	1.2	0.15	23.05
3	9.6	8.0	5.0	---	0.30	22.90
4*	9.8	9.4	5.0	---	0.30	24.50
			Trial II			
1	6.6	12.8	3.7	1.8	----	24.90
2	6.5	13.8	3.7	0.9	0.14	25.04
3	6.9	14.2	3.7	---	0.28	25.08
4*	7.2	14.3	3.7	---	0.28	25.48

*Stilbestrol added at the rate of 10 mg. per steer daily.

TABLE II

AVERAGE PERCENTAGE COMPOSITION OF FEED INGREDIENTS

	Hay	Corn	CSM	Urea	Molasses
			Trial I		
Moisture	9.82	15.22	9.40	----	15.34
Crude Protein	6.61	9.02	40.02	262	2.85
Ash	5.97	1.48	5.77	____	9.05
Ether Extract	1.75	3.03	5.82	----	----
Crude Fiber	36.34	1.68	9.49	----	----
N. F. E.	39.51	69.56	29.50	----	72.76
			Trial II		
Moisture	13.56	12.92	8.21	----	23.74
Crude Protein	10.33	9.42	39.31	262	2.69
Ash	6.07	1.47	5.20	----	7.00
Ether Extract	1.96	4.31	5.09	----	----
Crude Fiber	30.98	2.46	11.01	----	----
N. F. E.	37.10	69.42	31.18	----	66.57

TABLE III

AVERAGE PERCENTAGE CRUDE PROTEIN OF RATIONS

Lot Number	1	2	3	4
Treatment	CSM	Urea-CSM	Urea	Urea + Stilbestrol
		Trial I		
Crude Protein (Percent)				
As Fed Basis	9.9	9.9	10.0	9.9
Dry Matter Basis	11.4	11.5	11.5	11.5
From Urea	---	2.0	3.8	3.7
		Trial II		
As Fed Basis	10.93	11.22	11.39	11.44
Dry Matter Basis	12.67	13.12	13.35	13.40
From Urea	---	1.73	3.31	3.35

over the concentrate at the rate of one pound per day. All steers were weighed each twenty-eight days. Hay samples were taken from every fifth bale fed and composited for each twenty-eight day period. Samples of corn, molasses, and cottonseed meal were taken from the quantity on hand at the end of each twenty-eight day period. Chemical analyses were determined for each twenty-eight day period, and the average for these three analyses is shown in Table II. All chemical analyses were determined according to the procedure listed by the Association of Official Agricultural Chemists (1950) or slight modifications of these. Live weight grades were determined by the average of two individuals' grading and the initial value was set at what the steers would have brought on the market. Dressing percentage was figured from selling weight at the packing house and hot carcass weight. Carcass grades were U.S.D.A. grades. The method described by Snedecor (1946) was used for statistical analyses.

In the second study, thirty Hereford steers averaging 757 pounds were alloted into two lots of eight steers each (Lots I and II) and two lots of seven steers each (Lots III and IV). A 108 day feeding study (September 9 through December 26, 1955) was conducted. All lots were fed twice daily with the exception of omitting the concentrate at each Sunday evening feeding during the period. The hay used in the second trial was a grass-legume mixture containing approximately one-third legume; otherwise, the ration constituents were quite similar to those in the initial study. Three composited samples of ration ingredients were analyzed during the period, and the average results are shown in Table II. The percentage shrink was figured from the difference between

final weight at the feed-lot and the selling weight at the packing house, involving a hauling distance of approximately ten miles. With the exception of the alterations listed above, the experimental procedure was very similar to that of the initial study.

CHAPTER IV

RESULTS AND DISCUSSION

In the initial study, the resulting gains and weight records are shown in Table IV. The average daily rates of gain were 2.05, 2.12, 1.76, and 2.11 for Lots I, II, III, and IV, respectively. The steers in Lot III gained noticeably less (approximately four-tenths of a pound per day) than the steers in the other lots; however, this difference was not statistically significant. The steers in Lots I, II, and IV made quite similar daily gains. The steers in Lot II (C.S.M. and Urea) made the most efficient gains with a total of 1088 pounds of feed required per hundredweight gain. Lots I and IV required 1130 and 1162 pounds of feed per hundredweight gain, respectively, and the Lot III steers made the least efficient gains by a considerable margin, requiring 1302 pounds of feed per hundredweight gain. Lots III and IV (Urea versus Urea and Stilbestrol) show a difference of 140 pounds of feed per hundredweight gain favoring the stilbestrol group which represents a savings of approximately eleven percent of total feed. Feed costs per hundredweight gain amounted to $24.87, $23.60, $27.79, and $25.32 for Lots I, II, III, and IV, respectively.

Feed costs and financial results are shown in Tables V and VI. The returns per animal were $19.47, $21.46, $15.88, and $18.50 respectively, for Lots I through IV. These figures did not consider cost of labor or returns from manure. As noted above, the returns are in favor of Lots II, I, and IV, respectively. These differences are slight and reflect feeding efficiency of the animals in the various lots. The

TABLE IV

SUMMARY OF THE EFFECTS OF UREA AND STILBESTROL ON WEIGHTS AND GAINS

Lot Number	1	2	3	4
Treatment	CSM	CSM-Urea	Urea	Urea + Stilbestrol
	Trial I			
Number of Animals	8	8	8	8
Average per Animal (Pounds)				
Initial Weight	696	696	696	696
Final Weight	868	874	844	873
Total Gain	172	178	148	177
Daily Gain	2.05	2.12	1.76	2.11
	Trial II			
Number of Animals	8	8	7	7
Average per Animal (Pounds)				
Initial Weight	757	756	758	757
Final Weight	981	990	982	1030
Total Gain	224	234	224	273
Daily Gain	2.08	2.17	2.08	2.53**

**L. S. D. (P = .01) = 0.35 pounds per head daily in Trial II.

TABLE V

COSTS OF FEED PER STEER (TOTAL PERIOD)[a]

Lot No.	Hay	Corn	Molasses	CSM	Urea	Stilb.	Total
			Trial I				
1	12.02	15.33	7.14	8.15	----	----	42.74
2	12.12	17.88	7.14	4.07	0.84	----	42.05
3	12.09	20.29	7.14	----	1.64	----	41.17
4	12.37	23.63	7.14	----	1.64	0.08	44.86
			Trial II				
1	10.76	33.56	6.38	6.27	----	----	56.97
2	10.54	36.12	6.39	3.16	0.75	----	56.96
3	11.20	37.38	6.34	----	1.50	----	56.42
4	11.63	37.64	6.43	----	1.50	0.11	57.31

[a]Values (dollars per ton) used for feed ingredients in Trial I were as follows: hay-30, corn-60, molasses-30, CSM-80, and urea-130. Values used in Trial II were: hay-30, corn-48.60, molasses-32, cotton-seed meal-63, and urea-100.

TABLE VI

FINANCIAL RESULTS

Lot Number	1	2	3	4
Treatment	CSM	CSM-Urea	Urea	Urea + Stilbestrol
		Trial I		
Initial Cost per CWT	$18.00	$18.00	$18.00	$18.00
Feed Cost per CWT Gain	24.87	23.60	27.78	25.32
Average Selling Price per CWT	21.60	21.60	21.60	21.60
Return per Animal	19.47	21.46	15.88	18.50
		Trial II		
Initial Cost per CWT	$18.00	$18.00	$18.00	$18.00
Feed Cost per CWT Gain	25.37	24.31	25.11	20.96
Average Selling Price per CWT	20.00	20.00	20.00	20.00
Return per Animal	0.17	-0.26	-0.66	7.22

addition of stilbestrol, in the case of Lot IV, increased the return per steer over Lot III by $2.62; however, there was additional labor required for mixing the stilbestrol with the feed. The cost of the stilbestrol was small and amounted to less than one dollar for all steers in the lot during the total period.

Table VII shows that the effect of treatment on grade and dressing percentage were similar among the various lots. Final live weight grades were slightly higher for the all cottonseed meal lot and the all urea plus stilbestrol lot showing a grade advantage of 0.4 over the cottonseed meal-urea and urea lots; however, this advantage was not borne out by carcass grades. The percentage shrink was not figured in the initial trial since the last weights recorded at the feed-lot were two days prior to the date the steers were hauled to market.

In the second trial rations were formulated theoretically to contain approximately eleven percent crude protein on a dry matter basis. The average, from chemical analyses during the period, however, was approximately two percent higher as shown in Table III. Average daily rates of gain were somewhat higher in this trial being 2.08, 2.17, 2.08, and 2.53 pounds as shown in Table II. The average daily feed consumed by steers in the second trial was slightly higher than in the case of the initial trial. The higher rates of daily gain therefore may be due in part to the fact that the steers in trial two ate more feed of a higher protein content and that the ratio of concentrate to roughage was higher in the second trial. Comparable gains were quite similar in the two trials when Lots I and II and Lots III and IV are compared. The only apparent inconsistency in the two trials is the difference in

TABLE VII

EFFECT OF TREATMENT ON GRADE, DRESSING PERCENTAGE AND SHRINK

Lot Number	1	2	3	4
Treatment	CSM	CSM/Urea	Urea	Urea / Stilbestrol
		Trial I		
Animal Grade				
Average Initial	8.0	8.0	8.0	8.0
Average Final				
Live	11.7	11.3	11.3	11.7
Carcass	10.3	10.3	10.3	10.3
Dressing Percentage	56.8	55.8	56.3	55.6
		Trial II		
Animal Grade				
Average Initial	7.2	7.2	7.9	7.1
Average Final				
Live	10.9	10.9	10.6	11.5
Carcass	10.7	11.1	11.3	10.4
Dressing Percentage	59.7	60.7	58.9	58.6
Percent Shrink	1.4	2.7**	2.1	2.5**

**L. S. D. (P = .01) = 0.983%

comparable gains in the Lot III animals of the separate trials. In the initial study there was considerable difference in daily gains between Lots II and III; whereas, the gains by steers in these lots were quite similar in the second trial. There seems to be no logical explanation for this deviation since Lots II and III in the individual trials were on rations of near the same percentage crude protein and consumed about the same amount of feed per day; however, the percentage crude protein in the second trial was about two percent higher than in the first trial. Further work seems necessary to clarify this particular point since the conditions of the first trial indicate that urea does not adequately substitute for all the cottonseed meal needed to balance a low protein fattening ration, while the reverse was found true in the second study. Both trials were in agreement with the review of literature in that urea does adequately substitute for cottonseed meal, on a nitrogen basis, for one-half of the natural protein supplement necessary to balance low protein fattening rations.

Weber and Hughes (1940) and Culberson et al. (1951) agree with the results of the second trial that urea can be substituted for all the natural protein supplement used to balance a low protein fattening ration; however, the general consensus in the review of literature is in agreement with the indication of the initial study that urea does not adequately substitute for all the natural protein supplement.

In the second trial, stilbestrol increased the rate of gain of animals in Lot IV over Lot III by a highly significant difference of 0.45 pounds per day. There was also a highly significant difference in daily rate of gain favoring the ration fed the Lot IV steers over the

ration fed Lots I and II.

Feeding efficiency, shown in Table VIII, was consistent with daily rate of gain for the various lots and amounted to a total of 1210, 1153, 1206, and 1007 pounds of feed required per hundredweight gain for Lots I, II, III, and IV, respectively. Feeding efficiency was consistent in the two trials when Lots I and II and Lots III and IV are compared. In the case of Lots III and IV, stilbestrol reduced the feed required per hundredweight gain by about seventeen percent which amounted to a difference of $4.15 in feed cost per hundredweight gain.

The financial results (Table V) show returns per animal of 0.17, -0.26, -0.66, and 7.22 dollars for Lots I, II, III, and IV, respectively. These averages are considerably lower than those obtained in the initial trial. This difference is principally due to the fact that the steers in the initial trial brought $1.60 more per hundredweight than in the second trial while the initial values per hundredweight were the same. It is interesting to note that the use of stilbestrol increased the return per steer by $7.88 over the average for the Lot III steers; however, this does not include the cost of additional labor required for mixing the stilbestrol with the feed. As noted above, the Lot I steers show a return of $0.17 per animal and the Lot II steers a loss of $0.26. This is contrary to expectations since the Lot II animals made slightly higher daily gains and consumed less feed per hundredweight gain. This deviation is due to the greater percent shrink from feedlot to market in the case of the Lot II steers.

As in the initial trial, carcass grade, live grade, and dressing percents were unaffected by treatment. The percentage shrink was found

TABLE VIII

EFFECT OF TREATMENT ON FEED EFFICIENCY

Lot Number				4
Treatment	CSM	CSM-Urea	Urea	Urea + Stilbestrol
		Trial I		
Feed per CWT Gain (Pounds)				
Hay	470	453	544	466
Corn	297	335	457	445
CSM	119	57	0	0
Molasses	244	236	284	237
Urea	0	7	17	14
Total	1130	1088	1302	1162
Feed Cost per CWT Gain	$24.87	23.60	27.79	25.32
		Trial II		
Feed per CWT Gain (Pounds)				
Hay	319	300	332	283
Corn	615	634	685	566
CSM	89	43	0	0
Molasses	177	170	176	147
Urea	0	6	13	11
Total	1200	1153	1206	1007
Feed Cost per CWT Gain	$25.37	24.31	25.11	20.09

to be highly significantly lower in the case of Lot I over Lots II and IV and to approach significance at the five percent level over Lot III. This suggests that, unless the one case out of one hundred, a combination of urea and cottonseed meal supplement and urea plus stilbestrol resulted in an increased percentage shrink under the conditions of this study. Schrum and Riggs (1948) found an increase in shrink due to urea supplementation and Perry et al. (1953) noted increased shrink due to oral administration of estrogenic substances in beef steers.

No undesirable side effects were noted in either trial from the stilbestrol added to the rations of the Lot IV animals; however, an increase in teat length was noted in both trials varying from one and one-half to four times that of the animals in Lot III.

CHAPTER V

SUMMARY

Two separate trials, using sixty-two yearling steers, were conducted in a study to evaluate the substitution of urea and corn for part or all of the protein supplement needed to balance a low protein fattening ration. The effect of adding ten milligrams of stilbestrol per steer daily to a ration in which urea and corn were substituted for all of the natural protein supplement was also studied.

In the initial trial thirty-two Hereford and Angus steers averaging 696 pounds were allotted into four lots of eight steers each and used in an eighty-four day feeding trial. Thirty Hereford steers averaging 757 pounds were used in the second trial for a period of 108 days. Lots I and II of the second trial consisted of eight steers each and Lots III and IV, seven steers each. The animals in each trial were allotted on a basis of weight, grade, and breeding. The basal ration contained mixed grass-legume hay, ground yellow corn, cottonseed meal, molasses, and minerals. Lot treatments were the same for both trials and were as follows: Lot I, cottonseed meal; Lot II, fifty percent cottonseed meal and fifty percent urea; Lot III, urea; Lot IV, urea plus stilbestrol.

The average daily gains in the first trial were: 2.05, 2.12, 1.76, and 2.11 pounds for the steers in Lots I, II, III, and IV, respectively. Gains were quite similar for Lots I, II, and IV. The steers in Lot III made noticeably lower gains than steers in the other lots; however, this difference was not statistically significant. Average

daily gains in the second trial were: 2.08, 2.17, 2.08, and 2.53 pounds per steer for Lots I, II, III, and IV, respectively. In this trial gains were similar for Lots I, II, and III. Statistically, there was a highly significant difference in the average daily rate of gain made by the animals in Lot IV over each of the other lots. Both trials resulted in similar comparable gains when Lots I and II are compared and when Lots III and IV are compared showing agreement that similar gains were obtained when rations were supplemented with either cottonseed meal or one-half cottonseed meal and one-half urea, and that the addition of ten milligrams of stilbestrol resulted in higher rates of daily gain when urea was substituted as the sole protein supplement.

Feed efficiency was reflected by rates of gain in both trials. The addition of stilbestrol, in the case of Lot IV, resulted in a feed savings of about eleven percent in the initial trial and about seventeen percent in the second trial over Lot III.

Live grades, carcass grades, and dressing percentages were similar for all lots in both trials. A highly statistically significant difference in percent shrink from feed-lot to market was found in the second trial favoring Lot I over Lots II and IV.

These results show that urea and corn can be substituted for fifty percent of the cottonseed meal needed to supplement fattening rations for steers, and, under some conditions, that urea and corn may replace all the cottonseed meal. Oral administration of stilbestrol was shown to increase both rate of gain and feed efficiency when added to a ration in which urea was substituted for all the natural protein supplement.

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