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# Stilbestrol for Growing-fattening Cattle

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# STILBESTROL FOR GROWING-FATTENING CATTLE

By

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# INTRODUCTION

The production of beef in South Dakota is one of the largest industries in the state. Those in the business of producing beef are constantly looking for newer methods of management, nutrition and breeding which will economically increase the production of beef. It has been shown that adding diethylstilbestrol to the rations or implanting diethylstilbestrol pellets in the ears will generally economically increase beef production by increasing rate of gains and feed efficiency.

Several questions have been raised by livestock producers and research workers since the introduction of stilbestrol in beef cattle production. Some of the questions are:

Does the administration of stilbestrol affect carcass grade, or the proportion of lean to fat in a carcass?

What are the effects of administering stilbestrol over a long period of time?

Does the administration of stilbestrol lose its advantages when administered over a long period of time?

Is there any advantage of administering stilbestrol in only certain phases of beef cattle production or should it be administered continuously from weaning to slaughter?

What are the advantages of administering stilbestrol in each of the three major phases from weaning to slaughter?

How does orally administered stilbestrol compare to implanted stilbestrol?

How long does it take a stilbestrol implant to be absorbed in ears of cattle?

Is the stilbestrol pellet residue found in the ears of cattle at the time of slaughter still potent?

The experiments reported in this thesis were designed to help answer some of the above questions.

## REVIEW OF LITERATURE

### Nature and Activity of Diethylstilbestrol

Diethylstilbestrol, which is a synthetic compound, was first described and named by Dodds et al. (1938). The estrogenic activity of this compound, known chemically as 4 : 4' alpha, beta-diethylstilbene, was compared to several other synthetic chemical compounds and was found to be by far the most potent substance. The formula of diethylstilbestrol ($C_{18}H_{20}O_2$) has a structural resemblance to estrone ($C_{18}H_{22}O_2$) which is a natural female hormone. Diethylstilbestrol is commonly called "stilbestrol" which is actually another compound (4 : 4' - dihydroxystilbene). In this thesis, however, the terms "diethylstilbestrol" and "stilbestrol" shall be considered to be synonymous and will refer to diethylstilbestrol.

Soodern and Sealy (1940) made a study of the comparative estrogenic potency of diethylstilbestrol with estrone, estradiol and estriol, which are natural occurring estrogens. The oral administration of graded doses of stilbestrol to rats and mice showed a dose percent response almost identical to that obtained for the natural estrogens. When assayed by oral administration to spayed adult mice, estrone, estradiol and estriol were found to be respectively, 1/65th, 1/20th and 1/10th as effective as stilbestrol. In spayed rats estrone was 1/80th, estradiol 1/65th and estriol 1/30th as effective as stilbestrol. When assayed on spayed adult mice and spayed rats by subcutaneous injection, stilbestrol was found to have about the same order of potency as estrone.

A large group of compounds with relatively simple formulas have been prepared which have the properties of natural estrogens, though they have not been found in nature. Of these, diethylstilbestrol and hexestrol are the best known. Dubes (1955) in writing of these synthetic hormone-like substances states that they differ from the natural estrogens in one respect: they are not destroyed when given by the mouth; hence they can be incorporated in the feed.

Evidence has been accumulating over the past few years of the effects of hormones on various functions of the animal body. The synthetic estrogenic hormones have been shown to have marked effects on rates of growth and fattening, on growth of the mammary gland and on the control of the reproductive processes. The fact that hormones exert sizeable effects on body processes, which are of interest to the producers of livestock and poultry, has caused considerable research to find uses of the hormones for beneficial effects in the production of meat, milk and eggs.

Reports of experiments have been accumulating over the past few years on the effects of using hormones, especially the synthetic hormone diethylstilbestrol, for increasing the rate of gain and feed efficiency in sheep and cattle. The use of stilbestrol in fattening sheep is now a frequent practice, however, the levels and methods of administration are not well defined. Many undesirable side effects have been reported. This thesis is not concerned with sheep production so the many reports of experiments on the use of stilbestrol in sheep will not be discussed here. It is the intention of the author to review

the reports of experiments on the use of stilbestrol in beef cattle production.

In 1954 the Pure Food and Drug Administration approved the use of stilbestrol in cattle. Sufficient evidence had been accumulated that showe the meat from stilbestrol-treated cattle was safe for human consumption. It had been shown that the meat contained no harmful levels of estrogenic activity as a result of stilbestrol treatments (Stob et al., 1954, 1956; Cheng et al., 1953; Ellis et al., 1954; Jones and Deatherage, 1953; Swift, 1954; Preston, 1956a; Turner, 1956; and Armstrong and Hansel, 1956). Both the implant and oral methods of stilbestrol treatment were approved; however, the approved level of feeding stilbestrol was set at 10 milligrams of stilbestrol daily per head.

## Effects of Diethylstilbestrol in Cattle Rations

The most extensive review of the literature for this thesis was on the use of stilbestrol for beef cattle production. The use of stilbestrol is not recommended for the breeding herd. A considerable amount of research has been conducted to determine its value in the grazing and fattening rations for both steers and heifers intended for slaughter. Four rather distinct phases of cattle feeding have been investigated. These are wintering without much fattening, pasturing alone, pasturing with additional feeding and drylot fattening. These different feeding phases are reviewed separately.

There have been numerous experiments reported in recent years on the response of growing and fattening cattle to stilbestrol. There has been a response to stilbestrol in most of these experiments, though to varying degrees. Many of the reports have been of a preliminary nature and have covered only 1 trial in several instances. A review of such experiments individually does not present a clear and concise picture of the effects of stilbestrol treatment. Therefore, these results of most of the reported experiments have been reviewed and will be summarized in table form in the appropriate following sections. A few experiments will be reviewed individually in each section to point out general trends and special effects in the response to stilbestrol.

Effects of Stilbestrol Treatment to Cattle on Wintering Rations

Steer calves fed a wintering ration to gain 1½ to 2 pounds a day showed an increased rate of gain when stilbestrol was added to the ration (Richardson et al., 1956). Stilbestrol was fed at 5 milligrams per day for the first 56 days of the trial and 10 milligrams a day for the remaining 73 days of the trial. Average daily gain for the stilbestrol-fed lot was 1.92 pounds while the control lot gained 1.66 pounds per day. The feed efficiency was greater for the treated lot. In another trial steer calves fed 10 milligrams of stilbestrol daily in a wintering ration showed a tendency to gain more than the controls, but the difference was not significant (Baker et al., 1956a). No significant differences were noticed in feed consumption or feed efficiency. About one-half of the calves showed high tail heads and weak loins. In another Kansas trial feeding 10 milligrams of stilbestrol

daily to wintering calves increased the average daily gains 0.2 pound over the controls (Richardson et al., 1956a).

Klosterman and Bentley (1956) implanted half of each lot of steer calves being fed four different wintering rations with 36 milligrams of stilbestrol. They were wintered 183 days. The overall increase in gain due to stilbestrol treatment was 0.13 pound per head daily, which was statistically significant.

Steer calves wintered on silage, milo grain and soybean meal were implanted with 24 milligrams of stilbestrol, implanted with pellets containing 1000 milligrams of progesterone and 20 milligrams of estradiol or served as controls (Koch et al., 1957a). Both of the implanted lots showed significantly greater daily gains than the control lot. The stilbestrol-implanted calves ate somewhat more silage than the progesterone-estradiol implanted calves. Average daily gain was the same for both implant groups. Feed cost per unit of gain was lowest for the implanted steers. The progesterone-estradiol implanted steers apparently utilized silage somewhat more efficiently than those implanted with stilbestrol; however, the highest cost of the progesterone-estradiol implants eliminated the economical advantage in the trial reported. Undesireable side effects such as high tail heads, elongated teats and sexual stimulation were not apparent in any of the implanted steers.

A summary of trials where steers on wintering rations were fed stilbestrol orally is presented in table 1. In the 9 trials reported where 313 steers were fed stilbestrol orally, the average increase in

TABLE 1

Response of Steers on Wintering Rations to Oral Stilbestrol

| Reference Number | Daily Treatment Level (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency |
|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | |
| 16 | 10 | 190 | 20 | 1.50 | 1.70 | 13.3 | ---- |
| 27 | 5 | 127 | 20 | 1.10 | 1.21 | 10.0 | 11.0 |
| 30 | 10 | 127 | 20 | 1.21 | 1.09 | - 9.9 | ---- |
| 47 | 7.5 | --- | 60 | 1.09 | 1.06 | - 2.8 | - 1.5 |
| 48 | 10 | 112 | 60 | 1.41 | 1.60 | 13.5 | - 2.9 |
| 66 | 5 | 140 | 24 | 1.09 | 1.11 | 1.8 | ---- |
| 128 | 10 | 104 | 20 | 1.81 | 1.92 | 6.1 | 5.0 |
| 127 | 5 | 129 | 9 | 1.66 | 1.92 | 15.7 | 12.8 |
| 13 | 10 | 70 | 80 | 1.77 | 1.86 | 5.1 | 7.4 |
| Summary | | | 313 | | | 5.87 | 5.3 |

daily gains over the control steers was 5.87 percent. In 6 of the trials where feed required per 100 pounds of gain was reported, the treated steers showed an average of 5.3 percent decrease in feed requirement per 100 pounds of gain.

It appears from the results of the experiments that response to oral stilbestrol is quite variable when steers are fed wintering rations. One of the experiments showed a decrease in both rate of gain and feed efficiency. Another experiment showed a decrease in rate of gain, but the feed efficiency was not reported. In a third experiment, the results showed a slight decrease in feed efficiency but showed a good increase in the rate of gain. More experiments are needed to accurately evaluate the response of steers to oral stilbestrol when fed wintering rations.

A summary of trials where steers on wintering rations were implanted with stilbestrol is presented in table 2. Stilbestrol implants gave a good and consistent response in rate of gain in all experiments. In the 10 trials reported where 212 steers were implanted, the average increase in daily gains over the control steers was 27.1 percent. Only 2 of the trial reports reported the feed requirement per 100 pounds of gain, and the average of these 2 trials shows a 7.0 percent decrease in feed required per 100 pounds of gain.

Implants other than 36 milligrams of stilbestrol in wintering steers showed no great advantage over the 36-milligram implants in the results of the experiments. It can therefore be concluded that a 36-milligram implant should probably be high enough with wintering rations. Not enough experiments were reported using lower levels to properly

## TABLE 2

### Response of Steers on Wintering Rations to Stilbestrol Implants

| Reference Number | Level of Implant (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency |
|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | |
| 53 | 12 | 91 | 36 | 1.22 | 1.68 | 37.7 | ---- |
| 53 | 36 | 91 | 36 | 1.22 | 1.77 | 45.1 | ---- |
| 58 | 36 | 89 | 36 | 1.91 | 2.47 | 29.3 | ---- |
| 71 | 36 | 183 | 34 | 0.71 | 0.84 | 16.9 | ---- |
| 85 | 24 | 112 | 15 | 1.60 | 1.89 | 18.1 | 9.9 |
| 101 | 36 | 159 | 6 | 1.50 | 1.70 | 13.3 | ---- |
| 149 | 36 | 129 | 9 | 1.66 | 1.89 | 13.9 | 4.2 |
| 148 | 48 | 120 | 18 | .56 | .82 | 46.4 | ---- |
| 148 | 84 | 169 | 10 | .78 | 1.03 | 32.1 | ---- |
| 148 | 36 | 155 | 12 | 1.32 | 1.56 | 18.2 | ---- |
| Summary | | 212 | | | | 27.1 | 7.0 |

evaluate them. Although there are no direct comparisons made, stilbestrol implants showed a greater increase in average daily gain over control steers than did steers fed stilbestrol in wintering rations.

Feed efficiency was reported in only 2 of the trials, so it would be difficult to draw any definite conclusions as to the effects of stilbestrol implants on feed efficiency. However, the 2 reports did show an increase in feed efficiency in the stilbestrol-treated steers.

Occasionally stilbestrol treatments produced some undesirable side effects, but generally these side effects were not severe. In many cases, however, no undesirable side effects were noted. Stilbestrol treatments usually did not affect the general condition of the animals. Usually the only differences noted in the animals were the increases in body weight gains.

Effects of Stilbestrol Treatment to Cattle on Pasture

Some research has been conducted with beef cattle on pasture to determine if the use of stilbestrol would increase gains made on pasture. The experiments reviewed here report the trials where no grain was fed on pasture.

Two trials involving 36 steers were conducted to determine the effects of stilbestrol implanted in steers on pasture (O'Mary and Cullison, 1956). In the first trial, steers implanted with 24 milligrams of stilbestrol per head had a significant increase in gain of 0.69 pound per steer daily over the controls. They were on pasture for 69 days. In the second trial, steers treated the same as the first trial had an average increase in daily gain of 0.58 pound over the controls for a 68-day pasture trial.

Parsons et al. (1957a) implanted 4 groups of yearling steers with 0, 12, 24 and 36 milligrams of stilbestrol on a lush grass-legume pasture. The treatments showed 36.05, 33.72 and 36.60 percent increase, respectively, in gain over the control group.

Forty steers, divided into high and low-gaining groups, were placed on pasture with a random half of each group implanted with 24 milligrams of stilbestrol (O'Mary et al., 1956a). After a period of 114 days, the average daily gains were 1.02 pounds for the low-gaining control group, 1.37 pounds for the high-gaining control group, 1.38 pounds for the low-gaining stilbestrol-implanted group and 1.54 pounds for the high-gaining stilbestrol-implanted group. The average daily increase in favor of the stilbestrol-treated steers over the control steers was 0.26 pound, which was significant. A significant difference of 0.25 pound per head daily was noted in favor of the high-gaining group. The low-gaining group showed the greatest response to stilbestrol.

A summary of trials where steers on pasture were fed stilbestrol orally is presented in table 3. In the 7 trials reported, the oral feeding of stilbestrol increased the average daily gains an average of 8.0 percent over the control steers. In one of the trials, the gain was reduced 3.4 percent; and in another trial there was no difference between the control and treated steers. The increase in average daily gain due to stilbestrol treatment was from 15 to 20 percent in 3 of the trials.

The results of the experiment where the steers were fed 5 milligrams of stilbestrol daily indicate that this level of stilbestrol was too low. In most cases, better results were obtained where 10 milligrams

## TABLE 9

### Response of Steers on Pasture to Oral Stilbestrol

| Reference Number | Daily Treatment Level (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | |
|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase |
| 16 | 10 | 117 | 20 | 1.12 | 1.12 | 0 |
| 14 | 10 | 112 | 20 | 1.12 | 1.34 | 19.6 |
| 66 | 5 | 152 | 17 | 1.40 | 1.42 | 1.4 |
| 112 | 10 | 114 | 8 | 1.77 | 1.71 | - 3.4 |
| 128 | 10 | 89 | 10 | .96 | .99 | 3.1 |
| 141 | 10 | 139 | 12 | 1.62 | 1.94 | 19.8 |
| 141 | 10 | 178 | 16 | 1.47 | 1.70 | 15.6 |
| Summary | | | 103 | | | 8.0 |

of stilbestrol was fed daily. From the results presented here, it appears that the feeding of 10 milligrams of stilbestrol daily to steers on pasture will result in a significant increase in rate of gain.

A summary of trials where steers on pasture were implanted with stilbestrol is presented in table 4. A total of 600 animals were treated in the 35 trials that were reported. The average increase in average daily gains due to stilbestrol implants on pasture was 18.2 percent. Many different levels of implants are reported in this summary, varying from 12 to 120 milligrams. When the trials are grouped according to the level of implants, the average percent increase in daily gain are: 12 milligrams, 20.1 percent; 24 milligrams, 22.4 percent; 30 milligrams, 19.5 percent; 36 milligrams, 15.1 percent; 45 milligrams, 16.1 percent; 48 milligrams, 17.1 percent; 60 milligrams, 11.3 percent and 120 milligrams, 11.9 percent. The results indicate that 24 milligrams is an effective level of stilbestrol for steers on pasture. There was no apparent advantage from higher levels and undesirable effects were frequently reported from the higher levels. Although there are no direct comparisons made here, steers implanted with stilbestrol showed more increase in average daily gain over the control steers than steers fed stilbestrol orally.

Occasionally stilbestrol treatments produced some undesirable side effects, but generally those side effects were not serious except at the higher levels. Except for a few elevated tail heads and depressed loins, stilbestrol treatment showed no noticeable effects on conformation of steers on pasture.

TABLE 4

Response of Steers on Pasture to Stilbestrol Implants

| Reference Number | Level Of Implant (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | |
|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase |
| 18 | 30 | 40 | 50 | 2.10 | 2.51 | 19.5 |
| 18 | 45 | 40 | 25 | 2.10 | 2.72 | 29.5 |
| 42 | 24 | 86 | 9 | 1.35 | 1.76 | 30.4 |
| 52 | 24 | 134 | 9 | 1.01 | 1.23 | 21.8 |
| 52 | 60 | 134 | 9 | 1.01 | 1.29 | 27.7 |
| 61 | 24 | 112 | 6 | 1.84 | 1.98 | 7.6 |
| 67 | 12 | 144 | 13 | 1.72 | 1.93 | 12.2 |
| 67 | 24 | 144 | 14 | 1.72 | 1.83 | 6.4 |
| 67 | 36 | 144 | 15 | 1.72 | 1.85 | 7.5 |
| 67 | 48 | 144 | 14 | 1.72 | 1.90 | 10.4 |
| 67 | 60 | 144 | 14 | 1.72 | 1.92 | 11.7 |
| 67 | 24 | 144 | 8 | 1.79 | 1.91 | 6.7 |
| 67 | 36 | 144 | 10 | 1.79 | 1.76 | - 1.7 |
| 67 | 48 | 144 | 8 | 1.79 | 2.00 | 11.7 |
| 67 | 60 | 144 | 8 | 1.79 | 1.81 | 1.1 |
| 103 | 45 | 101 | 16 | 1.50 | 1.77 | 18.0 |
| 104 | 45 | 90 | 14 | 1.51 | 1.52 | 0.7 |
| 106 | 48 | 113 | 10 | 1.68 | 2.17 | 29.2 |
| 108 | 24 | 114 | 10 | 1.02 | 1.38 | 35.3 |
| 108 | 24 | 114 | 10 | 1.37 | 1.54 | 12.4 |
| 107 | 24 | 69 | 8 | 2.33 | 3.02 | 29.6 |
| 107 | 24 | 68 | 11 | 1.25 | 1.83 | 46.4 |
| 113 | 12 | 119 | 6 | 1.72 | 2.34 | 36.0 |
| 113 | 24 | 119 | 6 | 1.72 | 2.30 | 33.7 |
| 113 | 36 | 119 | 6 | 1.72 | 2.35 | 36.6 |
| 143 | 12 | 119 | 22 | 1.27 | 1.49 | 17.3 |
| 143 | 24 | 119 | 22 | 1.27 | 1.65 | 29.9 |

**TABLE 4 Continued**

**Response of Steers on Pasture to Stilbestrol Implants**

| Reference Number | Level Of Implant (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | |
|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase |
| 143 | 36 | 119 | 22 | 1.27 | 1.47 | 15.7 |
| 144 | 12 | 150 | 29 | 1.75 | 2.01 | 14.8 |
| 144 | 24 | 150 | 30 | 1.75 | 1.94 | 10.8 |
| 144 | 36 | 150 | 30 | 1.75 | 1.99 | 13.7 |
| 148 | 24 | 155 | 35 | 1.13 | 1.36 | 20.4 |
| 148 | 36 | 155 | 33 | 1.13 | 1.34 | 18.6 |
| 37 | 120 | 180 | 20 | 1.76 | 1.97 | 11.9 |
| 37 | 60 | 111 | 48 | 1.50 | 1.57 | 4.7 |
| Summary | | | 600 | | | 18.2 |

**Effects of Stilbestrol Treatment to Cattle Fed Concentrates on Pasture**

In addition to the experiments conducted where stilbestrol was administered to steers on pasture, other experiments have been conducted where a concentrate was added to the pasture ration; and the effects of stilbestrol treatment were measured in weight gains and feed efficiency.

Forty yearling steers were grazed on irrigated pasture, self-fed a concentrate mixture and implanted with 4 levels of stilbestrol by Smyrl et al. (1957). The average daily gains for the lots with 0, 15, 30 and 45-milligram implants of stilbestrol were 2.94, 3.31, 3.46 and 3.43 pounds, respectively. The 30-milligram implant group had the greatest feed efficiency; however, the 15-milligram lot gave the greatest financial return over the feed cost because the carcasses graded higher.

Klosterman and Kunkle (1957) conducted three experiments where stilbestrol implanted and control steers were pastured without grain for 60 days and then fed on pasture for the remaining 67 to 98 days of the trials. The average daily gains for the pasture without grain were 2.18 pounds for the controls and 3.02 pounds for those implanted with stilbestrol. The gain for the entire period was 2.13 pounds for the controls and 2.69 pounds for the stilbestrol-treated steers. The average carcass grade was reduced one-fifth of a grade and the dressing percentage was 0.5 percent higher in the treated steers.

Implanting steers fed corn on pasture with stilbestrol increased the beef produced per acre of pasture 16.4 percent in a trial reported by Harvey et al. (1957a). Twenty-four steers were allotted into 4 groups and grazed on fertilized and non-fertilized pastures for 112 days. Half of the steers were implanted with 24 milligrams of stilbestrol and the

other half served as controls. Steers not implanted with stilbestrol made average daily gains of 2.42 pounds per day on unfertilized pasture, while the implanted steers on the same pasture gained 2.75 pounds per day. Implanted steers fed grain on fertilized pasture gained 2.52 pounds per day while non-implanted steers on the same pasture gained 2.10 pounds per day. No explanation was offered for the greater gain on unfertilized pasture than on the fertilized pasture.

Stilbestrol-fed steers which outgained nonstilbestrol fed steers for a 126-day feeding period on pasture later gained at a lower rate during a 56-day finishing period. In this experiment reported by Albert and Baumann (1956), 29 steers that had been self-fed ground ear corn with or without stilbestrol on legume pasture were allotted into two treatments. Each group was further subdivided into a stilbestrol and a nonstilbestrol-supplemented lot for a 56-day finishing period. Stilbestrol supplemented steers (7.5 milligrams per steer daily) outgained the control steers (2.66 vs. 2.36 pounds per day) for 126 days while full-fed on pasture. However, the nonstilbestrol steers gained faster (2.00 vs. 1.87 pounds per day) during the 56-day finishing period.

Reynolds, R. A. et al. (1956) full-fed 3 lots of 10 yearling steers each on pasture. One lot received no stilbestrol, one received 5 milligrams per head daily and the third lot received 10 milligrams daily per head. The average daily gains were 2.30, 2.21 and 2.44 pounds respectively which were not significant. This indicates that the 5-milligram implant level is too low.

One hundred yearling steers were wintered on pasture with and without 10 milligrams of stilbestrol per head daily by Thomas et al. (1956).

The two groups were redivided into 4 groups for the summer pasture. One of the winter stilbestrol and one of the control groups were fed stilbestrol during the pasture season, and the other 2 groups received no stilbestrol. The difference in average daily gain between the winter treatments was non-significant. Steers fed stilbestrol continuously through both the summer and winter phases and during the summer phase only made significantly greater gains for the total period than did control steers.

Parsons and Garrigus (1957) showed a 19.5 percent increase in rate of gain when nursing steer calves on a creep ration were implanted with 12 milligrams of stilbestrol and 6.5 percent increase when implanted with 24 milligrams of stilbestrol. The initial weights varied from 447 pounds for the controls, 470 pounds for the 24-milligram implant and 506 pounds for the 12-milligram implant which may have influenced the gains. The results do show that even young calves respond to stilbestrol.

A summary of trials where steers fed concentrates on pasture were fed stilbestrol orally is presented in table 5. In the 13 trials reported, feeding stilbestrol increased the average daily gains an average of 6.9 percent and reduced the feed required per 100 pounds of gain an average of 2.1 percent in 7 of the 13 trials. There were 137 treated animals reported in the 13 trials. In 4 of the 13 trials, rate of gain was decreased in the stilbestrol-fed lots; and in 4 out of the 7 trials where feed efficiency was reported, stilbestrol feeding reduced feed efficiency. These results show a considerable amount of variation in the response of steers fed stilbestrol in concentrates on pasture. However, the average results show some response to the feeding of stilbestrol.

## TABLE 5

### Response of Steers Fed on Pasture to Oral Stilbestrol

| Reference Number | Daily Treatment Level (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency |
|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | |
| 1 | 7.5 | 126 | 15 | 2.36 | 2.66 | 12.7 | ---- |
| 20 | 10 | --- | -- | 2.20 | 2.08 | - 5.4 | - 5.7 |
| 21 | 10 | 125 | 15 | 2.71 | 2.56 | - 5.5 | - 6.9 |
| 57 | 10 | 97 | 8 | 2.24 | 2.19 | - 2.2 | - 1.1 |
| 97 | 10 | 157 | 13 | 2.16 | 2.55 | 18.1 | 16.6 |
| 98 | 10 | 151 | 16 | 2.06 | 2.46 | 19.4 | 7.5 |
| 112 | 10 | 114 | 8 | 1.90 | 2.09 | 10.0 | ---- |
| 125 | 5 | --- | 10 | 2.30 | 2.21 | - 3.9 | ---- |
| 125 | 10 | --- | 10 | 2.30 | 2.44 | 6.1 | ---- |
| 145 | 10 | 131 | 10 | 3.03 | 3.25 | 7.3 | - 6.5 |
| 15 | 10 | 113 | 20 | 1.40 | 1.55 | 10.7 | 10.8 |
| 18 | 10 | 146 | 6 | 2.43 | 2.64 | 8.6 | ---- |
| 18 | 10 | 68 | 6 | 2.56 | 2.93 | 14.4 | ---- |
| Summary | | | 137 | | | 6.9 | 2.1 |

An increase in feed efficiency usually occurs when the rate of gain is increased.

A summary of trials where steers fed concentrates on pasture were implanted with stilbestrol is presented in table 6. In the 25 trials reported, steers that had been implanted with stilbestrol gained an average of 17.6 percent faster than nonimplanted steers. In 11 of the trials where feed efficiency was reported, stilbestrol-implanted steers showed an 8.1 percent reduction in feed required per 100 pounds of gain.

Many levels of implants were used in the experiments reported in this summary. When the results of trials were grouped according to implant level, there was no best level clearly indicated. The average percent increases for the implant levels are: 24 milligrams, 6.1 percent; 30 milligrams, 25.2 percent; 36 milligrams, 14.5 percent; 45 milligrams, 17.0 percent; 48 milligrams, 34.8 percent and 60 milligrams, 22.9 percent. The average results of the 24-milligram implant level were lowered considerably because of one experiment showing a 17.8 percent decrease in average daily gain. The results of the higher implant levels (45 to 60 milligrams) are unusually high in these experiments in comparison to steers on pasture without grain and on drylot fattening rations. Because of the increased likelihood of undesirable side effects with the higher implant levels, it would appear that implants of 30 or 36 milligrams of stilbestrol in steers fed grain on pasture would be a satisfactory amount.

Effects of Stilbestrol Treatment to Cattle on Fattening Ration

Most of the research on the use of stilbestrol for cattle has been with fattening rations. The fattening period is the most expensive

TABLE 6

Response of Steers Fed on Pasture to Stilbestrol Implants

| Reference Number | Level of Implant (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency |
|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | |
| 2 | 48 | 128 | 8 | 1.96 | 2.56 | 30.6 | ----- |
| 20 | 24 | --- | -- | 2.20 | 2.49 | 13.2 | 11.4 |
| 20 | 36 | --- | -- | 2.20 | 2.63 | 19.5 | 16.3 |
| 21 | 24 | 125 | 15 | 2.71 | 3.07 | 13.3 | 10.9 |
| 21 | 36 | 125 | 15 | 2.71 | 3.19 | 17.7 | 14.2 |
| 24 | 24 | 150 | 24 | 2.52 | 2.07 | -17.8 | ----- |
| 44 | 30 | 74 | 10 | 2.47 | 3.28 | 32.8 | ----- |
| 44 | 45 | 74 | 10 | 2.47 | 3.29 | 33.2 | ----- |
| 61 | 24 | 112 | 6 | 2.26 | 2.62 | 15.9 | ----- |
| 72 | 2-60 | 127 | 10 | 1.93 | 2.52 | 30.5 | ----- |
| 72 | 60 | 158 | 10 | 2.18 | 2.74 | 25.7 | ----- |
| 72 | 36 | 131 | 11 | 2.29 | 2.80 | 22.3 | ----- |
| 98 | 36 | 151 | 16 | 2.06 | 2.35 | 14.1 | 6.1 |
| 101 | 36 | 112 | 6 | 2.26 | 2.58 | 14.2 | ----- |
| 105 | 45 | 90 | 14 | 1.74 | 1.76 | 1.1 | ----- |
| 106 | 48 | 113 | 10 | 1.88 | 2.46 | 30.8 | ----- |
| 132 | 15 | 136 | 10 | 2.94 | 3.31 | 12.6 | 8.8 |
| 132 | 30 | 136 | 10 | 2.94 | 3.46 | 17.7 | 12.8 |
| 132 | 45 | 136 | 10 | 2.94 | 3.43 | 16.7 | 5.2 |
| 134 | 48 | --- | -- | 1.60 | 2.44 | 52.5 | ----- |
| 145 | 36 | 131 | 9 | 3.03 | 3.19 | 5.3 | - 8.4 |
| 15 | 36 | 113 | 20 | 1.40 | 1.53 | 9.3 | - 1.2 |
| 15 | 24 & 15 | 113 | 10 | 1.40 | 1.27 | - 9.3 | 12.6 |
| 35 | 60 | 119 | 36 | 1.86 | 2.09 | 12.4 | ----- |
| 18 | 48 | 146 | 6 | 2.43 | 3.05 | 25.5 | ----- |
| Summary | | | 276 | | | 17.6 | 8.1 |

period before slaughter and is the period where the fastest gains are made. Any method that will generally reduce the cost and increase the rate of gain would be especially beneficial to the feeder of fattening cattle. Therefore, most of the stilbestrol research has been concentrated to fattening of cattle for slaughter. Many experiments have been conducted with many different rations.

Clegg et al. (1951) conducted several field trials to determine the effects of 60 milligram implants in cattle. The treated groups in most instances made greater increases in body weight and gain per day than the controls. Carcass grades at the time of slaughter were, in all cases, poorer than the treated groups. In both heifers and steers the hormone caused significant mammary development. These undesirable effects probably were emphasized by the high level of stilbestrol.

Three experiments were conducted by Andrews et al. (1954) to study the effects of stilbestrol, dienestrol, testosterone and progesterone on the growth and fattening of beef steers. The rate of gain was significantly increased by implantation of 60, 108 or 120 milligrams of stilbestrol, 60 milligrams of stilbestrol in combination with 200 milligrams of progesterone or 80 milligrams of dienestrol. Feed efficiency was consistently improved by all levels of stilbestrol and dienestrol pellets. The treatments had no effect on dressing percentage, but there was a reduction in carcass grade of some of the stilbestrol-treated steers. There were some undesirable side effects in the stilbestrol-treated steers such as depressed loins and increased mammary development. The levels were high in this experiment also.

Burroughs et al. (1954, 1955) reported the effects of feeding trace amounts of diethylstilbestrol in rations of fattening cattle. Three experiments were conducted with steers on fattening rations with varying levels of stilbestrol added to the ration. The results indicated that oral administration of diethylstilbestrol produced the desirable effects of pellet implantation without any of the undesireble side effects. The placing of trace amounts of stilbestrol (2.5 to 10 milligrams per head daily) in the feed of fattening steers increased the live weight gains as much as 35 percent over the control animals not receiving stilbestrol and reduced feed costs per unit of gain as much as 20 percent. There was no noticeable reduction in the fatness of the cattle or the quality of the meat in the stilbestrol-fed steers. Five additional feeding experiments with yearling steers or heifers with rations containing various grain to roughage ratios showed that stilbestrol feeding increased average live weight gains 20 percent, reduced feed required per unit of gain 11 percent and increased feed consumption 5 percent. The most effective levels of stilbestrol fed were between 5 and 10 milligrams per head daily.

In an experiment of 105 days, 36 milligrams of implanted stilbestrol resulted in a highly significant increase in rate of gain for the treated steers when compared to the controls (O'Mary et al., 1956a). An additional 36 milligrams implanted after 42 days failed to give an additional growth stimulus. There were no significant differences between the treated and control groups in either carcass grade or dressing percentage. The treated steers showed a depression of the loin at 85 days. In a second experiment of 146 days, the rate of gain of steers

implanted with 36 milligrams was significantly higher than for the control steers over the first 8 weeks, but 12 milligrams of stilbestrol implanted had no significant effect. During the second 8-week period an additional 24-milligram implant following the initial 12-milligram implant resulted in increased daily gains over the controls. There was no significant difference between treatments and controls during the final 4 weeks of the 140-day trial. This suggests that the effects of the stilbestrol implants are dropping off after 16 weeks. The final results of the experiment over the 140 days showed a highly significant difference in rate of gain between the 36-milligram stilbestrol implant steers and the control steers but no significant difference between the 12 plus 24 milligram treated steers and the controls. The treated steers showed a depression of the loin at 65 days.

Three lots of 7 steers each were full-fed by Mitchell et al. (1955). One of the lots served as the control and was fed for 124 days. The second lot was fed to reach the same weight as the control lot at slaughter and was fed for 96 days. The third lot was fed an equal amount of concentrates as the control lot and was fed for 125 days. The second and third lots received 10 milligrams of stilbestrol per head daily. The average daily gains for the first 96 days were 2.24, 2.56 and 2.46 pounds, respectively. The average daily gains for the total periods were 1.99, 2.56 and 2.34 pounds, respectively. [The lot fed to an equal weight as the control showed a 19.5 percent saving in feed cost over the control lot and graded nearly 1/3 of a grade less than the control lot. The lot fed an equal amount of concentratee as the control lot showed a 15.5 percent saving in feed cost per unit of gain over the

control lot and graded only one-sixth of a grade less than the control lot. The carcass grades reported in this experiment point out the need for feeding steers receiving stilbestrol the same length of time as control steers to get the same carcass grade.

Auman et al. (1956) conducted a trial where 16 steers were fed 10 milligrams of stilbestrol daily. Nine head served as controls and were fed the same length of time as the treated steers. Nine other control steers were fed for an additional twelve days so their carcasses would be approximately the same weight as the carcasses of the stilbestrol-fed steers which were fed 112 days. The average daily gains were 2.68 pounds for the treated steers, 2.38 pounds for the control steers fed the same length of time and 2.46 pounds for the control steers fed the extra twelve days. The savings in feed for the treated steers was 8.3 percent over the first control and 7.6 percent over the second control. The carcasses showed no apparent differences in dressing percent, moisture content, color of eye muscle and cooler shrinkage. In carcass grades, there was a difference of approximately two-thirds or a grade in favor of the 124-day control. Carcasses of the treated steers did not have as much marbling in the eye muscle as the second controls. This experiment also points out the need of feeding stilbestrol-treated steers the same length of time as nonstilbestrol treated steers. The same length of time is needed to bring the carcass grades of stilbestrol-treated steers up to about the same grade as control steers. The treated cattle will be heavier, however.

Koch et al. (1957) used steers to study the effects of bringing steers to full feed at two different rates. Half of each group was

implanted with 84 milligrams of stilbestrol. The cattle implanted with stilbestrol had a significantly greater daily gain than the controls. Some side effects were noted in some of the implanted animals (raised tail heads and elongated teats) but the stilbestrol treatment resulted in no difference in selling price per hundredweight.

Oral administration of stilbestrol together with half a grain ration the last two-thirds of the soiling season was fed to 60 yearling steers fed alfalfa soilage during a 163-day feeding period by Heinemann and Kyd (1956). A similar number of steers, also fed in 3 lots, served as controls. Cattle fed stilbestrol received 10 milligrams per day after 28 days on alfalfa silage and wheat straw. Significantly higher gains were made by the cattle fed stilbestrol, but the added cost of the hormone resulted in approximately equal feed costs per pound of gain. No prominent undesirable characteristics in conformation were noted in the stilbestrol-fed cattle at the time of slaughter, but the average selling price of carcasses was reduced. There was no difference in total length of feeding time required for the cattle from either group to reach the U. S. Choice grade.

Steers on full feed for 100 days before slaughter gained 2.97 pounds per day when fed 10 milligrams of stilbestrol daily for the entire period (Richardson et al., 1956b). Similar steers fed 10 milligrams of stilbestrol for the first 56 days of the period averaged 2.77 pounds per head daily for the 100 days, and the controls gained an average of 2.63 pounds per day. The feed efficiency was the greatest for the first group and the least for the control group. There were no side effects noted and there were no significant differences in the carcasses.

Matsushima et al. (1956, 1957) reported that feeding 10 milligrams of stilbestrol to steers on full-feed for 112 days increased weight gains and feed efficiency but there was little difference whether the steers were fed stilbestrol during the first 56 days, the last 56 days or the entire period. This is not in agreement with the experiments reported above.

A summary of 92 trials where steers on fattening rations in drylot were fed stilbestrol orally is presented in table 7. A total of 1357 treated animals were reported in the stilbestrol-treated lots. The average increase in daily gains over the control was 14.3 percent. In 82 of the trials, where feed requirements per hundred pounds of gain were reported, the average increase in feed efficiency in the stilbestrol-treated steers was 9.8 percent. Fifty-six of the trials reported the federal carcass grades which were scored as follows: high prime, 12; average prime, 11; low prime, 10; high choice, 9; average choice, 8; low choice, 7; high good, 6; average good, 5; low good, 4; high commercial, 3; average commercial, 2; and low commercial, 1. This system of scoring federal grades will be used throughout this entire thesis. The average carcass score for the treated steers was 6.5 while the average score for the control steers was 6.6. This difference of 0.1 of one-third of a federal grade is very small and insignificant.

Ten milligrams of stilbestrol were used in most of the experiments. From the results presented, it is shown that adding 10 milligrams of stilbestrol daily to rations of fattening steers will generally increase the rate of gain to an average of about 15 percent and decrease the feed requirement per 100 pounds of gain about 10 percent. Stilbestrol feeding

TABLE 7

Response of Steers on Fattening Rations to Oral Stilbestrol

| Reference Number | Daily Treatment Level (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency | Carcass Grades | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | | Control | Treated |
| 4 | 10 | 179 | 8 | 2.10 | 2.50 | 19.0 | 12.2 | 8.1 | 8.4 |
| 6 | 10 | 112 | 18 | 2.37 | 2.73 | 15.2 | 8.4 | 4.4 | 4.7 |
| 7 | 10 | 98 | 12 | 2.25 | 2.68 | 19.1 | 11.8 | --- | --- |
| 7 | 10 | 112 | 16 | 2.68 | 2.38 | -11.2 | 8.3 | 4.4 | 4.7 |
| 9 | 10 | 88 | 5 | 2.12 | 2.40 | 13.2 | 6.7 | 7.4 | 6.8 |
| 9 | 20 | 88 | 5 | 2.12 | 2.24 | 5.7 | 11.2 | 7.4 | 8.0 |
| 8 | 10 | 96 | 5 | 2.64 | 2.91 | 10.2 | 3.9 | 8.0 | 7.4 |
| 8 | 20 | 96 | 5 | 2.64 | 3.06 | 15.9 | 7.8 | 8.0 | 7.4 |
| 10 | 10 | 119 | 15 | 2.30 | 2.64 | 14.8 | 13.0 | 7.0 | 7.0 |
| 12 | 10 | 116 | 8 | 2.09 | 2.33 | 11.5 | 5.4 | 6.2 | 6.0 |
| 11 | 10 | 124 | 8 | 2.05 | 2.26 | 10.2 | 4.6 | 6.2 | 6.2 |
| 16 | 10 | 130 | 20 | 1.90 | 1.98 | 4.2 | 6.5 | 7.6 | 7.6 |
| 17 | 10 | 138 | 34 | 2.04 | 2.24 | 9.8 | 6.9 | 8.7 | 7.9 |
| 19 | 10 | 179 | 9 | 2.35 | 2.63 | 11.9 | 8.7 | 7.3 | 6.0 |
| 20 | 10 | 182 | 12 | 2.33 | 2.70 | 15.8 | 8.4 | --- | --- |
| 22 | 10 | 84 | 8 | 1.76 | 2.11 | 19.9 | --- | --- | --- |
| 23 | 10 | 108 | 7 | 2.08 | 2.53 | 21.6 | --- | --- | --- |
| 27 | 2.75 | 112 | 8 | 2.23 | 2.46 | 10.3 | 8.1 | --- | --- |
| 27 | 5.5 | 112 | 8 | 2.23 | 2.64 | 18.4 | 7.0 | --- | --- |
| 27 | 11 | 112 | 8 | 2.23 | 3.06 | 37.2 | 19.5 | --- | --- |
| 27 | 5 | 120 | 8 | 2.36 | 2.58 | 9.3 | 7.9 | --- | --- |
| 27 | 10 | 120 | 8 | 2.36 | 2.48 | 5.1 | 5.1 | --- | --- |
| 27 | 20 | 120 | 8 | 2.36 | 2.93 | 24.2 | 15.2 | --- | --- |
| 27 | 10 | 243 | 8 | 1.75 | 2.03 | 16.0 | 10.7 | --- | --- |
| 28 | 5 | 36 | -- | 2.12 | 2.84 | 33.9 | 18.8 | --- | --- |
| 28 | 10 | 36 | -- | 2.12 | 2.50 | 17.9 | 7.0 | --- | --- |
| 28 | 2.5 | 84 | -- | 2.50 | 2.71 | 8.4 | 7.0 | --- | --- |

TABLE 7 Continued

Response of Steers on Fattening Rations to Oral Stilbestrol

| Reference Number | Daily Treatment Level (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency | Carcass Grades | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | | Control | Treated |
| 28 | 5 | 84 | -- | 2.50 | 3.15 | 26.0 | 13.8 | --- | --- |
| 28 | 10 | 84 | -- | 2.50 | 3.41 | 36.4 | 20.9 | --- | --- |
| 28 | 5 | 84 | -- | 2.51 | 3.15 | 25.5 | 9.4 | --- | --- |
| 25 | 10 | 146 | 24 | 2.14 | 2.46 | 14.9 | 10.9 | 7.4 | 7.4 |
| 25 | 10 & 20 | 146 | 24 | 2.14 | 2.56 | 19.6 | 14.4 | 7.4 | 7.9 |
| 26 | 10 | 56 | 36 | 3.15 | 3.42 | 8.6 | 6.0 | --- | --- |
| 33 | 10 | 207 | 8 | 2.12 | 2.40 | 13.2 | ---- | 7.6 | 7.2 |
| 38 | 10 | 119 | 36 | 2.85 | 3.19 | 11.9 | 8.3 | 7.8 | 7.5 |
| 39 | 5 | 120 | 8 | 2.36 | 2.58 | 9.3 | 7.9 | --- | --- |
| 39 | 10 | 120 | 8 | 2.36 | 2.48 | 5.1 | 5.1 | --- | --- |
| 39 | 20 | 120 | 8 | 2.36 | 2.93 | 24.2 | 15.2 | --- | --- |
| 40 | 10 | 95 | 14 | 2.30 | 2.36 | 2.6 | 11.6 | 6.7 | 7.4 |
| 44 | 12 | 162 | 10 | 2.39 | 2.76 | 15.5 | 8.4 | 7.7 | 6.5 |
| 52 | 10 | 107 | 13 | 2.24 | 2.69 | 20.1 | 15.3 | 6.3 | 5.7 |
| 54 | 10 | 183 | 24 | 0.92 | 1.04 | 13.0 | ---- | --- | --- |
| 57 | 10 | 97 | 8 | 1.94 | 2.15 | 10.8 | 9.8 | 5.5 | 4.9 |
| 58 | 10 | 117 | 8 | 2.71 | 2.97 | 9.6 | 12.7 | 5.0 | 5.4 |
| 60 | 10 | 112 | 32 | 2.24 | 2.52 | 12.5 | 7.2 | 5.5 | 5.2 |
| 62 | 10 | 135 | 60 | 1.69 | 2.10 | 24.3 | 14.0 | --- | --- |
| 63 | 10 | 109 | 12 | 2.65 | 2.95 | 11.3 | 4.2 | 5.2 | 6.1 |
| 64 | 10 | 70 | -- | 3.05 | 3.60 | 18.0 | 8.3 | --- | --- |
| 69 | 10 | 84 | 8 | 1.93 | 2.19 | 13.5 | 12.1 | 8.0 | 8.0 |
| 70 | 10 | 126 | 21 | 1.97 | 2.31 | 17.2 | ---- | 7.8 | 7.7 |
| 70 | 10 | 238 | 10 | 2.05 | 2.36 | 15.1 | - 7.5 | 8.5 | 7.1 |
| 80 | 10 | 84 | 21 | 2.17 | 2.47 | 13.8 | 12.3 | --- | --- |
| 78 | 10 | 252 | 10 | 1.87 | 2.04 | 9.1 | 5.3 | 6.7 | 6.2 |
| 87 | 10 | 95 | 50 | 2.74 | 2.77 | 1.1 | 2.8 | --- | --- |

TABLE 7 Continued

Response of Steers on Fattening Rations to Oral Stilbestrol

| Reference Number | Daily Treatment Level (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency | Carcass Grades | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | | Control | Treated |
| 89 | 15 | 58 | 6 | 2.59 | 3.27 | 26.2 | ---- | 6.0 | 6.0 |
| 89 | 10 | 100 | 5 | 2.56 | 3.20 | 25.0 | ---- | 5.6 | 5.0 |
| 89 | 20 | 100 | 5 | 2.56 | 3.05 | 19.1 | ---- | 5.6 | 3.8 |
| 89 | 10 | 140 | 5 | 2.21 | 2.86 | 29.4 | 21.0 | 5.6 | 5.6 |
| 89 | 20 | 140 | 5 | 2.21 | 2.75 | 24.4 | 18.0 | 5.6 | 5.6 |
| 90 | 10 | 96 | 5 | 3.02 | 3.31 | 9.6 | 9.6 | 6.4 | 5.5 |
| 90 | 10 | 96 | 20 | 2.54 | 3.05 | 20.1 | 15.2 | 3.4 | 5.8 |
| 90 | 10 | 140 | 20 | 2.38 | 2.58 | 8.4 | 14.4 | 5.2 | 4.6 |
| 91 | 10 | 112 | 9 | 2.37 | 2.55 | 7.6 | 9.0 | 4.8 | 4.6 |
| 93 | 10 | 112 | 18 | 2.84 | 3.11 | 9.5 | 25.6 | 7.0 | 7.0 |
| 93 | 10 1st ½ | 112 | 17 | 2.84 | 3.11 | 9.5 | 8.5 | 7.0 | 7.5 |
| 93 | 10 2nd ½ | 112 | 17 | 2.84 | 3.11 | 9.9 | 8.3 | 7.0 | 7.5 |
| 94 | 10 | 112 | 18 | 2.46 | 2.57 | 4.5 | 2.9 | 6.5 | 6.8 |
| 94 | 10 1st ½ | 112 | 18 | 2.46 | 2.54 | 3.3 | 3.6 | 6.5 | 6.8 |
| 94 | 10 2nd ½ | 112 | 18 | 2.46 | 2.57 | 4.5 | 4.5 | 6.5 | 6.8 |
| 95 | 10 | 210 | 27 | 2.34 | 2.90 | 23.9 | ---- | 7.9 | 8.0 |
| 96 | 10 | 140 | 20 | 2.24 | 2.48 | 10.7 | 8.9 | --- | --- |
| 92 | 10 | 108 | 10 | 2.70 | 2.94 | 8.9 | 16.0 | --- | --- |
| 102 | 10 | 124 | 7 | 1.99 | 2.34 | 17.6 | 15.5 | 8.6 | 8.1 |
| 106 | 10 | 113 | 8 | 2.16 | 2.39 | 10.6 | 9.6 | 7.0 | 6.9 |
| 114 | 10 | 175 | 10 | 2.67 | 2.76 | 3.4 | 4.0 | --- | --- |
| 115 | 10 | 123 | 10 | 2.33 | 2.64 | 13.3 | 11.0 | 7.3 | 6.6 |
| 116 | 10 | 233 | 12 | 2.25 | 2.58 | 14.7 | 8.5 | 7.6 | 7.2 |
| 120 | 10 | 166 | 9 | 2.05 | 2.45 | 19.5 | 13.8 | --- | --- |
| 120 | 10 1st ½ | 166 | 9 | 2.05 | 2.24 | 9.3 | 16.1 | --- | --- |
| 121 | 10 | 162 | 12 | 2.45 | 2.62 | 6.9 | 9.5 | --- | --- |
| 122 | 10 | 164 | 10 | 2.01 | 2.50 | 24.4 | 13.2 | 6.3 | 6.8 |

TABLE 7 Continued

Response of Steers on Fattening Rations to Oral Stilbestrol

| Reference Number | Daily Treatment Level (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency | Carcass Grades | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | | Control | Treated |
| 122 | 10 2nd ½ | 164 | 10 | 2.01 | 2.33 | 15.9 | 10.2 | 6.3 | 6.3 |
| 123 | 10 | --- | 4 | 1.59 | 2.06 | 29.5 | 11.3 | 3.2 | 2.5 |
| 125 | 10 | 84 | 20 | 1.72 | 2.12 | 23.2 | 14.2 | --- | --- |
| 128 | 10 | 104 | 20 | 2.49 | 2.63 | 5.6 | 2.9 | 5.2 | 4.6 |
| 129 | 10 | 100 | 75 | 2.63 | 2.97 | 12.9 | 9.5 | 7.4 | 7.5 |
| 129 | 10 2nd ½ | 100 | 73 | 2.63 | 2.97 | 12.9 | 5.6 | 7.4 | 7.3 |
| 131 | 10 | --- | 10 | 2.34 | 2.64 | 12.8 | 4.9 | 6.8 | 6.7 |
| 138 | 10 | 195 | 14 | 1.78 | 1.98 | 11.2 | 8.4 | --- | --- |
| 142 | 10 | 112 | 13 | 2.33 | 2.63 | 12.9 | ---- | --- | --- |
| 150 | 10 | 154 | 10 | 1.91 | 2.17 | 13.6 | 5.1 | 7.4 | 7.6 |
| 18 | 12 | 75 | 74 | 2.94 | 2.99 | 1.7 | 1.5 | --- | --- |
| Summary | | | 1357 | | | 14.3 | 9.8 | 6.6 | 6.5 |

may occasionally lower carcass grade slightly, but this is not usually the case. The increase in gain and feed efficiency should usually more than offset any reduction in carcass grade, if there is any.

A summary of 63 trials where steers on fattening rations in dry-lot were implanted with stilbestrol is presented in table 8. The average increase in daily gain of 919 treated steers over controls was 18.3 percent. Feed requirements per 100 pounds of gain was reduced an average of 10.3 percent in the implanted steers in 38 of the trials where feed requirements were reported. In 35 of the trials where carcass grades were reported stilbestrol implants reduced the carcass grade an average of one-sixth of a grade. It is questionable whether any reduction of carcass grade of less than a full one-third of a grade would be a significant reduction.

Many different levels of implants were used in the experiments reported in this summary. When the experiments were grouped according to the level of implants, the average increase of each implant level was: 12 milligrams, 11.7 percent; 24 milligrams, 16.6 percent; 36 milligrams, 18.3 percent; 48 milligrams, 13.8 percent; 60 milligrams, 23.8 percent; 84 milligrams, 20.6 percent; 108 milligrams, 22.8 percent and 120 milligrams, 20.3 percent. Sixty-milligram levels and above appeared to show the most effective response in rate of gain, but most of the experiments where the high-level implants were used were the earlier trials. Often serious undesirable side effects and lower carcass grades were noted in the steers implanted with high levels of stilbestrol. Where direct comparisons have been made between levels of implants, the 36-milligram level gave just as good or better results in gain as higher

TABLE 8

Response of Steers on Fattening Rations to Stilbestrol Implants

| Reference Number | Level Of Implant (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency | Carcass Grades | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | | Control | Treated |
| 2 | 48 | 128 | 4 | 2.21 | 2.54 | 14.9 | ---- | --- | --- |
| 3 | 60 | 182 | 10 | 2.24 | 2.46 | 9.8 | 0.5 | 4.7 | 4.4 |
| 3 | 120 | 182 | 10 | 2.24 | 2.68 | 19.6 | 12.0 | 4.7 | 3.7 |
| 3 | 60 | 140 | 10 | 2.56 | 2.90 | 13.3 | 8.3 | 8.0 | 8.0 |
| 3 | 120 | 140 | 10 | 2.56 | 3.02 | 17.9 | 9.2 | 8.0 | 7.1 |
| 3 | 108 | 140 | 10 | 2.50 | 3.07 | 22.8 | 8.3 | 9.0 | 8.3 |
| 7 | 36 | 98 | 12 | 2.25 | 2.68 | 19.1 | 9.7 | --- | --- |
| 12 | 24 | 116 | 8 | 2.09 | 2.33 | 11.5 | 9.5 | 6.2 | 6.4 |
| 12 | 36 | 116 | 8 | 2.09 | 2.38 | 13.9 | 6.5 | 6.2 | 5.6 |
| 12 | 48 | 116 | 8 | 2.09 | 2.44 | 16.7 | 10.9 | 6.2 | 5.6 |
| 12 | 36 & 12 | 116 | 8 | 2.09 | 2.41 | 15.3 | 5.8 | 6.2 | 5.9 |
| 11 | 24 | 124 | 8 | 2.05 | 2.34 | 14.1 | 11.8 | 6.2 | 6.1 |
| 11 | 36 | 124 | 8 | 2.05 | 2.37 | 15.6 | 10.7 | 6.2 | 6.5 |
| 11 | 48 | 124 | 8 | 2.05 | 2.28 | 11.2 | 9.3 | 6.2 | 5.6 |
| 11 | 2-36 | 124 | 8 | 2.05 | 2.29 | 11.7 | 10.4 | 6.2 | 5.9 |
| 20 | 12 | 182 | 12 | 2.33 | 2.55 | 9.4 | ---- | --- | --- |
| 20 | 24 | 182 | 12 | 2.33 | 2.55 | 9.4 | ---- | --- | --- |
| 20 | 36 | 182 | 12 | 2.33 | 2.78 | 19.3 | ---- | --- | --- |
| 20 | 48 | 182 | 12 | 2.33 | 2.70 | 15.9 | ---- | --- | --- |
| 42 | 24 | 62 | 9 | 1.53 | 2.20 | 45.1 | ---- | 4.9 | 5.2 |
| 44 | 36 | 162 | 10 | 2.39 | 2.79 | 16.7 | 9.1 | 7.7 | 6.5 |
| 44 | 24 / 12 | 162 | 10 | 2.39 | 2.59 | 8.4 | - 0.3 | 7.7 | 7.1 |
| 50 | 36 | 84 | 17 | 2.43 | 3.03 | 24.7 | 23.7 | --- | --- |
| 52 | 36 | 107 | 14 | 2.24 | 2.70 | 20.5 | 16.4 | 6.3 | 5.2 |
| 53 | 12/mo | 110 | 36 | 1.84 | 2.12 | 15.2 | ---- | 4.5 | 3.7 |
| 53 | 36 | 110 | 36 | 1.84 | 2.04 | 10.9 | ---- | 4.5 | 4.0 |
| 56 | 36 | 98 | 36 | 2.24 | 2.78 | 24.1 | ---- | 7.8 | 8.3 |

TABLE 8 Continued

Response of Steers on Fattening Rations to Stilbestrol Implants

| Reference Number | Level Of Implant (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency | Carcass Grades | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | | Control | Treated |
| 58 | 84 | 117 | 8 | 2.71 | 3.28 | 21.0 | 10.2 | 5.0 | 5.8 |
| 68 | 24 | 71 | 18 | 2.13 | 2.63 | 23.5 | ---- | --- | --- |
| 68 | 36 | 71 | 18 | 2.13 | 2.79 | 31.0 | ---- | --- | --- |
| 68 | 48 | 71 | 18 | 2.13 | 2.59 | 21.6 | ---- | --- | --- |
| 68 | 60 | 71 | 18 | 2.13 | 2.54 | 19.2 | ---- | --- | --- |
| 70 | 60 | 126 | 21 | 1.97 | 2.22 | 12.7 | ---- | 7.8 | 6.9 |
| 70 | 36 | 238 | 10 | 2.05 | 2.39 | 16.6 | - 3.9 | 8.5 | 7.4 |
| 80 | 60 | 84 | 21 | 2.17 | 2.47 | 13.8 | 11.3 | --- | --- |
| 74 | 60 | 182 | 12 | 2.09 | 2.59 | 23.9 | ---- | --- | --- |
| 81 | 2-84 | 168 | 10 | 2.31 | 2.79 | 20.8 | 16.0 | 7.9 | 7.3 |
| 77 | 48 | 140 | 21 | 2.06 | 2.33 | 13.1 | 10.6 | 7.0 | 6.0 |
| 78 | 36 | 252 | 10 | 1.87 | 1.97 | 5.3 | 2.0 | 6.7 | 6.0 |
| 79 | 36 | 266 | 28 | 1.91 | 2.04 | 6.8 | 1.6 | 7.7 | 6.9 |
| 82 | 2-36 | 238 | 8 | 1.89 | 2.39 | 26.5 | ---- | 8.0 | 8.8 |
| 83 | 36 | 224 | 16 | 1.79 | 2.36 | 31.8 | ---- | 7.3 | 7.8 |
| 84 | 84 | 84 | 10 | 2.91 | 3.49 | 19.9 | ---- | 6.8 | 6.0 |
| 87 | 24 | 95 | 25 | 2.74 | 3.24 | 18.2 | 11.0 | --- | --- |
| 87 | 36 | 95 | 25 | 2.74 | 3.32 | 21.2 | 11.0 | --- | --- |
| 101 | 36 | 56 | 6 | 1.92 | 2.08 | 8.3 | ---- | --- | --- |
| 106 | 60 | 113 | 8 | 2.16 | 2.48 | 14.8 | 12.9 | 7.0 | 6.9 |
| 106 | 60 | 113 | 8 | 1.64 | 2.34 | 42.7 | 29.9 | 4.8 | 4.7 |
| 109 | 36 | 105 | 25 | 1.34 | 1.74 | 29.8 | ---- | 2.2 | 1.4 |
| 109 | 36 | 140 | 15 | 1.64 | 2.03 | 23.8 | ---- | --- | --- |
| 109 | 12 & 24 | 140 | 10 | 1.64 | 1.83 | 11.6 | ---- | --- | --- |
| 116 | 12 | 233 | 12 | 2.25 | 2.45 | 8.9 | 3.1 | --- | --- |
| 116 | 24 | 233 | 12 | 2.25 | 2.42 | 7.5 | 0.6 | --- | --- |
| 116 | 36 | 233 | 12 | 2.25 | 2.61 | 16.0 | 7.4 | 7.6 | 6.9 |

TABLE 8 Continued

Responses of Steers on Fattening Rations to Stilbestrol Implants

| Reference Number | Level Of Implant (mg) | Days On Trial | Number of Treated Animals | Average Daily Gains | | | Percent Increase in Feed Efficiency | Carcass Grades | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Control lbs. | Treated lbs. | Percent Increase | | Control | Treated |
| 116 | 48 | 233 | 12 | 2.25 | 2.54 | 12.9 | 5.2 | --- | --- |
| 134 | 48 | --- | -- | 2.71 | 2.78 | 2.6 | ---- | --- | --- |
| 142 | 36 | 112 | 12 | 2.33 | 2.59 | 11.1 | ---- | --- | --- |
| 34 | 15 | 207 | 8 | 2.12 | 2.40 | 13.2 | ---- | 7.6 | 7.2 |
| 35 | 60 | 135 | 32 | 2.52 | 3.09 | 22.6 | 17.7 | --- | --- |
| 35 | 120 | 115 | 30 | 2.40 | 2.96 | 23.3 | 9.7 | --- | --- |
| 35 | 60 | 115 | 44 | 2.40 | 3.07 | 27.9 | 11.9 | --- | --- |
| 35 | 60 | 91 | 20 | 1.96 | 2.64 | 34.7 | 23.3 | --- | --- |
| 35 | 60 | 71 | 10 | 2.52 | 3.64 | 44.4 | 27.3 | --- | --- |
| Summary | | | 919 | | | 18.3 | 10.3 | 6.6 | 6.1 |

levels. In view of these facts, the 36-milligram implants of stilbestrol appear to be the best recommendation for fattening steers.

Generally no serious undesirable side effects were noted in these experiments where 36-milligram implants were used. The summary of results shows a reduction in average carcass grade of implanted steers of about 0.5 of one-third of a grade. Four tenths of one-third of a grade reduction was noted when only the steers that received 36 milligram stilbestrol implants are compared with the control steers.

The above results show that stilbestrol implants will increase rate of gain about 18 percent, increase feed efficiency 10 percent and reduce carcass grade slightly. Although there are no direct comparisons here, the stilbestrol implants appear to increase rate of gain slightly more than stilbestrol fed orally but tended to lower carcass grade more than did the oral stilbestrol.

Effects of Stilbestrol Treatment to Cattle on Long-Term Trials

A few trials have been conducted with steers treated with stilbestrol over a long period of time to determine if the stilbestrol treatments would show the same advantages in a long trial as has been shown in shorter trials. Most of the trials run over a long period of time can be subdivided into three phases or periods--wintering, pasture and fattening.

Baker et al. (1956a) conducted a trial with steers fed 10 milligrams of stilbestrol daily in soybean oil meal. The stilbestrol feeding during the wintering phase showed a 0.2 pound advantage in average daily gain over the control steers. During the grazing period the average daily gains were: stilbestrol during both the wintering and

grazing periods, 1.42 pounds; stilbestrol in the grazing period only, 1.32 pounds; stilbestrol in the wintering period only, 1.20 pounds; and control steers, 1.04 pounds. During the fattening phase, the average daily gains were: stilbestrol during all three phases, 2.24 pounds; stilbestrol in the fattening phase only, 2.17 pounds; stilbestrol during the grazing and fattening periods, 1.92 pounds; stilbestrol during the wintering and grazing periods, 1.90 pounds; stilbestrol during the grazing period only, 1.89 pounds; stilbestrol during the wintering period only, 2.09 pounds; and controls, 1.72 pounds. Feeding stilbestrol did not appear to affect the carcass grades of the steers. This experiment points out an apparent advantage for using stilbestrol throughout all three phases of growing and fattening of steers.

Three lots of steer calves were carried through a wintering, grazing and fattening phases with one lot receiving stilbestrol during the wintering and fattening phases, one lot receiving stilbestrol during the fattening phase only, and the third lot receiving no stilbestrol (Richardson et al., 1956a). Ten milligrams of stilbestrol were fed per head daily. Animals that received stilbestrol during the wintering phase gained 0.25 and 0.30 pound more daily than the 2 lots which did not get stilbestrol. They also required less feed per 100 pounds of gain. No harmful side effects were observed. There was no beneficial carryover effect on the grazing phase from feeding stilbestrol during the wintering phase. In the fattening phase, the rate of gain was highest for the lot that received stilbestrol during both winter and fattening phases. Animals receiving stilbestrol were more efficient in feed costs per unit of gain than the control animals. Carcass grades

were lower for the treated groups, especially for the group that received stilbestrol twice. They appeared fatter and were graded higher before slaughter; however, their carcass grades were the lowest. This was due primarily to less marbling and a tendency toward less firmness of the carcass. There was no difference between lots in outside fat covering of the carcasses.

Walker et al. (1957) implanted steers with 84 milligrams of stilbestrol at the start of an experiment to study the effect of stilbestrol implants on a wintering, grazing and fattening program. The implanted steers made greater gains than the control steers in the wintering and fattening phases, but the opposite was true during summer grazing. During the wintering and grazing phases some of the implanted steers displayed an uneven topline; however, it appeared that during the fattening phase the noticeable effect from treatment was reduced. Steer calves implanted with 36 milligrams of stilbestrol, wintered in drylot, grazed on pasture in early summer and self-fed grain in drylot during the fall gained 106 more pounds per head than similar nonimplanted steers.

The results of these few long-term experiments show that the highest average daily gains were obtained where stilbestrol was administered continuously throughout the trials. There was no apparent build-up of resistance to stilbestrol treatment when stilbestrol was used for long periods of time.

Comparison of Feeding and Implanting Stilbestrol

It is generally agreed that the administration of stilbestrol will increase rates of gain in sheep and cattle on fattening rations. Two

types of administration--oral and implant--have been effectively used in beef cattle feeding. Several experiments have been conducted to study the effects of the 2 methods of stilbestrol administration. The results are not consistent in all of the trials conducted.

Klosterman (1956) and Klosterman et al. (1956) fattened steers with control, 60-milligram stilbestrol implants or 10 milligrams stilbestrol per head daily fed orally as treatments. In the first trial the control steers gained an average of 1.97 pounds daily, the 60-milligram implants averaged 2.22 pounds and the 10 milligrams orally averaged 2.31 pounds. The carcass grade was lowered slightly with the oral stilbestrol and still more with the implant but the differences were not statistically significant. There were no significant differences in average daily gain, dressing percentage or lumbar-sacral angle between the implanted and stilbestrol-fed steers in the first trial. In the second trial, control steers gained 2.05 pounds per day, 36-milligram stilbestrol implants gained 2.39 pound and 10 milligrams stilbestrol orally gained 2.36 pounds. The carcass grades were lowered one-third of a grade with both of the stilbestrol treatments.

Steers full-fed by Perry et al. (1956) gained 2.25 pounds per day. Similar steers fed 10 milligrams of stilbestrol daily gained 2.58 pounds per day, and steers implanted with 36 milligrams of stilbestrol gained 2.61 pounds per day. The side effects were the same, regardless of whether steers were implanted with 36 milligrams of stilbestrol or fed 10 milligrams of stilbestrol per head daily.

Good et al. (1957) conducted 2 trials with steers to compare stilbestrol implants, stilbestrol fed and controls. Stilbestrol was

implanted at 84 milligrams and fed at 10 milligrams daily. Stilbestrol ingested or implanted increased appetite, and the gains were greater and more economical. The controls gained 2.71 pounds per head daily, those fed stilbestrol 2.97 pounds and the implanted cattle gained 3.28 pounds. Both feeding and implanting stilbestrol caused side effects, but in these trials the effects were not sufficiently strong to significantly affect the performance of steers. The side effects were more pronounced in the implanted group.

Steers on full feed gained 2.39 pounds per day when treated as controls, 2.79 pounds per day with a 36-milligram stilbestrol implant, 2.59 pounds per day with a 24-milligram stilbestrol implant initially and a 12-milligram stilbestrol implant 133 days later. Similar steers gained 2.76 pounds per day when fed 12 milligrams of stilbestrol daily and 2.71 pounds per day when implanted with 24 milligrams of stilbestrol and fed 6 milligrams daily in a 162-day trial (Dowe et al., 1957).

Clegg and Carroll (1957) reported a trial where steers full-fed and treated as controls gained 2.12 pounds per day. Similar steers treated with a 15-milligram stilbestrol implant gained 2.35 pounds per day, and those treated with 10 milligrams of stilbestrol daily orally gained 2.40 pounds per day. Seven of the control steers, 8 of the implant steers and 6 of the oral steers graded choice. The rest of the 8 steers in each lot graded good. No significant differences could be demonstrated for average percentage of fat, lean, bone, moisture and ether extract. The eye muscle areas were essentially the same for each treatment. A slight, but significant increase in the percent of rump of both treated groups over the controls was noted. There was no

difference, however, in the percentage of chuck, loin or kidney among the groups. There was a marked increase in the weight and size of prostates, seminal vesicles and teats as a result of the treatments.

On the basis of the results from an experiment where yearling steers were grazed 113 days on native pasture, Baker, G. M., et al. (1956) concluded that there was very little difference in gains between the steers that were fed 10 milligrams of stilbestrol per head daily and those that were implanted with 36 milligrams of stilbestrol. Both stilbestrol treatments increased gains and feed efficiency. An initial implant of 36 milligrams of stilbestrol produced larger gains than an initial implant of 24 milligrams followed by a 15-milligram stilbestrol implant 56 days later.

Baker, F. S. (1956b) fattened steers for 124 days and treated them in 6 lots as controls, 10 milligrams of stilbestrol orally, and implanted with 24, 36, 48 or 36 milligrams in 2 implants. The oral-stilbestrol group showed an increase in rate of gain over the controls, but not as much as the 24 and 36-milligram implants, which gave the best results in this trial. There was no appreciable difference in carcass grades or marbling in the eye muscle between the various treatments.

Baird and Sell (1957) reported that in 4 experiments either oral or implanted stilbestrol increased the gains of fattening steers on temporary pasture. The response to implanted stilbestrol appeared to be greater and more rapid than to oral stilbestrol. More side effects resulted from the implants which were 30, 45 and 48 milligrams of stilbestrol than from the oral feeding of 10 milligrams of stilbestrol daily.

The tests reported were on winter pasture with and without additional grain.

Beeson et al. (1956a, 1957) fattened steers in drylot with 10 milligrams of stilbestrol fed daily or implanted with 12, 24, 36 or 48 milligrams of stilbestrol. The greatest increase in rate of gain over the controls occurred with the oral stilbestrol and the 36 and 48-milligram implant groups. Steers fed on pasture and treated with oral and implanted stilbestrol showed that implants of 24 and 36 milligrams were more effective in increasing the rate of gain than feeding 10 milligrams daily. Feeding 10 milligrams of stilbestrol daily did not improve gain or feed efficiency but caused a slight depression in both. Side effects were essentially the same regardless of whether the steers were implanted or fed stilbestrol. Carcass grades were lowered by either feeding 10 milligrams of stilbestrol or implanting with 36 milligrams, but there was no change in the carcass grade of steers implanted with 24 milligrams of stilbestrol.

A summary of 6 trials where stilbestrol administered orally at a level of 10 milligrams daily per head was compared to 24-milligram stilbestrol implants in steers is presented in table 9. The average daily gain for the implanted steers was greater than for the oral-stilbestrol steers (2.58 pounds compared to 2.47 pounds). Feed efficiency was compared by assigning an index of 100 to the feed requirements per 100 pounds of gain of the orally stilbestrol-treated steers. The feed efficiency for implanted steers was then calculated as the percent of the feed requirement of the oral-treated steers. This same method was also used in table 10. Five of the trials reported feed requirements

## TABLE 9

Comparison of 10 mg Oral Stilbestrol Daily and 24 mg Stilbestrol Implants in Steers

| Reference Number | Days On Trial | Number of Animals In Trial | Oral Stilbestrol Average Daily Gain | Oral Stilbestrol Feed Efficiency Index | Stilbestrol Implant Average Daily Gain | Stilbestrol Implant Feed Efficiency Index | Type of Ration |
|---|---|---|---|---|---|---|---|
| 15 | 116 | 16 | 2.33 | 100.0 | 2.33 | 95.7 | Fattening |
| 14 | 124 | 16 | 2.25 | 100.0 | 2.34 | 102.5 | Fattening |
| 23 | 182 | 24 | 2.70 | ----- | 2.55 | ----- | Fattening |
| 23 | --- | -- | 2.08 | 100.0 | 2.49 | 83.8 | Pasture Fattening |
| 104 | 112 | 18 | 2.67 | 100.0 | 2.52 | 102.9 | Fattening |
| 105 | 95 | 75 | 2.77 | 100.0 | 3.24 | 91.6 | Fattening |
| Summary | | 149 | 2.47 | 100.0 | 2.58 | 97.1 | |

TABLE 10

Comparison of 10 mg Oral Stilbestrol Daily and 36 mg Stilbestrol Implants in Fattening Steers

| Reference Number | Days On Trial | Number of Animals In Trial | Oral Stilbestrol | | | Stilbestrol Implant | | |
|---|---|---|---|---|---|---|---|---|
| | | | Average Daily Gain | Feed Efficiency Index | Carcass Grade | Average Daily Gain | Feed Efficiency Index | Carcass Grade |
| 10 | 98 | 24 | 2.68 | 100.0 | --- | 2.74 | 97.6 | --- |
| 13 | 116 | 16 | 2.33 | 100.0 | 6.0 | 2.38 | 98.9 | 5.6 |
| 14 | 124 | 16 | 2.26 | 100.0 | 6.2 | 2.37 | 105.4 | 6.5 |
| 23 | 182 | 24 | 2.70 | ----- | --- | 2.78 | ----- | --- |
| 23 | --- | -- | 2.08 | 100.0 | --- | 2.63 | 79.2 | --- |
| 50 | 162 | 20 | 2.76 | 100.0 | 6.5 | 2.79 | 99.2 | 6.5 |
| 52 | 107 | 27 | 2.69 | 100.0 | 5.7 | 2.70 | 98.7 | 5.2 |
| 87 | 238 | 20 | 2.36 | 100.0 | 7.1 | 2.39 | 103.4 | 7.4 |
| 95 | 252 | 20 | 2.04 | 100.0 | 6.2 | 1.97 | 103.5 | 6.0 |
| 104 | 112 | 19 | 2.67 | 100.0 | 6.9 | 2.71 | 103.4 | 6.6 |
| 105 | 95 | 75 | 2.77 | 100.0 | --- | 3.32 | 91.6 | --- |
| 117 | 151 | 32 | 2.46 | 100.0 | 5.3 | 2.35 | 101.5 | 4.7 |
| 142 | 112 | 25 | 2.63 | ----- | --- | 2.59 | ----- | --- |
| 116 | 233 | 24 | 2.58 | 100.0 | 7.2 | 2.61 | 101.2 | 6.9 |
| 145 | 131 | 19 | 3.25 | 100.0 | 6.5 | 3.19 | 101.8 | 6.3 |
| Summary | | 342 | 2.55 | 100.0 | 6.4 | 2.63 | 99.4 | 6.2 |

per 100 pounds of gain, and the average of these trials shows that feed efficiency was 2.9 percent greater for steers implanted with 24 milligrams of stilbestrol than for steers fed 10 milligrams of stilbestrol daily. The results indicate that stilbestrol implanted steers showed more response in gains and feed efficiency than steers fed stilbestrol orally. There was very little difference reported between implant and oral stilbestrol treatments in undesirable side effects.

A summary of 15 trials where stilbestrol fed orally at a level of 10 milligrams daily per head was compared to 36-milligram stilbestrol implants in fattening steers is presented in table 10. The average daily gain for the implanted steers was greater than for the orally-treated steers (2.63 pounds as compared to 2.55 pounds). Feed requirements per 100 pounds of gain were slightly greater (0.6 percent) in the implanted cattle than in the oral-treated cattle. When comparing carcass grades of the 2 treatments in 10 trials where carcass grades were reported, the stilbestrol-implanted steers graded 0.2 of one-third of a grade less than the oral stilbestrol-treated steers. The results presented in the table show that more response in gains was obtained from 36-milligram stilbestrol implants than from oral stilbestrol with fattening cattle. There was little difference in feed efficiency between the 2 treatments. The difference shown in carcass grades is small.

Studies on the Action of Stilbestrol in the Animal Body

Several experiments have been conducted to study the action of stilbestrol on growth response, the metabolic pathway of stilbestrol, and the effects of stilbestrol on body constituents and organs.

Clegg and Cole (1954) studied the effects of stilbestrol implants on rate of gain, economy of feed utilization, endocrine gland histology, nitrogen retention and differential blood counts in about 350 treated animals and an equal number of controls. Treated steers, in the feed lot or on pasture with and without supplemental concentrates, made greater gains than controls. The growth response of treated heifers in the feed lot was in no case as marked as treated steers. On pasture, treated heifers showed no increase in gain over controls. Feed consumption and economy of feed utilization was increased in all treated animals. Nitrogen retention was almost doubled in steers following stilbestrol administration. The weights of the pituitary and adrenal glands were significantly larger in the treated animals. Thyroids of treated steers were larger but not significantly greater. In treated heifers, the thyroid weight was significantly depressed. Ovarian weight was not altered after treatment, but corpora lutea formation was depressed. Growth hormone and ACTH content of treated steer pituitaries was not significantly different from controls. The hypophysis of treated heifers contained twice as much growth hormone as the untreated. The percent of treated animals in the higher carcass grades was less than the percent of untreated. The predominant signs of treatment were masculinization and mammary gland development. Several cases of vaginal prolapse occurred in heifers as a result of stilbestrol implantation. The role of the pituitary in stimulating the growth response to stilbestrol was suggested by the increased nitrogen retention.

Three trials were carried out to determine the effect of stilbestrol on fat and protein deposition in the carcasses of steers and

spayed and nonspayed heifers fed a fattening ration (Clegg and Carroll, 1956). Carcass cutout values, analysis of the percentage of separable fat, lean and bone of the 12th rib cut, analysis of blood constituents and histological studies of the seminal vesicles were made. The data indicate that stilbestrol treatment resulted in a decrease in fat and an increase in protein deposition. Treatment did not affect the percentage of bone nor the percentage of moisture in the steers but caused a significant increase in moisture percentage in the heifers. Levels of plasma glucose and non-protein nitrogen and serum protein-bound iodine, potassium and sodium were unaffected by stilbestrol. Treated steers showed a significant increase in the cross-sectional area of the eye muscle in all trials and an enlargement of the kidney. The average daily gain was increased as a result of stilbestrol treatment. Carcass grades were in some cases lowered in heifers but not in steers. Dressing percentage was also reduced as a result of treatment. Histological studies of the seminal vesicles indicate a stimulated epithelium as well as an increased development of fibrous tissue.

Carcass studies were made by Stouffer et al. (1956) on control steers and steers which had been fed 10 milligrams of stilbestrol daily. Half of the stilbestrol-fed steers were slaughtered at the same final weight as the control steers, and the other half of the stilbestrol-fed steers were slaughtered after they had consumed the same amount of total concentrates as the control lot. The steers in the stilbestrol lot fed to the same weight as the control lot had a lower percentage of brisket and a higher percentage of rump than the other lots. The percentage of front quarter was lower and the percentage of the hind quarter was higher

in the stilbestrol lot fed to an equal weight as the control lot. The control lot had a higher percentage of ether extract in the longissimus dorsi muscle from the wholesale rib cut than either of the other lots. The stilbestrol lot fed to equal concentrate consumption as the control lot had a higher percentage of moisture in the longissimus dorsi muscle than the control lot. The carcass grades of the control lot tended to be higher than the treated lots. There were no differences between lots in area of rib eye, in percentages of lean, fat and bone of the wholesale rib cut and in specific gravity of the wholesale rib cut. Specific gravity had correlation coefficients of -0.86 with percentage of separable fat and -0.93 with ether extract of the wholesale rib cut.

Cahill et al. (1956) studied the effects of 84-milligram stilbestrol implants in steers and bulls on carcass composition and certain endocrine glands. Treatment of steers lowered the carcass grade, but treatment of bulls produced carcasses of higher grade. Slightly heavier pituitary glands and significantly heavier adrenal glands were obtained from the implanted cattle. Thyroid glands of the implanted bulls were significantly lighter in weight than from the untreated bulls, but treatment of steers had little effect on the weight of this gland. Measurement of the lumbro-sacral angle gave evidence that treatment made this angle more acute. Implanting of bulls increased the percentage of fat and lowered the edible portion in carcasses while the reverse appeared to be true in the case of the steers. Measurement of the cross-sectional area of the longissimus dorsi muscle correlated directly with the edible portion.

Preston et al. (1956) conducted studies to determine physiological routes followed by stilbestrol when injected subcutaneously into the neck region of rumen-fistulated steers. Estrogenic activity of rumen ingesta, saliva, blood and feces were measured at various time intervals following stilbestrol injection using the mouse-uterine weight response technique. In the first trial, the mice receiving rumen ingesta collected 72 hours following stilbestrol injection had uterii 3 times as heavy as those receiving rumen ingesta collected prior to injection. No increase was noted 24 hours after injection. Venous blood showed some stimulation at 24 hours but not at 72 hours following injection. In the second trial, rumen samples were collected 0, 1, 2, 3, 5, 7 and 9 days following stilbestrol injection. Uterine weights were increased in mice receiving the third and fifth-day samples, showed a lesser response in those receiving the seventh-day samples and showed normal weights in those receiving the ninth-day samples. In a third trial, samples of venous blood and feces were collected 0, 1, 2, 3, 4, 5, 6 and 8 days after stilbestrol injection. Uterine weights of mice receiving the feces reached a maximum at 3 days and declined thereafter. Venous blood showed no activity. Saliva collected on the fourth day of this trial showed estrogenic activity following acidification, refluxing and extraction with ether.

Story et al. (1957) placed four lambs on metabolism studies and fed two different levels of stilbestrol. At the 1 milligram level per lamb per day, 51 percent of the stilbestrol appeared in the feces and 25 percent in the urine. At the 2 milligram level 45 percent appeared in the feces and 39 percent in the urine. When the data for both levels of feeding are combined, 80 percent of the stilbestrol fed was recovered

in the urine and feces. The possible fate of the remaining 20 percent was undetermined. The mouse uterine assay method of stilbestrol was used to determine the stilbestrol activity.

Tritium labeled diethylstilbestrol was fed to 2 yearling steers at a level of 10 milligrams per day until 100 milligrams were fed to study the metabolism of radioactive stilbestrol (Mitchell et al., 1956, 1956a). One of the steers had a bile fistula. Radioactivity in the urine accounted for 18.2 percent of the total fed to the intact steer and for 21.8 percent of that fed to the fistulated steer. Most of the activity in the bile was in the conjugated form. The radioactivity found in the tissues was very small, indicating there would be no danger of eating the meat that comes from stilbestrol-fed cattle.

Erwin et al. (1956) fed stilbestrol, chlorotetracycline and fat singly and in all possible combinations with alfalfa and straw plus a grain mixture to steers. Liver biopsies were taken at 0, 72 and 183 days and subjected to vitamin A and carotene determinations. Neither stilbestrol nor chlorotetracycline influenced liver carotene or vitamin A storage.

Wilkinson et al. (1954) conducted experiments to determine the influence of stilbestrol implantation on blood and liver composition in feeder lambs. Blood analyses were performed on samples taken from the jugular vein of 20 lambs on the twenty-third day of the experiment. Fifteen milligrams of stilbestrol were implanted in the ear of one-half of the animals. Samples of blood were taken from one-half of each lot in the morning and the other half in the afternoon. The treated lambs had lower hematocrit and higher levels of plasma-free cholestrol and

fibrinogen than their controls. Total plasma lipids were higher in the afternoon samples for both treated and control lambs. There was an interaction of estrogen treatment and time of bleeding for non-protein nitrogen, globulin, total protein and phospholipids. There were no statistically significant differences between treated and control animals for these constituents in the morning blood samples. In the afternoon blood samples, the treated animals had a significantly lower quantity of non-protein nitrogen and phospholipids and a significantly higher quantity of globulin and total protein than their controls. There were no significant effects of estrogen treatment of time of bleeding on plasma glucose, albumin, ester cholestrol, total cholesterol or neutral fat. Liver samples from 2 estrogen treated and 2 control lambs receiving each of 5 different rations were obtained at the time of slaughter. A significantly greater amount of total liver dry matter and a smaller amount of liver ester cholesterol were found in the treated lambs. Estrogen treatment did not affect the liver content in dry matter, glycogen, protein, phospholipids, free cholesterol, total cholesterol, neutral fat or total lipids.

From the discussion of these results, it appears that stilbestrol increases nitrogen retention, adrenal and pituitary weights and development of masculine characteristics. Some of the reports suggest that the protein content of the body tissues is increased. Occasionally, it was reported that the area of the eye muscle was increased, but this was not always the case. There was hardly sufficient evidence to draw any definite conclusions on the action of stilbestrol in the animal body.

Sparing Action of Stilbestrol on Protein

Several experiments have been conducted to determine if stilbestrol treatments would have any sparing action of an essential food nutrient. Most of the work that has been reported has been conducted with various levels of protein supplementation.

Klosterman et al. (1955b, 1956b) fed and implanted steers with stilbestrol that were being fed three levels of protein supplement (soybean oil meal at 0, 1 and 2 pounds daily per head). The results indicated that stilbestrol was ineffective in stimulating gains when protein was limited. On the average, stilbestrol increased average daily gains about 0.3 pounds per day.

Protein was varied during a 182-day feeding trial with steers fed oxytetracycline and/or stilbestrol or implanted with stilbestrol by Reynolds et al. (1956). Growth and feed efficiency were improved by stilbestrol and/or oxytetracycline in the initial period with adequate protein but during the period of marginal protein intake, growth was no better in these supplemented groups than in the controls. In the final period, with a full feed and adequate protein, there was a resumption of response to stilbestrol and oxytetracycline. The results indicated the importance of adequate protein for growth response to estrogens and antibiotics.

Dowe et al. (1956, 1957b, 1957c) reported the results of several trials where 7.5 milligrams of stilbestrol were fed daily to steers fed a wintering ration. The results of the first trials indicated that feeding stilbestrol at this level had no appreciable effect on gains and that stilbestrol did not have a sparing action on protein with rations

composed of low-quality roughage and limited grain. In a similar trial conducted later, the feeding of 10 milligrams of stilbestrol daily increased the average daily gains 0.18 pound per day. The interaction of protein level and stilbestrol showed that stilbestrol had more of an effect at the low-protein level which differs from the previous trials. The three protein levels used in the trial were 75, 100 and 125 percent of the National Research Council recommended daily allowance.

It cannot be concluded from the experiments reported that stilbestrol has a sparing action on protein. Only one of the trials reported gave any indication of this effect.

## METHODS OF PROCEDURE

Forty-eight Hereford steers averaging 428 pounds in weight were used to begin the experiment on November 14, 1956. The cattle were raised in central South Dakota and were purchased through a local commission firm. The calves were purchased at $21.00 a hundredweight.

The main objective of this experiment was to determine the effects of stilbestrol on steers over a long period of time as compared to shorter periods of time. Other objectives were to compare implanted and oral methods of administering stilbestrol and the length of time that implanted stilbestrol pellets remained effective. The experiment was conducted in three phases, wintering, pasturing and fattening.

### Wintering Phase

The winter phase of the trial was conducted at the Central Research Substation, Highmore, South Dakota. The 48 steers were allotted to 4 lots equalizing the average weight as closely as possible on November 14, 1956, 2 days after arriving at the substation. The 4 treatments were randomly assigned to the 4 lots of cattle. The cattle were fed a ration of prairie hay and soybean oil meal pellets balanced to 10 percent total protein based on the analysis at the beginning of the trial. The calves that had horns were dehorned on the day the experiment started. All the calves were vaccinated for blackleg before the experiment began.

The main experiment at the Central Substation, of which the stilbestrol work was a part, dealt with the effects of method and length of storage of prairie hay on steer gains and feed efficiency.

Only three of the lots were suitably a part of the stilbestrol trial. These three lots were all fed hay harvested in 1956. The fourth lot was fed 1955 hay of better quality. The data from this lot will be included in the results because these animals are included in later phases of the stilbestrol work.

The stilbestrol treatments assigned were 10 milligrams of stilbestrol orally daily per head to lot 1 and a 36-milligram stilbestrol implant to lot 2 at the beginning of the trial. Lot 3 was considered the control lot.

The protein supplement used was pelleted, 44 percent protein, solvent-processed soybean oil meal.

The cattle were kept in 4 adjacent lots of equal size with an open shed at one end. Water was available in heated automatic waterers. The prairie hay and soybean oil meal was fed once a day in the afternoon. The hay was fed inside the shed and the soybean oil meal pellets were fed in bunks in the open lot. A mineral supplement was offered free choice and consisted of a mixture of equal parts of steamed bonemeal and salt.

The steers were fed all the hay they would clean up each day and not leave more than 10 percent of the amount fed. If the refusal was mostly weeds and other stemmy materials, the refusal was allowed to approach the 10 percent figure; otherwise the refusal was not allowed to go quite so high. The level of protein supplement was adjusted daily according to the amount of hay fed to give a ration containing a calculated 10 percent protein.

The wintering phase of the experiment was concluded on April 17, 1957, after a period of 154 days. Six days after the close of the

wintering phase the steers were shipped to Brookings for the pasture phase of the experiment. The steers were then full-fed alfalfa hay of fair quality until the cattle went to pasture in late May.

## Pasturing Phase

The pasture phase of the trial was conducted on a 75-acre pasture on the West Farm one mile west of Brookings. The cattle were placed on the pasture on May 28, 1957.

The cattle were reallotted into 6 groups. Lots 1 and 2 from the wintering phase were allotted according to weight and winter gains into 3 groups and were called lots 1, 2 and 3. Lots 3 and 4 from the wintering phase were allotted on the same basis into 3 groups and were called lots 4, 5 and 6. Each lot contained 8 steers.

Lots 1 and 3 received a 24-milligram stilbestrol implant at the beginning of the pasture phase. Lot 2 received no stilbestrol in the pasture phase. Lot 4 served as the control lot through the entire trial and received no stilbestrol. Lot 5 received a stilbestrol implant during the pasture phase, and lot 6 received no stilbestrol during the pasture phase. The level of stilbestrol implant used was 24 milligrams.

The steers were individually weighed on May 27, 1957 to obtain an initial filled weight and again weighed May 28 after a 16-hour shrink period where feed and water were withheld. The steers that were implanted were treated on May 27.

The pasture was in good condition at the start of the pasture phase, being heavily covered with a luxuriant growth of an estimated 85 percent brome grass and 15 percent alfalfa and sweet clover. The

water supply was a dugout located at one edge of the pasture and fed by runoff water and underground seepage. Water was available during the entire pasture phase, although the level of water got low towards the end of the season because of the dry weather. Minerals were available to the steers in an open sectional box located near the water dugout. One section of the box was kept filled with trace-mineralized salt and the other section of the box was kept filled with a mixture of 3 parts steamed bone meal and 1 part salt.

The pasture remained in good condition during the first 6 or 8 weeks of the season. Sufficient moisture was available to keep the grass growing faster than the cattle could graze. The pasture was noted to be undergrazed and the brome grass was getting tall and coarse. During the last half of the pasture season, the pasture became dry and very little new undergrowth was noted; however, there was a considerable amount of tall, coarse brome grass which went to seed in July.

From time to time, additional cattle were placed in the pasture from another experiment. During a part of the season as many as 35 extra steers were grazing on the pasture, which caused overgrazing of the new growth.

The cattle were weighed twice while on the pasture--July 8 and August 21. A portable scale was used to weigh the steers on the pasture. In order to weigh the cattle on pasture, it was necessary to drive them to a corral and chute about one-half mile away. A short time as possible was used to round up the cattle and get them weighed to keep shrinkage at a minimum.

Numerous cases of pinkeye were noted while the steers were on pasture, and the pinkeye cases were treated with an antibiotic powder. By the end of the pasture season all of the pinkeye cases had cleared up. Two steers were treated for foot rot on June 19 and appeared to return to normal within a short time with no undesirable effects.

At the close of the pasture season, the cattle were trucked to the Nutrition Laboratory corrals on September 30. They were placed in a small brome grass pasture and given free access to water so that they would regain their shrink from the short haul. On October 1 individual weights were taken to be used as the final filled weights for the pasture phase. After a 16-hour shrinking period, shrunk weights were taken on October 2. These same final pasture weights were also used as the initial weights for the fattening period.

## Fattening Phase

The steers were placed in their respective lots located near the Nutrition Laboratory on October 2, 1957. The initial filled weights were taken the previous afternoon and shrunk weights were taken in the morning of October 2. Steers in lots 1, 5 and 6 were each implanted with 36 milligrams of stilbestrol in the left ear. The left ear was used as it had the ear tag, and a later study was planned to remove the ears at slaughter to determine the rate of absorption of the stilbestrol pellets. The ear tag provided a means of identifying the animal's ears. The steers in lots 2 and 3 received 10 milligrams of stilbestrol orally per head daily during the fattening phase. Lot 4 served as the control lot.

The design of the entire experiment is presented in table 11. The experiment was designed to determine the relative effects of implanting in none, one, two or three of the phases. Oral and implant methods of administering stilbestrol also were compared in this experiment.

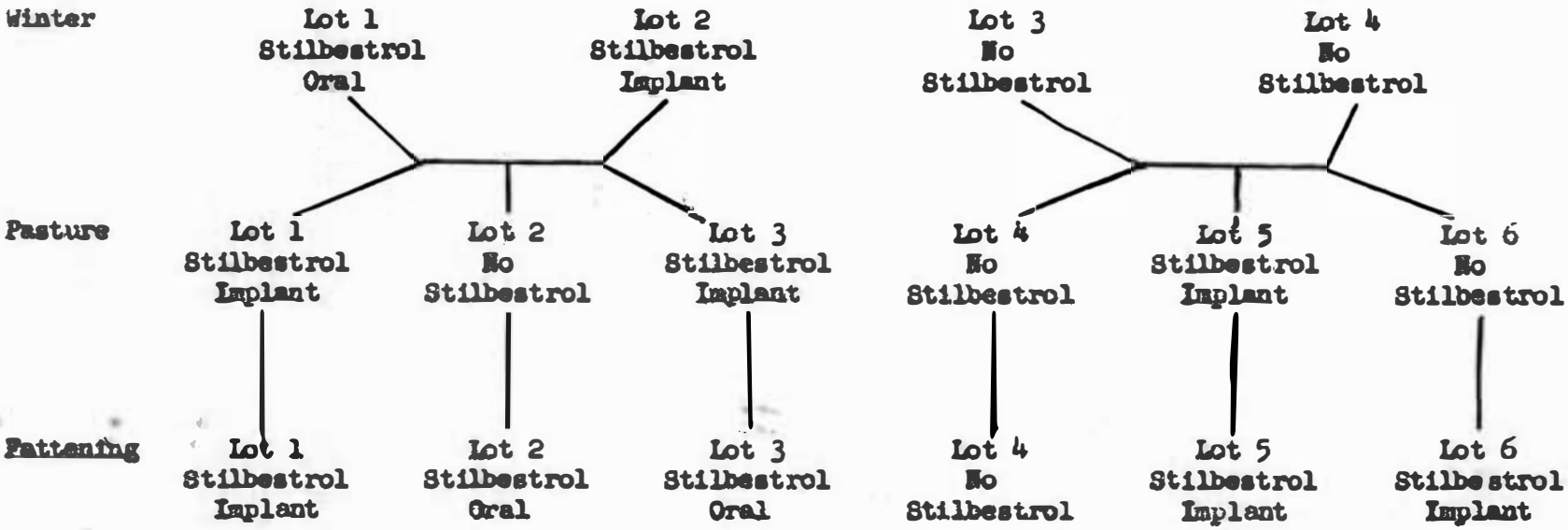
The 6 feeding lots are identical lots located north of the Nutrition Laboratory in a line running north and south. Each lot is 24 feet wide and 56 feet long with an in-the-fence bunk in the west side of the lot. The lots have gravel bottoms with an 8-foot wide concrete feeding apron located adjacent to the bunk. Each lot is equipped with a stock watering tank with an electric heater and a 2-sectional open salt and mineral box.

Corn silage was used as the roughage in the fattening phase of this trial. One hundred-fifty tons of silage were put up in a corn crib stack on September 23, 24 and 25. The silage was cut with a field ensilage harvestor and hauled to the stack in trucks to be blown on the pile. Two and three men were in the stack all the time tramping the silage, but the silage was not packed well because the trucks came in faster than the men could keep the silage well-packed. The relatively poor job of packing the silage was evidenced by the large amount of spoiled silage throughout the stack. The warm weather also caused molding on the surface as the silage was being fed. Otherwise the silage was good quality. The corn used to make this silage was estimated to yield about 60 bushels per acre.

The steers were started on feed with the afternoon feeding on October 2 and were fed twice daily thereafter until the end of the experiment. The steers were started at a constant level of corn silage

TABLE 11

Design of Stilbestrol Experiment with Growing-Fattening Steers[1]




[1] The levels of stilbestrol implants used were 36 milligrams for the wintering and fattening phases and 24 milligrams for the pasture phase. Ten milligrams of stilbestrol daily were used in the steers that were fed stilbestrol orally.

of 30 pounds per head daily. Rolled shelled corn was used for the concentrate portion of the ration. The level of corn was started at 2 pounds per head daily and raised one-half pound per head per day until the steers were on full feed. The level of full feed was determined as the highest level of corn at which the steers would not clean up any additional feed. Each lot was fed corn according to appetite to determine the maximum response to the various treatments. Soybean oil meal was fed at a level of 2 pounds per head daily after starting the steers at one-half pound daily and raising the level one-fourth pound per day until the 2 pound level was reached.

Minerals were provided free choice in the mineral boxes. One section of the box contained a mineral mix of 3 parts steamed bone meal, 1 part limestone and 1 part salt. Trace-mineralized salt was placed in the other section of the box. Water was available at all times in the heated stock tanks.

Lots 2 and 3 were fed soybean oil meal which contained diethylstilbestrol. The stilbestrol was mixed in the soybean oil meal using a V-blender for making premixes and a 500-pound horizontal mixer for making the final mix. For the source of stilbestrol, a premix containing 1000 milligrams of stilbestrol per pound was used. Each 100 pounds of soybean oil meal was mixed with one-half pound of this premix to give a level of 5 milligrams of stilbestrol per pound of soybean oil meal. Two pounds of the soybean oil meal was fed daily to each steer; thus each steer received 10 milligrams of stilbestrol daily.

Occasionally, it was necessary to clean out the feed bunks and weigh the refused feed which was mostly moldy silage. There was a lot

of moldy silage in the stack. This moldy silage was not sorted from the good silage at time of feeding. However, it was felt that the steers should not be restricted in feed offered to a point where they would be forced to eat all of this silage. When the feed bunks were cleaned out, the feed weighed back was subtracted from the silage offered to compute the average daily ration. Near the end of the trial, the feed refused occasionally contained some rolled shelled corn, but no attempt was made to separate the small amount of corn from the refused silage.

Near the end of the first 56 days of the trial, the steers were not cleaning up the amount of silage offered. The level of silage appeared to be too much to keep the steers on a full feed of corn; therefore the level of silage was reduced to 25 pounds per head daily after the first 56 days on trial. When this was done the level of corn on all lots was dropped to 12 pounds per head daily and then raised one-fourth pound per day until the steers were again on full feed. The steers were kept at this level of silage for the remainder of the experiment.

The steers were individually weighed every 28 days during the fattening period except the January weigh day was moved up six days in order to weigh just prior to Beef Cattle Feeders Day on January 17. The December weigh day was moved up 2 days as the scheduled weigh day fell on Christmas Day.

Four cases of foot rot were noted and treated in November and the early part of December. Steers 153, 365, 384 and 397 were treated with sulfa pills as prescribed by a local veterinarian. Steer 399 had a lump in the left jaw which was treated with an injection containing a combination of penicillin and dihydrostreptomycin on December 23. All of the

treatments apparently cured the infections and the animals recovered satisfactorily.

Samples of the silage that was being fed were taken weekly during the trial. The analysis of the silage showed that the silage had a moisture content of 66.3 percent and a protein content of 3.66. An analysis of a sample of corn showed that it contained 7.36 percent moisture and 10.62 protein. Most of the corn used in the trial was corn purchased by the College Feed Unit from a local grain elevator and had been dried to 14 percent or less moisture content. Most of the 1958 corn crop in eastern South Dakota was high in moisture content and it was necessary to dry it before storing as shelled corn. An analysis of the soybean oil meal showed a 45.0 percent protein content. The protein content of the average daily ration fed during the trial was 14.1 percent on a moisture-free basis. The protein levels are higher than the common recommendation of 10 percent for fattening yearling cattle. However, this was due to the feeds having a higher protein content than expected.

## Carcass Studies

The steers were taken off the trial on February 24, 1958, after a 145-day feeding period. Filled weights were taken at 1:30 p.m. for the final filled weight, and at 4:00 p.m. the 48 steers were loaded on 2 semi-trailer trucks to be hauled to Armour and Co. packing plant at Huron, South Dakota. The trucks arrived at the packing plant about 6:15 p.m. and the steers were immediately weighed. The cattle were held overnight for slaughter the next morning. Coarse prairie hay and water were available in the overnight holding pens. The next morning the steers

were individually weighed before slaughter. During slaughter the carcasses were numbered with the same number that was on the neck chain so that carcass information could be obtained for each steer. Hot carcass weights were recorded immediately after slaughter. The left ears were collected and brought back to Brookings so that stilbestrol pellet residue could be measured.

The carcasses were chilled for 2 days before being graded by Federal graders. Prior to grading, the right side of each carcass was ribbed down. A 2.5 percent shrink was taken from the hot carcass weights to get the cold carcass weights. Actual cold carcass weights were not taken.

After the carcasses were ribbed down a color photograph was taken of each rib eye through a one-fourth inch grid square in order to measure the rib-eye area. Schoonover and Stratton (1957) outlined a procedure for making a photographic grid to measure rib-eye areas. This method was followed with some slight modifications.

An Exakta 33 mm camera with a reflex lens fitted with a Kodak No. 1 portrait lens was used. For measurement purposes, a rectangular aluminum frame was constructed with the inside measurements of 7 X 11 inches. Holes were drilled at one-fourth inch intervals around the frame and these were threaded with a black nylon fishing line. This gave a grid square of one-fourth inch squares. The camera and grid square were then mounted on a Cal-Cam Focus Guide. The camera was mounted with the tripod mounting on the guide and the grid square was fastened to the copy frame of the guide with four clips. Two photo flood lamps were mounted on the back of the focus guide with a wooden stick to provide sufficient light for taking

the colored pictures. A picture of the photographic equipment is presented in figure 1.

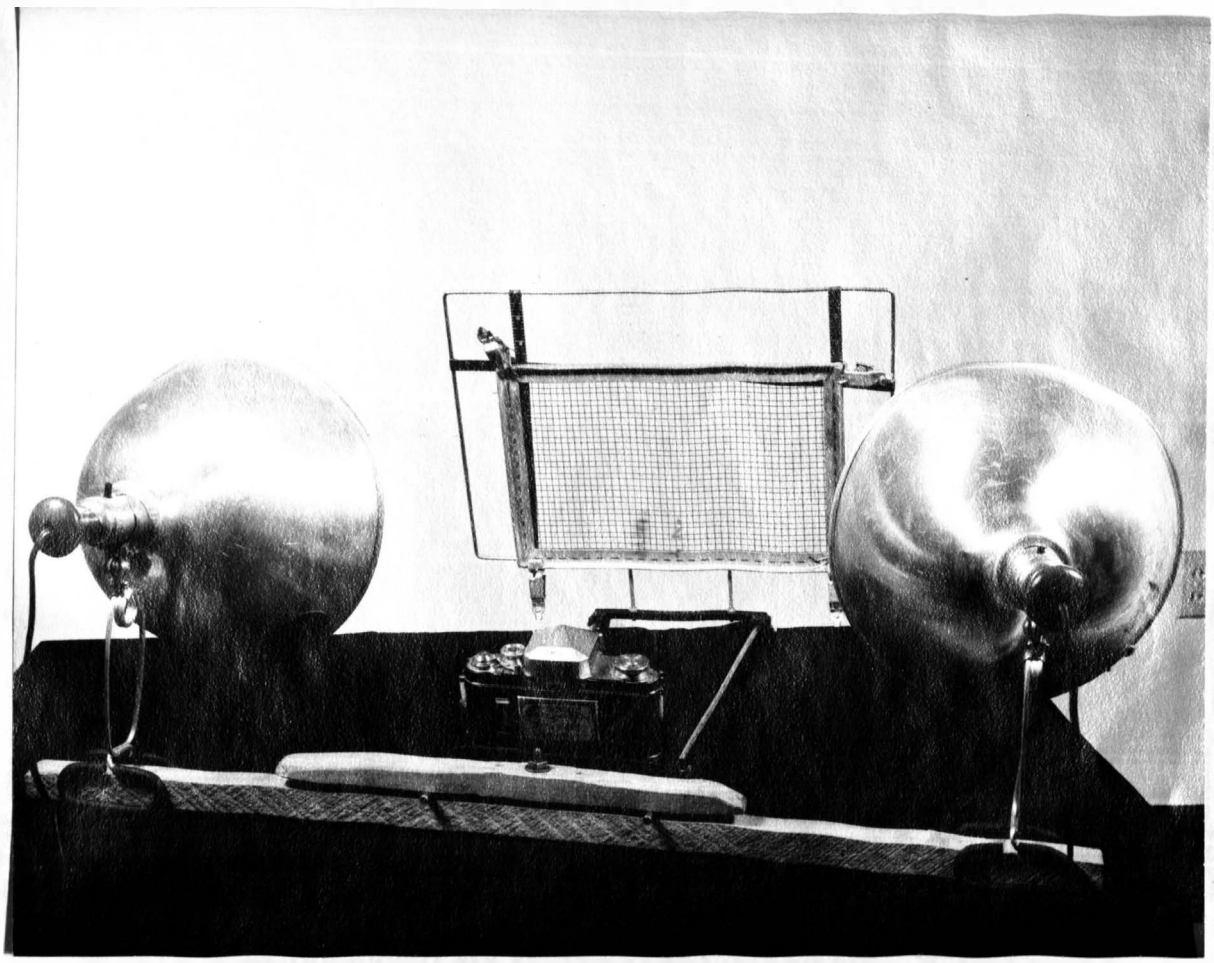


Figure 1. Focus Guide and Photographic Grid Used in Measuring Rib Eye Areas

Type F Kodachrome film was used for the pictures using an exposure of f3.5 at a 100th of a second. Excellent results were obtained with this equipment. The finished 2 X 2 colored slides were projected on a screen to count the squares of lean and fat as outlined by the grid square which was superimposed over the rib eye in the picture.

The area of the rib eye was determined by counting the squares in the rib eye muscle area. Only those squares which were filled with one-half or more lean tissue were counted. The number of squares counted, which were one-quarter inch squares multiplied by 16 gave the area in square inches. The area of external fat was determined by plotting two perpendicular lines at both ends of a straight line drawn through the long axis of the rib eye muscle (longissimus dorsi muscle). The external fat within the boundary of these 2 perpendicular lines was measured in the same manner as rib-eye area for an estimate of area of fat. The proportion of lean was determined by the following formula:

$$\text{Proportion of lean} = \frac{\text{rib eye area}}{\text{rib eye area plus area of external fat}}$$

Stilbestrol Pellet Residue Bioassay With White Mice

Studies were made to determine the length of time that implanted stilbestrol pellets remained in the ears of cattle. The estrogenic activity of the pellet residues was determined by bioassay using white mice. Residues from the ears of 2 groups of cattle were used in this study. Group 1 consisted of cattle that had been implanted 107 days before slaughter and group 2 consisted of cattle which were implanted 180 days before slaughter. The cattle in both groups had been implanted

with 3 pellets of 12 milligrams of stilbestrol each.

The study was made to determine the estrogenic activity of the stilbestrol pellet residue compared with the estrogenic activity of 0, 0.02, 0.04 and 0.06 microgram of stilbestrol per gram of feed. The residue was added to the mouse ration at a level of 0.04 microgram per gram of feed.

Rations 1 through 4 were the standard rations containing 0, 0.02, 0.04 and 0.06 microgram of stilbestrol per gram of ration, respectively. Rations 5 through 10 were mixed with the pellet residue premixes to contain 0.04 microgram of residue per gram of ration. Table 12 presents a summary of the weights of the dried pellet residues removed from the ears of the cattle, the ration in which the residue and the notations made at the time of removing the pellet residue.

TABLE 12

Stilbestrol Pellet Residue in Ears of Cattle

| Ear Number | Weight of[1] Pellet Residue (gm) | Assay Ration Number | Remarks |
|---|---|---|---|
| Group 1 - Implanted 107 days before slaughter | | | |
| 1 | ------ | -- | No pellets found in ear |
| 2 | ------ | -- | Infected around pellets-small specks of pellets |
| 3 | 0.0061 | 5 | All pellets present in ear, but small |
| 4 | 0.0212 | 6 | All pellets present in ear |
| 5 | 0.0148 | 7 | Two whole pellets, one broken up |
| 6 | 0.0058 | -- | Pellets broken up |
| 7 | 0.0068 | 5 | Pellets intact, but small |
| 8 | 0.0084 | 8 | Two pellets intact, one broken |
| 9 | 0.0050 | 8 | Pellets broken up |
| Group 2 - Implanted 180 days before slaughter | | | |
| 1 | ------ | -- | Pellets broken up, too small to use |
| 2 | ------ | -- | Pellets broken up, too small to use |
| 3 | ------ | -- | No pellets found in ear |
| 4 | 0.0051 | 9 | Two whole pellets, one broken up |
| 5 | 0.0012 | 10 | Only one pellet found |
| 6 | 0.0011 | 10 | Two very small pellets found |
| 7 | 0.0001 | 10 | Two particles of pellets found |
| 8 | 0.0003 | 10 | One very small pellet found |
| 9 | 0.0050 | 10 | Three small pellets found |
| 10 | 0.0051 | 9 | Three pellets found |

[1] Weight of 3 unused dried pellets weighed at same time was 0.0442 grams.

The basal mouse ration was formulated to give a 26 percent protein ration and is presented in table 13.

TABLE 13

Basal Mouse Ration Used in Stilbestrol Bioassay

| Ingredient | Parts |
|---|---|
| Ground corn meal | 41 |
| Ground oat meal | 41 |
| Steamed bone meal | 1 |
| Trace mineralized salt | 1 |
| Casein | 16 |

A standard stilbestrol premix was made up by adding one 12 milligram stilbestrol pellet to corn starch to make 100 grams of premix. The premix then contained 120 micrograms of stilbestrol per gram. The premix was added to the basal mouse ration at levels to give 0, 0.02, 0.04 and 0.06 micrograms of stilbestrol per gram of feed.

One hundred immature female white mice, Webster-Swiss strain, average weight 10-14 grams, were put in cages and given laboratory chow pellets and water until being placed on experiment. They were weighed and allotted into 10 pens for the experiment about 10:00 a.m. on April 30, 1957. The ten treatments were assigned at random to the 10 lots of 10 mice each. Feed and water were offered free access.

The mice were sacrificed after 7 days and their weights recorded. An incision was made with a scissors from the vulva to the diaphram. Then a cross-incision was made to expose the intestines and the uterus brought into clear view. Each uterus was removed by scraping away most of the adipose tissue and cutting at the cervix and the anterior end of each horn.

The uterii were placed on filter paper in a large bacterial petri dish and identified according to the mouse numbers. After slightly drying to keep the uterii in place, they were covered with Bouin's fluid, (75 parts picric acid, 5 parts glacial acetic acid, 20 parts formaldehyde).

The uterii were left in the fluid for two days and dried on the filter paper in the vacuum oven for 3 to 5 hours at 83° Centigrade. After drying and cooling in a dessiccator the uterii were weighed to the nearest 0.1 milligram. Calculations were made as percent of body weight.

$$\text{Percent Body Weight} = \frac{\text{uterus wt. mg}}{\text{body wt. mg}} \times 100$$

Stilbestrol Pellet Residue in Ears of Cattle at Time of Slaughter

Studies were made with 7 groups of stilbestrol-implanted cattle to determine the residual weight of the stilbestrol implants in the ears of cattle at time of slaughter. Three levels of implants and various lengths of time were studied. The cattle were slaughtered by packing companies in the area and the ears were removed at time of slaughter.

Stilbestrol pellets were removed from the ears of cattle following slaughter. The pellets were found by skinning the implanted ear until the residues could be removed with as little other tissue as possible. The pellet residues were dried and weighed along with unused pellets so that a valid comparison could be made.

## RESULTS AND DISCUSSION

The growing-fattening steer experiment was conducted in three phases--wintering, pasturing and fattening. Each phase will be discussed separately before the overall results of the 415-day experiment are discussed. The results of the separate phases are important as they contribute to the overall results.

### Wintering Phase

A summary of the results for the wintering phase is presented in table 14.

When comparing the effects of stilbestrol treatment in the wintering phase, lot 4 should not be considered as a control lot because this lot was fed a different source of hay. Lot 3 was fed the same type of hay as lots 1 and 2 and is the control lot for the winter phase.

The oral and implanted stilbestrol treatments gave about the same average daily gain (0.80 and 0.83 pound, respectively). Both stilbestrol treatments resulted in a significantly greater average daily gain than the control lot, which gained 0.63 pound per day. The stilbestrol treatments show a 30 percent increase in average daily gains over the control lot, which is a considerably greater increase than the average of the trials reported in the review of literature.

When comparing the feed required per 100 pounds of gain, the stilbestrol treatments showed a decided advantage over the control lot. The implanted stilbestrol lot had a slightly better feed efficiency than the steers fed stilbestrol orally.

TABLE 14

Weight Gains and Feed Efficiency--Wintering Phase

Nov. 14, 1956 - April 17, 1957 (154 days)

| | Lot 1 Oral Stilbestrol | Lot 2 Implant Stilbestrol | Lot 3 No Stilbestrol | Lot 4[1] 1955 Hay |
|---|---|---|---|---|
| Number of steers | 12 | 12 | 12 | 12 |
| Average Initial Weight, lbs. | 430.0 | 426.9 | 429.8 | 427.2 |
| Average Final Weight, lbs. | 553.2 | 554.2 | 526.3 | 549.2 |
| Average Gain, lbs. | 123.2 | 127.3 | 96.6 | 122.0 |
| Average Daily Gain, lbs. | 0.80 | 0.83 | 0.63 | 0.79 |
| Average Daily Feed Consumption, lbs. | | | | |
| Prairie Hay | 11.48 | 11.48 | 10.80 | 11.09 |
| Soybean Oil Meal | 0.98 | 0.98 | 0.83 | 0.90 |
| Salt and Bone Meal | 0.06 | 0.05 | 0.05 | 0.06 |
| Feed Required Per 100 Pounds of Gain, lbs. | | | | |
| Prairie Hay | 1434.3 | 1388.7 | 1721.5 | 1400.2 |
| Soybean Oil Meal | 122.4 | 122.4 | 131.6 | 113.1 |
| Salt and Bone Meal | 7.05 | 6.30 | 8.21 | 7.22 |

[1] Lot 4 is not considered as a part of the stilbestrol wintering trial; however, it is included in this table because the steers in lot 4 were used in the pasturing and fattening phases of the experiment.

Analysis of Variance
Average Daily Gains

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Square |
|---|---|---|---|
| Total | 1.0656 | 35 | |
| Treatment | 0.2821 | 2 | 0.1410** |
| Stilbestrol vs. Control | 0.2775 | 1 | 0.2775** |
| Oral vs Implant | 0.0045 | 1 | 0.0045 |
| Error | 0.7835 | 33 | 0.0237 |

** P is less than 0.01

The steers in all of the lots had about the same general appearance except that some of the steers in the stilbestrol-implant lot had elevated tail heads. This condition was not serious. An example of an elevated tail head in lot 2 is shown in figure 2.

Figure 2. Steers From Lot 2 (Stilbestrol-Implanted) at Close of Wintering Trial. Note the elevated tail head on the steer on the left and the comparative level top-line on the steer on the right.

## Pasture Phase

A summary of the results on the pasture phase of this experiment is presented in table 15.

All of the lots that were implanted with 24 milligrams of stilbestrol at the beginning of the pasture season gained faster than the nonimplanted lots. The largest average daily gain (1.26 pounds) was obtained in lot 5 where the steers received a stilbestrol treatment for the first time when they were placed on pasture. Lots 1 and 3, which received stilbestrol in both wintering and pasturing phases made average daily gains of 0.97 and 1.07 pounds, respectively. Lot 2, which received stilbestrol in the wintering phase but none in the pasture phase made an average daily gain of 0.90 pound. The gains made by the steers that did not receive stilbestrol during the winter or when on pasture (lots 4 and 6) were 0.89 and 0.78 pound.

An analysis of variance of the average daily pasture gains is shown at the bottom of table 15. The difference between the lots was significant (P is less than 0.05), and the least significant difference was 0.28 pound. The reason for a least significant difference this large was the great variation in average daily gains shown by the individual animals in each lot.

TABLE 15

Weight Gains - Pasture Phase

May 28, 1957 - Oct. 1, 1957 (126 days)

| | Lot 1 Stil. Imp. | Lot 2 No Stil. | Lot 3 Stil. Imp. | Lot 4 No Stil. | Lot 5 Stil. Imp. | Lot 6 No Stil. |
|---|---|---|---|---|---|---|
| Number of Steers | 8 | 8 | 8 | 8 | 8 | 8 |
| Average Initial Weight, lbs. | 626.6 | 629.8 | 616.5 | 589.8 | 606.2 | 612.4 |
| Average Final Weight, lbs. | 748.5 | 743.8 | 751.5 | 701.2 | 765.8 | 711.9 |
| Average Gain, lbs. | 121.9 | 114.0 | 135.0 | 111.4 | 159.6 | 99.5 |
| Average Daily Gain, lbs. | 0.97 | 0.90 | 1.07 | 0.89 | 1.26 | 0.78 |

Analysis of Variance
Average Daily Gains

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Square |
|---|---|---|---|
| Total | 4.5192 | 47 | |
| Between Lots | 1.1565 | 5 | 0.2312* |
| Within Lots | 3.3627 | 42 | 0.0800 |

* P is less than 0.05

Least Significant Difference is 0.28 pounds

Fattening Phase

A summary of the results of rate of gain and feed efficiency for the fattening phase of this experiment is presented in table 16.

An analysis of variance of the average daily gains is shown in table 16. The variation between lots was significant (P is less than 0.05) and the least significant difference between lots was 0.33 pound.

The average daily gains during the fattening phase were about the same for all of the implanted lots. Lot 1, which received stilbestrol in

TABLE 16

Weight Gains and Feed Efficiency - Fattening Phase

Oct. 2, 1957 - Feb. 24, 1958 (145 days)

| | Lot 1 Stil. Imp. | Lot 2 Stil. Oral | Lot 3 Stil. Oral | Lot 4 No Stil. | Lot 5 Stil. Imp. | Lot 6 Stil. Imp. |
|---|---|---|---|---|---|---|
| Number of Steers | 8 | 8 | 8 | 8 | 8 | 8 |
| Average Initial Weight, lbs. | 748.5 | 743.8 | 751.5 | 701.2 | 765.8 | 711.9 |
| Average Final Weight, lbs. | 1221.5 | 1220.8 | 1173.2 | 1104.4 | 1227.6 | 1181.9 |
| Average Gain, lbs. | 473.0 | 477.0 | 421.8 | 403.1 | 461.9 | 470.0 |
| Average Daily Gain, lbs. | 3.26 | 3.29 | 2.91 | 2.78 | 3.19 | 3.24 |
| Average Daily Ration, lbs. | | | | | | |
| Corn Silage | 26.1 | 25.7 | 25.7 | 24.8 | 25.8 | 26.1 |
| Rolled Shelled Corn | 14.7 | 13.9 | 13.6 | 12.5 | 14.7 | 14.0 |
| Soybean Oil Meal | 1.96 | 1.96 | 1.96 | 1.96 | 1.96 | 1.96 |
| Mineral Mix | 0.07 | 0.06 | 0.05 | 0.06 | 0.07 | 0.06 |
| Salt | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.03 |
| Feed Required Per 100 Pounds of Gain, lbs. | | | | | | |
| Corn Silage | 800.4 | 780.5 | 882.4 | 891.1 | 809.7 | 806.1 |
| Rolled Shelled Corn | 449.8 | 423.3 | 468.6 | 449.5 | 462.4 | 432.2 |
| Soybean Oil Meal | 60.2 | 59.7 | 67.5 | 70.6 | 61.7 | 60.6 |
| Mineral Mix | 2.3 | 1.9 | 1.8 | 2.0 | 2.2 | 1.8 |
| Salt | 1.0 | 0.9 | 0.9 | 1.0 | 1.1 | 1.0 |

Analysis of Variance
Average Daily Gains

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Square |
|---|---|---|---|
| Total | 6.2502 | 47 | |
| Between Lots | 1.8171 | 5 | 0.3634* |
| Within Lots | 4.4331 | 42 | 0.1056 |

* P is less than 0.05

Least Significant Difference is 0.33 pounds

all three phases, gained 3.26 pounds per day; lot 5, which received stilbestrol in the pasturing and fattening phases, gained 3.19 pounds per day; while lot 6, which received stilbestrol in the fattening phase only, gained 3.24 pounds per day.

Lot 2, which received 10 milligrams of stilbestrol daily in the feed of each steer, gained as high as any of the implanted steers. This lot had received stilbestrol previously in the winter phase only. Lots 1, 2, 5 and 6 all showed a significant increase in average daily gains over the control lot (lot 4).

Lot 3, which also received stilbestrol orally, did not show as much response to the stilbestrol treatment as lot 2. There was no apparent reason why lot 3 did not respond like lot 2 to the stilbestrol treatment. The only difference between the treatments of lots 2 and 3 during the entire experiment is that lot 3 received a 24-milligram stilbestrol implant in the pasture phase of the experiment while lot 2 did not receive the summer implant. There was no significant difference between lots 3 and lot 4, the control lot, in rate of gain during the fattening phase. This one experiment would have to be checked before any definite conclusions could be drawn. The effect obtained in this experiment has not been reported previously in the literature to the author's knowledge.

All lots of the steers were fed the same amount of corn silage and soybean oil meal but the rolled shelled corn was fed according to appetite. Thus, the effect of the stilbestrol treatment on feed consumption would be reflected only in the amount of corn consumed. However, lot 4 refused more silage than any of the other lots so the consumption of silage was less for that lot.

Lots 1 and 5 had the greatest corn consumption (14.7 pounds per day) while lots 2, 3 and 6 were slightly less (13.6 to 14.0 pounds per day). Lot 4, which had the least average daily gain also had the smallest daily consumption of corn (12.5 pounds per day). It is apparent that all stilbestrol treatments stimulated feed consumption.

When comparing the feed requirements per 100 pounds of gain the corn silage and soybean oil meal, which were fed at constant rates, were similar for lots 1, 2, 5 and 6. These lots also had similar rates of gain. More silage and soybean oil meal were required per unit of gain for the lower gaining lots, 3 and 4. Feed requirements for these feeds fed at constant rates appeared to be closely related to the rate of gain.

The corn, which was fed according to appetite, shows a different trend in the feed requirement per 100 pounds of gain. Both the amount of corn consumed and the rate of gain are involved here. The relationship between rate of gain and feed requirement appears to exist for the steers receiving stilbestrol. However, in the control lot (lot 4) the lower rate of gain was also accompanied by a lower corn consumption. The corn requirement per 100 pounds of gain for lot 4 was equal to or less than for two of the higher gaining lots (lots 1 and 5).

## Overall Growing-Fattening Trial

The average daily gain results of the entire 415-day growing-fattening trial are summarized in table 17. The results show that the highest overall average daily gains occurred when stilbestrol was administered in more than one phase of the trial.

Lot 1, which received stilbestrol in all three phases, shows no advantage over either lot 2 or lot 5, which received stilbestrol in only two of the three phases. The average daily gain of lot 3, which received stilbestrol in three phases, is less than the lots which received stilbestrol in either two or three phases because of the reduced average daily gain in the fattening phase which was discussed previously. The results of lot 6 indicated that there would have been an advantage for administering stilbestrol previously in at least one of the other phases. All of the stilbestrol-treated lots show a distinct advantage in average daily gain over the control lot.

TABLE 17

Average Daily Gains of Overall Trial

| | Lot 1 | Lot 2 | Lot 3 | Lot 4 | Lot 5 | Lot 6 |
|---|---|---|---|---|---|---|
| Winter Treatments | Stil. | Stil. | Stil. | No Stil. | No Stil. | No Stil. |
| Average Daily Gains, lbs.[1] | 0.81 | 0.82 | 0.81 | 0.71 | 0.71 | 0.71 |
| Pasturing Treatments | Stil. Imp. | No Stil. | Stil. Imp. | No Stil. | Stil. Imp. | No Stil. |
| Average Daily Gains, lbs. | 0.97 | 0.90 | 1.07 | 0.89 | 1.27 | 0.78 |
| Fattening Treatments | Stil. Imp. | Stil. Oral | Stil. Oral | No Stil. | Stil. Imp. | Stil. Imp. |
| Average Daily Gains, lbs. | 3.26 | 3.29 | 2.91 | 2.78 | 3.19 | 3.24 |
| Overall Average Daily Gains, lbs. | 1.70 | 1.71 | 1.60 | 1.46 | 1.72 | 1.61 |

[1] The average daily gains shown here are different than those reported previously because the four winter lots were regrouped into six lots for this table.

## Effects of Stilbestrol Treatments on Carcass Data

The carcass data are summarized in table 18. When these results were compared, there were no great differences between the lots. All of the steers except one were graded choice. Each whole number difference in carcass score represents one-third of a federal carcass grade, and the greatest difference in the average score between lots is 0.7. An analysis of variance shows that there was no significant difference in carcass grade between the lots (table 19). Lot 2, which received stilbestrol orally, and lot 5, which received stilbestrol implants in two of the phases, had the same carcass score (7.9). Lots 1 and 6 had average carcass scores of 7.4 and 7.8 respectively. Three of the stilbestrol treated lots (lots 2, 5 and 6) graded higher than the control lot (lot 4, which graded 7.6). Two other stilbestrol treated lots (lots 1 and 3) graded slightly lower than the control lot. The lowest grading lot in the trial was lot 3 which had an average carcass score of 7.2. Lot 3 was fed stilbestrol orally but apparently did not respond to stilbestrol treatment like the other lots in increased weight gains.

There was a difference in farm-to-market shrink. The analysis of variance (table 19) showed a significant difference between lots (P is less than 0.05). The greatest difference between any two lots in shrink was 1.52 percentage units difference between lot 2 and lot 5. This difference exceeds the least significant difference (0.91). Lot 2 received oral stilbestrol and lot 5 received stilbestrol implants.

Shrink for the other lots, including the control lot 4, was about the same. Except in the case of lot 5, stilbestrol implants did not

TABLE 18

Carcass Data

| | Lot 1 Stil. Imp. | Lot 2 Stil. Oral | Lot 3 Stil. Oral | Lot 4 No Stil. | Lot 5 Stil. Imp. | Lot 6 Stil. Imp. |
|---|---|---|---|---|---|---|
| Number of Steers | 8 | 8 | 8 | 8 | 8 | 8 |
| Carcass Grades - Number in each lot | | | | | | |
| High Choice | 1 | 2 | | 1 | 2 | 1 |
| Average Choice | 1 | 3 | 3 | 3 | 3 | 4 |
| Low Choice | 6 | 3 | 4 | 4 | 3 | 3 |
| High Good | | | 1 | | | |
| Average Carcass Score[1] | 7.4 | 7.9 | 7.2 | 7.6 | 7.9 | 7.8 |
| Average Percent of Shrink | 4.92 | 4.08 | 5.16 | 4.84 | 5.64 | 4.95 |
| Average Dressing Percent | 60.56 | 60.28 | 60.53 | 60.09 | 59.70 | 60.62 |
| Live Grades - Number in each lot | | | | | | |
| Low Prime | | | | 1 | | 2 |
| High Choice | | 1 | | 1 | 2 | 3 |
| Average Choice | 5 | 4 | 3 | 4 | 3 | 2 |
| Low Choice | 3 | 3 | 4 | 1 | 3 | 1 |
| High Good | | | 1 | | | |
| Average Good | | | | 1 | | |
| Average Live Grade Score[1] | 7.6 | 7.8 | 7.2 | 7.9 | 7.9 | 8.8 |

[1] Carcass and live grade score based on low prime, 10; high choice, 9; average choice, 8; low choice, 7; high good, 6 and average good, 5.

TABLE 19

Analysis of Variance - Carcass Data

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Square |
|---|---|---|---|
| **Carcass Grade** | | | |
| Total | 27.25 | 47 | |
| Between Lots | 3.07 | 5 | 0.61 |
| Within Lots | 24.18 | 42 | 0.58 |
| **Farm-to-Market Shrink** | | | |
| Total | 44.7251 | 47 | |
| Between Lots | 10.3921 | 5 | 2.0784* |
| Within Lots | 34.3330 | 42 | 0.8174 |

* P is less than 0.05

Least Significant Difference is 0.91 pounds

| | | | |
|---|---|---|---|
| **Dressing Percentage** | | | |
| Total | 97.4068 | 47 | |
| Between Lots | 5.0176 | 5 | 1.004 |
| Within Lots | 92.3892 | 42 | 2.199 |

appear to influence the amount of shrink. In lots 2 and 3, fed stilbestrol, lot 2 had a low shrink but lot 3 was higher than all others except lot 5. Thus, the influence of stilbestrol treatment on amount of shrink appears rather inconclusive in this experiment.

There was very little difference in the dressing percent between the lots; however, lot 5 had a slightly lower average dressing percent than any of the other lots. It was the only lot that fell below 60 percent. An analysis of variance was made and the results (table 19) show that there was no significant difference between the lots.

The live grades (table 18) were placed on each individual animal by 2 of the buyers at the packing company where the steers were sold. In all cases except for lot 6, the average live grade score corresponded very closely to the average carcass score. In lot 6, the graders placed 2 animals in the low prime grade which did not place as well in the carcass grade. Also 2 more steers were placed in the high choice live grade than were placed in the carcass grade. This higher grading in the live grades than in the carcass grades for lot 6 could not be used as evidence of a treatment effect since lots 1 and 5 did not show the same trend.

At the conclusion of the experiment, no treatment effects of stilbestrol were noted in the steers. The elevated tail heads which were noted at the end of the wintering phase were normal at the conclusion of the fattening experiment. There were no great differences among the lots in the general appearance of the steers except that lot 4 (the control lot) was smaller in size.

A summary of results of the rib eye measurements is presented in table 20. No significant differences could be measured among the lots because there were large variations of the rib-eye measurements within the lots. Lot 6 had the greatest total area of rib eye and external fat covering, but had the smallest proportion of lean. The control lot (lot 4) had the same proportion of lean as lot 6. Lot 2, which received stilbestrol orally, had the largest rib-eye area and the greatest proportion of lean to fat. Lot 3, which did not respond to oral stilbestrol in average daily gains, had the smallest total rib eye area. Because of the small variations between the lots, it appears that the stilbestrol did not have any important effect on amount or proportion of lean in the rib eye to the external fat covering.

TABLE 20

Rib Eye Measurements

| | Lot 1 | Lot 2 | Lot 3 | Lot 4 | Lot 5 | Lot 6 |
|---|---|---|---|---|---|---|
| Average Square Inches | | | | | | |
| Rib Eye Muscle | 10.31 | 10.92 | 10.16 | 10.34 | 10.72 | 10.85 |
| External Fat | 3.88 | 3.72 | 3.70 | 3.99 | 3.95 | 4.21 |
| Total | 14.19 | 14.64 | 13.86 | 14.33 | 14.67 | 15.06 |
| Proportion of Lean | .726 | .750 | .736 | .722 | .731 | .722 |

Analysis of Variance - Proportion of Lean

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Square |
|---|---|---|---|
| Total | 1268.11 | 45 | |
| Between Lots | 43.61 | 5 | 8.72 |
| Within Lots | 1224.50 | 40 | 30.61 |

Stilbestrol Pellet Residue Bioassay With White Mice

A preliminary study of the estrogenic uterine response of stilbestrol pellets in immature white female mice showed that the bioassay method used was satisfactory to measure estrogenic activity of stilbestrol pellets.

A summary of the feed consumption is shown in table 21. Lots 1 through 4 received 0, 0.02, 0.04 and 0.06 microgram of stilbestrol per gram of feed respectively. Lots 5 through 10 each received 0.04 microgram of stilbestrol pellet residue from the ears of cattle. From the results of the total feed consumption for the seven days, there was no apparent effect on feed consumption for any of the treatments. A considerable amount of feed was wasted and could not be measured.

TABLE 21

Seven Day Feed Consumption of Mice on Stilbestrol Pellet Bioassay Ration

| Lot No | Feed Consumed or Wasted (gm) | Lot No | Feed Consumed or Wasted (gm) |
|---|---|---|---|
| 1 | 336 | 6 | 362 |
| 2 | 344 | 7 | 313 |
| 3 | 318 | 8 | 378 |
| 4 | 342 | 9 | 275 |
| 5 | 329 | 10 | 321 |

The average results of the mouse weights and uterine responses to stilbestrol treatment are presented in table 22. One mouse died in lot 7 on the second day of the trial and one mouse died in each of lots 5, 7 and 8 on the fourth. No attempt was made to determine the causes of the deaths, but it is assumed that the deaths were not caused by the treatment. It was not possible to include the data from the dead mice with the rest as the length of treatment would have a substantial effect on the results.

From the results of lots 1 through 4, it can be concluded that the response from the stilbestrol generally increases with the increasing rate of stilbestrol. The response shown by the 0.02 microgram per gram of ration lot cannot be definitely explained. Two mice (numbers 1 and 2) varied considerably from the rest of the lot, and it is their response which caused the average response of the lot to be inconsistent with the other lots. Several reasons can be postulated but none can be proven. Possibly those 2 mice were more sensitive to the treatment than the rest of the lot or the feed was not mixed uniformly. The average uterine weight as percent of body weight without including those 2 mice would be 0.0501. There is not sufficient evidence to justify removing those 2 mice from the experiment.

TABLE 22

Mouse and Uterine Weights

| Lot No. | Stilbestrol Per Gram Of Feed (mcg) Or Group Number[1] | Number Of Mice | Average Body Weight (gm) | Average Uterus Weight (gm) | Percent of Body Weight |
|---|---|---|---|---|---|
| 1 | None | 10 | 20.61 | 0.0089 | 0.04 |
| 2 | 0.02 | 10 | 21.89 | 0.0157 | 0.07 |
| 3 | 0.04 | 10 | 22.99 | 0.0138 | 0.06 |
| 4 | 0.06 | 10 | 22.53 | 0.0231 | 0.10 |
| 5 | Group 1 | 9 | 22.57 | 0.0122 | 0.05 |
| 6 | Group 1 | 10 | 21.80 | 0.0157 | 0.07 |
| 7 | Group 1 | 8 | 22.72 | 0.0156 | 0.07 |
| 8 | Group 1 | 6 | 18.98 | 0.0120 | 0.06 |
| 9 | Group 2 | 10 | 21.84 | 0.0093 | 0.04 |
| 10 | Group 2 | 10 | 20.59 | 0.0105 | 0.05 |

[1] Pellet Residue was added at the rate of 0.04 micrograms per gram of feed in lots 5 through 10. Group 1 cattle were implanted for 107 days, and group 2 cattle were implanted 180 days. All of the cattle were implanted with 36 milligrams of stilbestrol and an average of 9.73 milligrams of residue was recovered from group 1 cattle and an average of 2.27 milligrams was recovered from group 2 cattle.

It was pointed out earlier that the pellet residue was added to the rations at the level of 0.04 micrograms per gram of feed. When comparing the uterine response of lots 5, 6, 7 and 8 to the first four lots, most of those treatments corresponded reasonably close to the 0.04 microgram per gram level. There is some deviation from this lot, but it is not too great.

In lot 8, one male mouse was accidently included without the worker's knowledge. Female mice had been ordered from the supply house and it was assumed that all of the mice received were female. This was the only male mouse in the shipment of 105 mice. Examination of the uterii of lot 8 showed that mice 7 and 8 were pregnant so their data were excluded from the experiment.

In comparing lots 9 and 10 to the first 4 lots there is no significant difference in the uterine responses between the control lot and lots 9 and 10. Apparently there was little or no estrogenic response in lots 9 and 10.

The results indicate that pellets removed from ears of cattle after 107 days contain estrogenic activity in proportion to the weight of pellet residue. The results also indicate that pellet residue removed 180 days after implanting contains little or no estrogenic activity. The 12-milligram pellets used were reported by the manufacturer to contain 12 milligrams of stilbestrol and 3 milligrams of binding agent.

From these results, it appears that the estrogenic activity of the stilbestrol pellet residue was proportional to the weight of the residue recovered from the ears of cattle. These results also show that pellet residues contain considerable estrogenic activity after being implanted for 107 days, but none at 180 days. Somewhere between these 2 times would be the effective life of the pellets. There was no evidence of encapsulation of the pellets in this phase of the experiment.

## Stilbestrol Pellet Residue Study

The average results of the data on the residues of stilbestrol pellets implanted in the ears of cattle are presented in table 23.

When the cattle that were implanted with three 12 milligram pellets are compared by lots, they tend to divide themselves into 2 groups. The cattle that had been implanted for 120 days or less (group numbers 1, 4 and 6) had a stilbestrol pellet half-life of 67 to 75 days while cattle that had been implanted for more than 145 days had a stilbestrol pellet

## TABLE 23

### Stilbestrol Pellet Residue in Cattle Ears

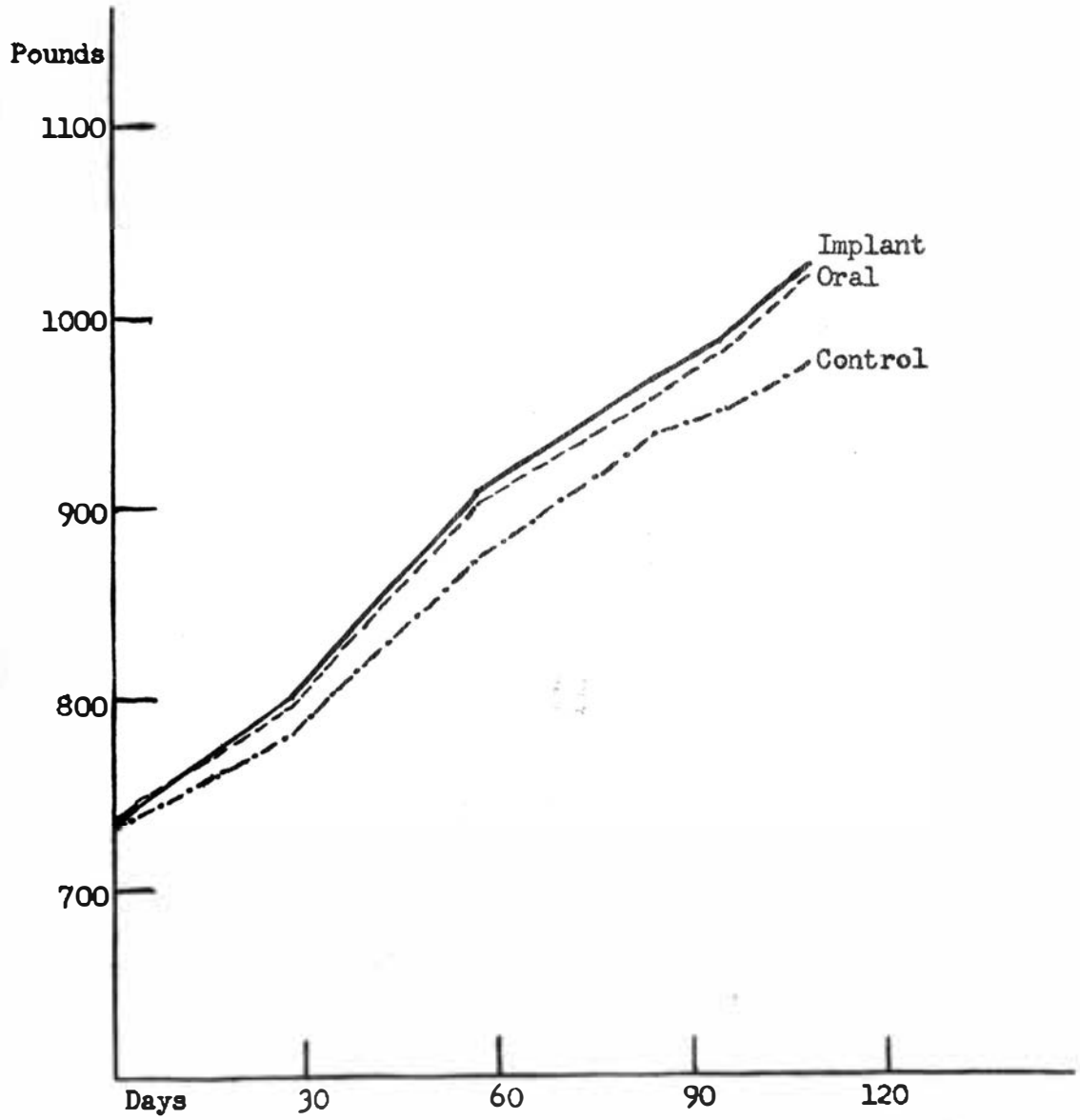
| Group Number | Number of Ears With Pellets | Stilbestrol Level (mg) | Days Implanted | Ave. Wt. of Pellet Residue | Wt. of Each Pellet Used Per Day | Half Life Of Pellets Days |
|---|---|---|---|---|---|---|
| **Cattle implanted at the same level but for different number of days** | | | | | | |
| 1 | 7 | 36 | 107 | 9.73 mg | 102 mcg | 74.5 |
| 2 | 7 | 36 | 180 | 2.27 mg | 75 mcg | 101.3 |
| 4 | 7 | 36 | 66 | 21.6 mg | 105 mcg | 72.4 |
| 6 | 7 | 36 | 120 | 3.61 mg | 113 mcg | 67.3 |
| 7 | 21 | 36 | 145 | 14.4 mg | 68 mcg | 111.8 |
| **Cattle implanted at different levels but for same number of days** | | | | | | |
| 3 | 7 | 24 | 66 | 16.6 mg | 87 mcg | 87.4 |
| 4 | 7 | 36 | 66 | 21.6 mg | 105 mcg | 72.4 |
| 5 | 7 | 60 | 66 | 30.4 mg | 128 mcg | 59.4 |

half-life of 101 to 112 days. These results indicate that there is a slowing down of the rate of absorption between 120 and 150 days. This suggests that the stilbestrol pellet is practically used up at 150 days. Hale et al. (1957) concluded that a single implantation of two or three 12 milligram stilbestrol pellets will exert its growth-promoting effect for a 150-200 day feeding period.

When the three levels of stilbestrol implants are compared, the higher the stilbestrol-implant level, the shorter the half-life of the stilbestrol pellets. This is shown in table 23. No definite explanation can be given for this effect. It does indicate that high levels of implants are not more lasting. No other trial of this nature has been reported in the literature. The results of this trial can be used to help explain the undesirable side effects often reported in trials where higher levels of implants were used. Not only does increasing the number of pellets increase the dosage but the rate of absorption also appears to be increased.

In order to help determine the length of time that stilbestrol implants affect the rate of gain in fattening steers, the average weights of the fattening steers in two trials were plotted on graphs. A comparison of the rate of gain was made between steers implanted with 36 milligrams of stilbestrol per head daily. This was done so as to determine whether there is a reduction in rate of gain with time in implanted steers as compared to the control steers or oral-stilbestrol steers.

In figure 3, the average weights at each weigh day are plotted from a 107-day fattening feeding trial, which was conducted in the winter of 1956 and 1957. It was noted from a study of the graph that

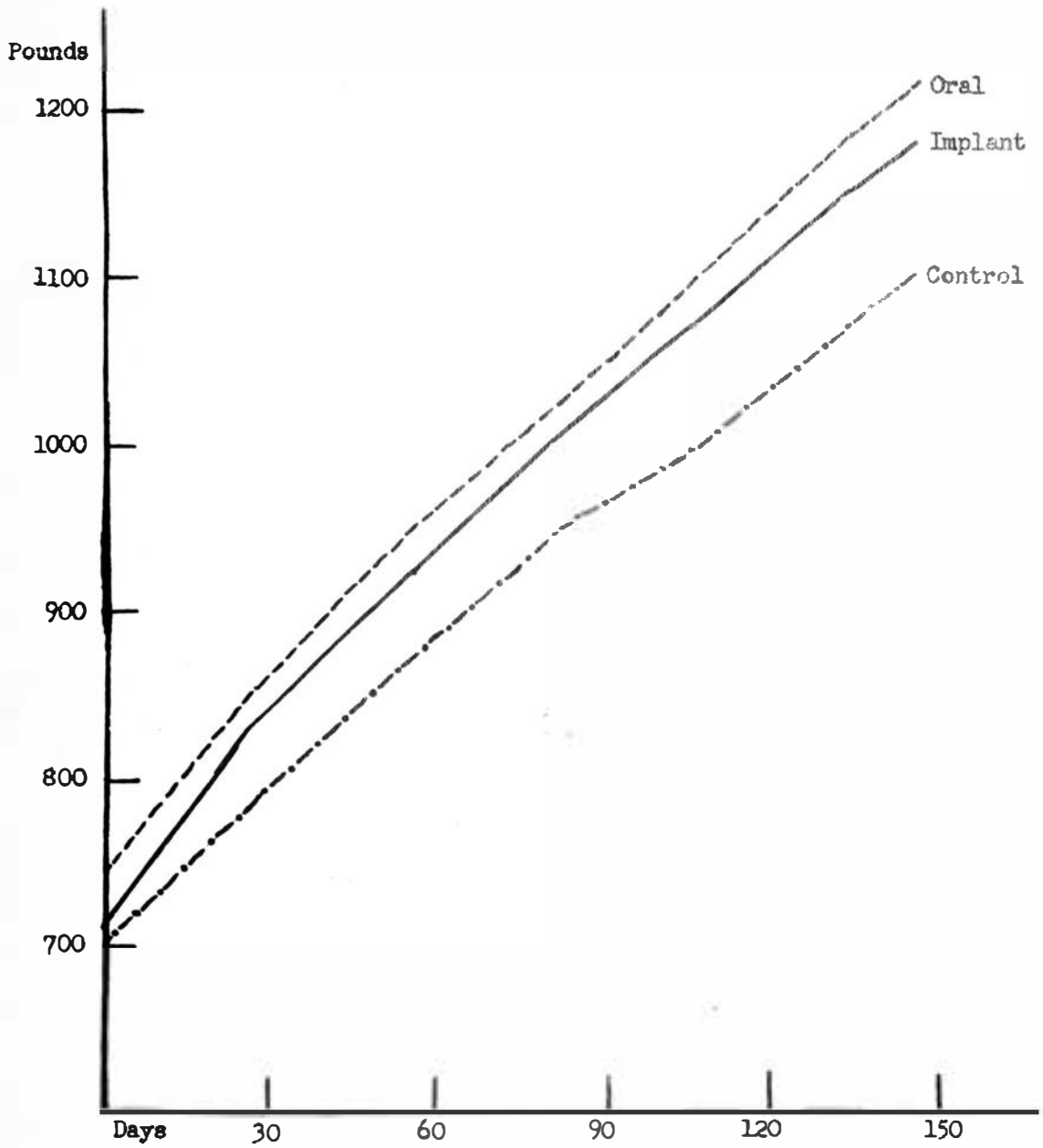



| Day of Trial | Control (lbs.) | Oral (lbs.) | Implant (lbs.) |
|---|---|---|---|
| 1 | 735.3 | 731.4 | 736.1 |
| 28 | 784.8 | 797.4 | 797.8 |
| 56 | 870.2 | 900.1 | 906.9 |
| 84 | 939.7 | 957.6 | 982.4 |
| 107 | 975.7 | 1021.0 | 1029.9 |

Figure 3. Average Weights of Steers at Each Weigh Day - 1956-57 Trial

the implanted cattle gained faster than either the control cattle or the stilbestrol-fed cattle. This shows that there was no reduction in rate of gain in the implanted lot as compared to the oral lot and the control lot up to 107 days.

In figure 4, the average weights at each weigh day are plotted from the 145 day fattening trial reported earlier. When the distances between the lines are compared in this graph, there is a suggestion of a very slight dropping off of the implant lot after the 133rd day of the trial as compared to the oral and control lots. This would indicate that the effects of the stilbestrol implant are being reduced after 133 days and the stilbestrol implant is not as effective as it was earlier. This is in agreement with the results shown earlier where the half-life of stilbestrol pellets in ears of cattle was discussed. However, the evidence here is not conclusive and more work along this line is needed.




| Day of Trial | Control (lbs.) | Oral (lbs.) | Implant (lbs.) |
|---|---|---|---|
| 1 | 701.2 | 743.8 | 711.9 |
| 28 | 790.1 | 857.2 | 835.6 |
| 56 | 874.2 | 953.1 | 925.4 |
| 82 | 950.9 | 1030.1 | 1006.1 |
| 104 | 995.6 | 1094.8 | 1070.1 |
| 133 | 1072.2 | 1188.6 | 1152.4 |
| 145 | 1104.4 | 1220.8 | 1181.9 |

Figure 4. Average Weights of Steers at Each Weigh Day of 1957-58 Trial

## SUMMARY AND CONCLUSIONS

The results of a 415-day experiment using growing-fattening steers to study the use of stilbestrol are reported in this thesis. The experiment was divided into three phases--wintering, pasture and fattening. There were 48 steers in the trial which were divided into 4 groups in the wintering phase and then redivided into 6 groups during the pasture and fattening phases.

The use of stilbestrol in the wintering phase with a prairie hay and soybean oil meal ration increased the average daily gains 30.1 percent over the control steers. There was no significant difference between the steers that were implanted with 24 milligrams of stilbestrol and the steers that were fed 10 milligrams of stilbestrol per head daily.

Implants of 24 milligrams of stilbestrol increased the average daily gains 22.7 percent in the steers that were pastured for 126 days on a primarily brome grass pasture over the nonimplanted steers. The greatest response to stilbestrol on pasture was obtained with steers which had not received stilbestrol during the winter. Steers which received stilbestrol during the winter but not on pasture gained at a similar rate as steers which did not receive stilbestrol in either phase.

The use of stilbestrol in the fattening phase increased the average daily gains 16.7 percent in 4 of the 5 stilbestrol-treated lots over the control lot. One of the lots that received stilbestrol orally in the fattening phase and had received stilbestrol previously in both the wintering and the pasture phases did not gain much faster than the control lot. This situation cannot be adequately explained without further work.

The lot that received 10 milligrams of stilbestrol orally per head daily gained 0.06 pound per day faster than the average of the three 36 milligram implanted lots, which is not a significant difference. There were no significant differences due to stilbestrol treatment in carcass grade or dressing percentage. The carcass grade score of the control lot was 7.6, while the average of the lots fed stilbestrol was 7.55 and the average of the implanted lots was 7.7, which indicated that stilbestrol treatment did not affect carcass grade.

The results of the overall experiment indicate that stilbestrol should be used in two or more phases of growing-fattening cattle. There does not appear to be any advantage of using stilbestrol in three phases over only two phases; however, stilbestrol should be used in the fattening phase.

Rib eye measurements were made on the carcasses after slaughter. Because of the large variation within the lots, no significant differences were found between the stilbestrol treatments on the proportion of lean in the loin. A few previous reports had suggested that stilbestrol affects the proportion of lean to fat in the carcass.

The results are presented in this thesis on a study of the estrogenic activity of stilbestrol pellet residue left in the ears of cattle at the time of slaughter. The results from one group of cattle implanted 108 days before slaughter indicate that the estrogenic activity in the pellet residue is comparable to the stilbestrol pellet before implanting at the same weights. However, it must be remembered that a considerable weight loss takes place while in the ear, 50 percent or more.

The results of another group of cattle, which had been implanted for 180 days, indicated that there was little or not estrogenic activity in the residue at 180 days.

From the study of pellet residue in ears of cattle at the time of slaughter it was concluded that the maximum rate of absorption has been reduced after 120 to 150 days. This is also suggested in the graph of cattle weights during the 145-day trial where the rate of gain of stilbestrol implanted steers drops off after 133 days. The one study of the level of implant on the rate of absorption indicates that the higher levels of implants absorb faster than the lower levels of implants.

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