1967

Feedlot Performance of Heifers as Affected by Spaying and Hormone Treatment

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FEEDLOT PERFORMANCE OF HEIFERS AS AFFECTED BY SPAYING AND HORMONE TREATMENT

BY

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A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in
Animal Science, South Dakota
State University

1967

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BY SPAYING AND HORMONE TREATMENT

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser Date

Head, Animal Science Department Date

ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation to Dr. L. B. Embry, Professor of Animal Science, for his guidance, suggestions and criticisms during this study and the preparation of this thesis.

Acknowledgments are due to Dr. R. C. Wahlstrom, Head of Animal Science Department, other staff members and fellow graduate students for assistance during my graduate study.

The author is also deeply indebted to his wife, Diann, for her encouragement and assistance throughout this study, and to Mrs. Pat Dooley for final typing of the material.

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INTRODUCTION

Thirty-three percent of the animals which comprised the fed slaughter market in 1966 were heifers (U.S.D.A., 1967). When heifers are compared to steers, they gain at a slower rate, require more feed under similar feeding systems and sell at a lower price. These are important economic considerations in view of the large number of heifers fed for slaughter. The meat from heifers has been shown to be equal to that of steers in eating quality. It, however, sells at a lower price because heifer carcasses tend to be fatter and to have more waste as fat trim than steer carcasses when fed to the same market grade.

The margin of profit on which livestock feeders operate is usually small. Profits often depend on rapid and efficient live-weight gains because of frequent negative margins between buying and selling prices of the animals. This makes it necessary to analyze the rations and methods of feeding and to study ways in which they may be improved. One method available is hormone administration which may be in the form of an additive to the feed or an implant placed under the skin of the animal. The feed additive or implant furnishes no essential nutrients but are substances used in relatively small amounts to improve gain, feed efficiency or carcass quality.

Relatively little research has been published on methods of fattening of heifers for market. Since heifers make up a considerable portion of the fed cattle, more research is needed to study ways of

improving feedlot performance and to determine the most profitable ways to feed them.

This experiment was conducted to determine the effects of spaying and the effects of diethylstilbestrol and Synovex-H (200 mg. testosterone propionate and 20 mg. estradiol benzoate) implants on feedlot performance and certain carcass characteristics of spayed and nonspayed heifers.

REVIEW OF LITERATURE

A price discrimination against heifers of a few dollars per head affects the producer very materially. It also affects the feeder in that less profit is realized upon his operations unless he purchases on a correspondingly lower basis. The prejudice against heifers is due to certain basic differences which exist between the sexes. It is important for the cattle feeder to know these, their economic influence and ways in which differences between sexes may be modified.

The approach taken to this study is centered around the role of the gonadal hormones in influencing weight gains, feed conversion and carcass characteristics of heifers. A review of the basic differences found between the sexes and the effects of gonadectomy followed by a review of research with the individual gonadal hormones used to affect rate of gain will be covered in this review of literature.

Comparison of Bulls, Steers and Heifers

Only a few experiments appear to have been conducted where direct comparisons were made between intact male and female cattle in the feedlot. More frequently steers were compared with heifers. Recently there has been an increase in research comparing bulls with steers.

One of the recent trials which involved a study of gain, feed efficiency and carcass quality between bulls, steers and heifers was

conducted by Williams et al. (1965). Thirty Angus and 15 Hereford animals, divided equally among bulls, steers and heifers within each breed were used. Five animals of the same sex and breed were fed per lot. All animals were fed on a high corn silage wintering ration for 133 days and then on a fattening ration for an average of 74 days. One-third of each sex group was slaughtered at three market weights. The first slaughter weight was when all the heifers averaged 750 lb. The second slaughter weight was when the remaining steers averaged 875 lb. The third slaughter weight was when the remaining bulls averaged 1,000 lb. This constituted a representative slaughter weight for the different sex groups. The average daily gain, air-dry feed per 100 lb. gain and total feed per animal for bulls, steers and heifers, respectively, were (lb.): 2.21, 729, 3332; 1.85, 865, 3315; and 1.63, 961, 3241. Average daily gain was higher ($P < .01$) for bulls than for steers and higher ($P < .01$) for steers than for heifers. Carcass grades were: bulls--average good; steers--low choice; and heifers--average choice. Heifers and steers graded significantly higher ($P < .01$) than bulls, but there were no significant differences in dressing percent. Rib-eye areas were significantly ($P < .01$) larger for bulls in comparison to steers and for steers in comparison to heifers. Marbling scores were 4.4, 5.7 and 6.7 for bulls, steers and heifers--a larger number representing a higher degree of marbling. Fat thicknesses over the 12th rib were 6.4, 10.3 and 14.3 mm.; these were also significantly different ($P < .01$).

Another recent trial comparing bulls, steers and heifers was conducted by McGinty and Marion (1965). Young bulls were compared with steers in one trial and bulls, steers and heifers in a second trial. Groups of 20 each of bulls, steers and heifers were selected for the second trial with one-half in each group implanted with diethylstilbestrol. Five implanted animals and five untreated animals from each group were placed in each of six lots. One lot each of bulls, steers and heifers was fed a low-concentrate ration and the other a medium-concentrate ration. Daily gains for bulls, steers and heifers were: low level--2.20, 1.96 and 1.91 lb.; medium level--2.39, 2.27 and 2.03 lb. Implanted bulls, steers and heifers gained 2.43, 2.19 and 2.04 lb. daily, respectively, whereas untreated animals gained 2.17, 2.06 and 2.04 lb. Rib-eye areas for bulls, steers and heifers averaged 9.8, 8.7 and 8.8 sq. in. respectively. Bulls averaged the lowest and heifers the highest in marbling score and carcass grade.

Results of this experiment show little advantage for the diethylstilbestrol treatment or the higher level of energy for the heifers. The effects of sex and castration on the response to varying levels of energy intake appear to be an area warranting further study.

Whetzal et al. (1965) compared heifers and steers of similar breeding under similar feeding systems. Seventy-five heifer and 75 steer calves were purchased for the trial with an equal number of

each sex originating from the same herd. Twenty-five of each sex were implanted with diethylstilbestrol, implanted with Synovex or served as controls. The cattle were marketed on two different dates. One-half of the cattle from each lot were sold after 250 days on trial when the heifers averaged about 950 lb. and were considered to have reached a typical market grade for heifers. The remaining cattle were sold 40 days later when the steers averaged 1125 lb. and were considered to have reached a typical market grade for steers. After 250 days on trial, the steers had gained 10.3% faster than the heifers with an average daily gain of 2.15 lb. for all the steers and 1.95 lb. for all the heifers. At this marketing, the steers averaged about 100 lb. heavier than the heifers but little difference between them was noted in carcass grade and dressing percent. The heifers appeared to be fatter and had a slightly greater over-all fat covering and degree of marbling. The greater covering of fat on the heifers, even though they averaged 100 lb. lighter than the steers at market time, further points out the ability of heifers to finish at lighter weights than steers. Over-all daily gains were not changed appreciably by feeding 40 days longer. However, fat deposition appeared to occur more rapidly in the heifers than in the steers during the extended feeding period. This was evidenced by a greater increase in fat covering, marbling score and dressing percent for the heifers than for the steers.

The results of these three trials are typical of what has been shown in the past and is commonly accepted. Females gain slower than

the males of the species. Castration of young bulls slows down their rate of gain, but it is still superior to that of heifers. Feed requirements are also higher for heifers. As was shown by Williams et al. (1965), heifers required 31% more feed per pound of gain than bulls and 11% more than steers. Rib-eye areas are usually smaller for heifers than bulls and steers but are more highly marbled. Fat covering over the carcass of heifers is thicker. These carcass characteristics result in heifers being finished to comparable grades to bulls and steers at a lighter market weight.

The preceding comparisons give a background of the relationship between the male and female of the bovine species and a basis for working in the area of improving the feedlot performance of heifers. The following portion of the literature review will be concerned with the use of gonadal alteration and gonadal hormones in improving the performance of feedlot heifers.

Effect of Gonadectomy (Spaying)

Castration of bull calves is a very common practice. Steers, the result of castrating bulls, gain at a slower rate and are less efficient than bulls. In the past, it has been thought that the increased fat deposition of the carcass and the quieter disposition of steers made castration of bulls an acceptable practice. Present demands for a leaner carcass and increased knowledge in methods of feeding bulls may change this practice in the future.

Castration of heifers is not as common a practice as castration of bulls. It was more common during the earlier part of the 20th century because cattle were kept for longer periods of time before going to slaughter. It allowed the rancher to graze heifers intended for slaughter in herds along with bulls without these heifers becoming pregnant.

Gramlich and Thalman (1930) reported data on spaying, sex and age as factors in cattle feeding. They concluded that heifers made the most desirable beef carcasses at 8 to 15 months of age; and that if the animals were marketed at these earlier ages, there was little occasion for spaying. In three direct comparisons with spayed and open heifers, two with yearlings and one with calves, the average daily gain was 2.0 lb. for open against 1.8 lb. for the spayed animals. The feed required for 100 lb. of gain was 10% greater for the spayed groups. There was also a difference in dressing percentage--59.1% for open against 57.3% for the spayed group. They concluded that no advantage was gained by spaying feedlot heifers, and the criticism often voiced against open heifers that repeated heat periods tend to inhibit the amount of beef produced was not borne out in these trials with yearlings and calves.

Hart et al. (1940) concluded that data from their two feeding trials confirmed that from other sources—no advantage occurs from spaying heifers that are going into the feedlot. Activity of open heifers in riding at estrual periods was not serious. It became reduced as market weight was approached and did not appear an

important factor in feed consumed or in cost per 100 lb. of gain. The activity of unbred heifers in riding at estrual periods was particularly noticeable in the early stages of feeding in drylot, probably because of the stimulating action of high food intake. As fattening progressed, this behavior became less marked; and toward the end of the feeding period, the only evidence of a heifer being in heat was her failure, at times, to eat with other animals in the pen.

Dinusson et al. (1950) reported spaying of heifers for the feedlot resulted in decreased rate of gain and decreased feed efficiency. It also significantly increased the blood lipid content. Similar findings have been reported by Smith et al. (1958), Clanton et al. (1966) and Ray et al. (1966). On the other hand, Clegg and Carroll (1956) found spaying to have no effect on growth rate, dressing percent or carcass grade in a 217-day fattening experiment.

Response of Heifers to Diethylstilbestrol

Diethylstilbestrol, commonly referred to as stilbestrol or DES, is a synthetic compound possessing female hormone-like activity. The empirical formula of diethylstilbestrol ($C_{18}H_{20}O_2$) is similar to that of a natural estrogen of high potency, estrone ($C_{18}H_{22}O_2$), but the structures of the two substances are dissimilar. Other synthetic hormones have been produced, but are not as potent as diethylstilbestrol and haven't been tested as extensively.

The physiological mechanism whereby diethylstilbestrol improves feed utilization and growth rate in cattle is not definitely known, but available evidence appears to support an indirect effect mediated through the anterior pituitary gland. One theory proposed is that estrogens stimulate the pituitary gland to produce larger quantities of growth hormones which in turn causes cattle to grow faster. Another theory is that estrogens stimulate the pituitary gland to produce more adrenocorticotropic hormone which in turn stimulates the adrenal cortex to produce more androgens, and it is the androgens which cause cattle to grow faster. A third theory is that estrogens stimulate the pituitary gland to produce more thyroid-stimulating hormone which in turn stimulates thyroxin production from the thyroid gland, and it is the thyroxin which is responsible for the faster growth. The first of these theories seems to be the most popular (Burroughs, 1966).

Early tests with diethylstilbestrol were often conducted using high levels which resulted in undesirable side effects, although promoting increased daily gains. Such side effects are elevated tail head, sagging of the loin, mounting other cattle, mammary development and prolapse of the vagina. Frequently, the grade of the carcass is also lowered.

Levels which may be suitable for use on steers may be too high for heifers. Thirty-six mg. is a commonly used level of implanting for finishing steers, but at this level with heifers one may expect to encounter problems such as vaginal prolapse, excessive mammary

development and other noticeable effects. A feed level of 10 mg. per head daily is used for steers and heifers alike without many if any signs of side effects and yet obtain maximum or near maximum gains.

The response from administering diethylstilbestrol to heifers is not as pronounced as that obtained with steers (Dinusson et al., 1950; Clegg and Cole, 1954; Burroughs et al., 1955; Richardson et al., 1958; McGinty and Marion, 1965; Whetzal et al., 1965). In general, implantation or feeding diethylstilbestrol improves gross feed efficiency under drylot feeding conditions, or when supplementary feed is fed while the animals are on pasture. The amount of feed required per unit of gain is related to the energy content per unit of feed consumed, and is at least roughly correlated with rate of gain. In cattle fed grain rations under drylot conditions, DES-treated animals usually consume 10-15% less feed per unit of gain. In some animals fed high-roughage rations, there has been no improvement in feed efficiency; and in other cases, there has been a feed savings of up to about 10% (Clegg and Cole, 1954; N.R.C., 1959).

Burroughs et al. (1955) reported results of an experiment with three lots of eight Hereford-Angus crossbred yearling heifers fed for 113 days on a heavy corn fattening ration. The ration consisted of a full feed of a mixture of 60% rolled shelled corn and 40% ground cobs with a limited feed (2.9 lb.) of protein supplement. Diethylstilbestrol was dissolved in corn oil and thoroughly mixed into the supplement so that one lot of heifers received an average of 12 mg. of DES, a second lot received 6 mg. and a third lot served as

controls. The heifers fed diethylstilbestrol responded by making more rapid live-weight gains at reduced feed costs as compared with similar heifers receiving no DES. Rate of gain was stimulated as much as 0.31 lb. per heifer daily which was not quite as much stimulation as that noted with steers in previous experiments. Feed requirement per unit of gain with DES feeding was reduced 10 to 12% with the heifers which compares favorably with 5 to 20% in the case of the steers fed comparable rations and levels of DES.

Fletcher et al. (1957) reported a 25% increase in rate of gain from implanting heifers with 24 mg. of diethylstilbestrol. Thirty-three purebred replacement heifers, 12-24 months of age, were fed 63 days on a high-roughage ration with the following chlortetracycline supplementation: I--none; II--25 mg.; and III--75 mg. Four heifers in each lot received a 24-mg. implant. Average daily gains for non-implanted and implanted heifers, respectively, were: I--1.50, 1.73; II--1.59, 1.70; III--1.38, 2.03. Highly significant increases in rates of gain were produced by DES implants with the DES-75 mg. chlortetracycline treatment producing the fastest gains. The responses shown with treatments I and II in this trial are probably more typical of what is to be expected on a high-roughage ration than the response shown for treatment III.

Hall (1962) implanted yearling beef heifers with 24 mg. diethylstilbestrol and fed a full feed of concentrates with 3 to 5 lb. hay per day for 56 to 58 days. Three experiments involving a total of 88 short yearling heifers were conducted to determine the effects

of DES on feedlot performance. The heifers weighed approximately 560 lb. and graded standard when started on trial. The heifers full-fed in drylot and implanted with 24 mg. DES gained 19% faster than comparable controls. They required 14% less feed per unit of gain than controls and feed costs were reduced from 14.9 to 13.1 cents per pound of gain. Final condition grades and selling prices were not significantly different for the treated and control animals.

Fletcher et al. (1957) fed 33 purebred replacement heifers, 12-24 months of age, for 63 days on a high-roughage ration. Half the animals in each lot were implanted with 24 mg. of diethylstilbestrol. Highly significant increases in rates of gain were produced by DES implantation. Implanted heifers exhibited excessive mucous secretions and prolonged estrus, but no indications of vaginal prolapse or other serious side effects were noticed.

Further research reported by the Florida workers (Hentges et al., 1960) with 24-mg. implants showed that diethylstilbestrol produced a significant increase in rate of gain but the majority of implanted heifers exhibited increased teat and udder development, slight relaxation of the loin and excessive mucous secretions from the vulva midway between heat periods. These observations indicate that the 24-mg. level of implants may be too large from the standpoint of undesirable side effects. However, there were no indications of vaginal prolapse, and subsequent ovary palpations and visual observations revealed no gross harmful effects from the DES implants.

Richardson et al. (1958) designed an experiment to study the effect of low level (12 mg.) implanting of diethylstilbestrol for heifers being fattened for slaughter. There were no noticeable side effects from the implants. Neither was there any unusual behavior on the part of any of the heifers. Animals receiving the DES implant gained an average of 0.27 lb. faster per day than the controls. There were no significant differences in carcass grade, fat thickness, fat distribution, degree of marbling or degree of firmness. Size of rib eye was larger from the group receiving DES. However, in general size of rib eye increases as weight of the animal increases.

In a summary of research with diethylstilbestrol, Radabaugh and Embry (1959) concluded undesirable side effects were more frequently reported with heifers than with steers, especially when implanted with 36 mg. or more of diethylstilbestrol. In view of the possible undesirable side effects, they recommended the level should not exceed 24 mg. when implanting heifers.

An example of the results which may be obtained from using high levels of diethylstilbestrol was reported by Neumann et al. (1956). Three lots of 16 heifers each were fed 196 days on similar fattening rations. The heifers were randomly allotted to one of four implant treatments as follows: 1) no DES implant, 2) 40 mg. DES at the start of the trial, 3) 40 mg. DES implanted at 98 days, and 4) 20 mg. DES implanted each 28 days. Imposed upon these treatments was the feeding of 5 mg. of diethylstilbestrol daily to one of the

lots. Single implants early or midway in the feeding period did not significantly increase average daily gain, although there was a temporary response in each case. Oral administration of DES, either alone or in combination with implants, resulted in a significant increase in gains. The combination of oral and implanted DES resulted in an additive response. Intermittent implantation significantly improved gains over the controls as compared with no response to single implants. Serious physiological disturbances including prolapsed uteri, extremely elevated tail heads, excessive mammary development and low loins resulted from the combination of intermittent implanting and oral administration of DES. Less severe disturbances were noted when these treatments were used alone. On-foot grades were lowered by DES administration in all cases.

Clegg et al. (1951) demonstrated the results of high level diethylstilbestrol implants in heifers. The treated groups in most instances made greater gains in body weight than the controls. Carcass grades at time of slaughter, however, were in all cases lower in the treated groups. In both heifers and steers, the DES implants caused significant mammary development. Considerable milk was present in the mammary glands of the heifers at the time of slaughter. Vaginal prolapses occurred in two trials. In one group of 80 heifers treated with 60 mg. of DES, four developed vaginal prolapse. In another group of 10 heifers, one animal developed this condition. Weights of pituitary and adrenal glands were increased above that of the controls.

Clegg and Cole (1954), in reporting early work with high levels of diethylstilbestrol, state the predominant signs of treatment were masculinity and mammary gland development. Several cases of vaginal prolapse also occurred in heifers as a result of diethylstilbestrol implantation.

Significant reductions in dressing percent and carcass grades have been reported from the use of high level DES implants (Clegg et al., 1951, Clegg and Carroll, 1956, Neumann et al., 1956). The implant levels represented here were from 40 to 80 mg. The use of 24 mg. or smaller implants or the feeding of 10 mg. per day seems to present little or no effect on carcass grade or dressing percent (Kastelic et al., 1956, Richardson et al., 1958, Williams and Baker, 1961).

The growth response to DES implants appears to decrease after 120-140 days. If the cattle are to be fed for more than 150 days, it is recommended to reimplant after about 120 days (Radabaugh and Embry, 1959).

Response of Heifers to Testosterone

As was pointed out earlier, in most species the male makes more rapid and efficient gains than does the female. Castration of the male results in a reduction in rate and efficiency of gains and in increased fattening. From this it could be conceived that testosterone administration could increase growth rate and efficiency as does diethylstilbestrol. A number of trials have proved this to be

true. It has been established that androgens such as testosterone stimulate protein anabolism in most animals studied. Protein anabolism resulting from testosterone injections is evidenced by reduced urinary nitrogen excretion and increased nitrogen retention. The effects of testosterone on protein anabolism are shown when the diet is adequate in protein, but increases in protein in the diet above optimum levels does not lead to greater nitrogen retention as a result of testosterone treatment (N.R.C., 1959).

Females show a greater response to androgens than males in growth rate, feed efficiency and in nitrogen retention (Burris et al., 1952). Six steers and six heifers were injected weekly with 1 mg. per kg. of body weight of testosterone in the form of aqueous suspension of micropellets. The testosterone injections increased the rate of gain of the heifer calves 0.5 lb. and the steer calves 0.1 lb. per day. Treated heifers required 120 lb. less TDN per 100 lb. gain than nontreated heifers.

Klosterman et al. (1958) conducted four experiments using implants of diethylstilbestrol, testosterone and combinations of the two on fattening steers and heifers. A total of 172 heifers and 75 steers were used. Diethylstilbestrol was implanted in pellet form and testosterone in a paste-type carrier. Testosterone implants of 240-400 mg. per head significantly increased growth rate of heifers over controls, but 240 mg. had no apparent effect on steers.

Temporary growth stimulation along with increased daily feed consumption was reported by Dinusson et al. (1950) in beef heifers

receiving an intramuscular injection of 50 mg. of testosterone propionate in oil, followed by a second injection of 32.5 mg. of testosterone propionate 56 days later. Average daily gain and efficiency of feed utilization were not significantly different from those of control calves.

Testosterone administration usually causes no severe side effects; however, treated animals may show definite changes in body proportions. Fat deposition is reduced and muscle production is increased which lends to a meatier carcass, but a reduction in dressing percent and a slightly lower carcass grade.

Heifers treated with levels of testosterone which produce significant increases in weight gain quite often show secondary masculine sex characteristics (Burris et al., 1954; N.R.C., 1959). They may develop crests, a coarse bellow, the desire to mount, a yellowish color of the white hair areas and curly hair similar to normal bulls. The development of these various masculine characteristics in testosterone-treated calves is indicative of the androgenic activity of this substance.

Testosterone injections can partially or completely inhibit ovulation. After injections are discontinued, animals return to normal and settle quite readily (Berry et al., 1958). These researchers implanted two age groups of 12 heifers each with 0, 100, 1,000 and 10,000 mg. of testosterone propionate. One group was implanted at 1 week of age and the other at 6 months of age. The 10,000-mg. level suppressed follicular development of the ovaries throughout a 6-month

period. All levels depressed follicle development for the first 30 days, but animals on the 100 and 1,000 mg. levels resumed follicular growth before slaughter. Only 10,000 mg. suppressed uterine development. The most noticeable difference in carcass values was a marked decrease in percent of carcass fat. No testosterone residue could be detected in the meat of animals receiving the highest level of 10,000 mg.

Some of the research with testosterone has indicated that the hormone may have some advantages over estrogens when administered to feedlot heifers. Results in some instances would appear to justify more attention than it has received in the past. Levels required for effective growth stimulation and cost of the material appear to be limiting factors at present.

Response of Heifers to Combinations of Estrogens and Testosterone

Some experiments have been conducted where the effects of estrogens and testosterone combinations were tested with heifers. A product is available commercially which has a combination of an estrogen and testosterone or progesterone. Synovex is the trade name for this combination of hormones prepared in pellet form for implanting cattle and sheep. The composition of the implants differs for use on heifers, steers or lambs. They are designated as Synovex-S for steers, Synovex-H for heifers and Synovex-L for lambs. One implant treatment consists of eight pellets which contain 200 mg. progesterone and 20 mg. estradiol benzoate for steers and 200 mg.

testosterone propionate and 20 mg. of estradiol benzoate for heifers. The implant for lambs is the same as for steers only at one-eighth the dose and is given to both ewes and wethers.

Klosterman et al. (1958) reported the results of implanting a male and a female hormone in cattle. Four experiments were conducted using implantations of diethylstilbestrol, testosterone and combinations of the two on fattening steers and heifers. Diethylstilbestrol was implanted in pellet form and testosterone in a paste-type carrier. Implantations of DES (36-72 mg. per head) significantly increased rate of gain in steers and heifers. Testosterone implantations of 240-400 mg. per head significantly increased growth rate of heifers. A combination of diethylstilbestrol and testosterone implanted in heifers produced gains greater than those obtained from either one alone and approached the response from DES in steers. DES tended to lower slightly the grade of steer carcass, but neither DES or testosterone appeared to affect heifer carcass grade. No severe side effects, such as prolapse of the vagina, were noticed in the treated animals.

Richardson et al. (1958) compared the effects of low level (12 mg.) implanting of diethylstilbestrol with Synovex-H-7 (combination of 100 mg. testosterone propionate and 20 mg. estradiol benzoate) on heifers being fattened for slaughter. The level of testosterone used in this early trial was not as high as the present implant preparation on the market. There were no noticeable side effects from either of the implants; neither was there any unusual behavior on the part of any of the heifers. Animals receiving the

DES implant gained an average of 0.27 lb. faster than the controls, while the ones receiving Synovex-H-7 gained 0.13 lb. faster than the controls.

Whetzal et al. (1965) compared heifers implanted with Synovex or diethylstilbestrol with controls using 25 head per lot of similar breeding and fed under similar conditions. DES was implanted initially at 24 mg. and Synovex-H at the recommended level (200 mg. testosterone propionate and 20 mg. estradiol benzoate). The cattle implanted initially were reimplanted with the same levels after 155 days on trial. After 250 days on trial, the increase in weight gains from DES and Synovex were 4.0 and 8.0%, respectively for these compounds. Feed requirements were decreased 3.5% with Synovex and increased 3.5% with DES. Carcass grades and other carcass characteristics did not show any differences due to the implant treatments.

Only a small amount of research has been published where Synovex-H, or other combinations of estrogens and testosterone, have been compared with diethylstilbestrol or testosterone for feedlot heifers. Available results do not justify any conclusion concerning levels of compounds and comparative effects. This would appear to be an area justifying additional research.

Response of Heifers to Melengestrol Acetate

Studies have been conducted with various estrogens and androgens for improving feedlot performance of heifers. Progestogens have, however, not been considered anabolic for heifers and only recently

have potent and orally-active synthetic progestogens become available. Progesterone has been used in the Synovex implants for steers but not for heifers.

One orally-active progestogen is melengestrol acetate, commonly referred to as MGA. This new synthetic hormone is being tested for use as a feed additive for feedlot heifers. MGA prevents estrus in heifers. It was originally thought that when estrus is prevented, it should minimize riding, restlessness of other animals in the feedlot, maintain regular feed consumption and thereby result in greater gains and improved feed efficiency. These were some of the early objectives of spaying; however, spaying resulted in a decreased rate of gain.

MGA is fed in the daily ration, usually mixed with the protein supplement. The minimal effective dose of MGA to prevent ovulation in heifers has been determined to be in the range of 0.2 to 0.5 mg. daily (Zimbelman and Smith, 1966).

Burroughs (1966) reported the results from an experiment recently conducted at the Iowa station with MGA. The compound was tested at 3 levels (0.20, 0.35 and 0.50 mg. per animal daily) each with 4 lots of heifers over a 5-month feeding period. Response from the three levels of MGA was similar. Liveweight gain was stimulated by an average of 15% and feed efficiency was improved by 9%. Carcasses showed the same trends as diethylstilbestrol feeding--slightly less backfat and slightly more retail meat per 100 lb. of carcass as compared to the control cattle.

Matsushima et al. (1966) have reported the results of four field trials completed in Colorado which involved 2,106 feedlot heifers. One thousand fifty-seven served as controls and 1,049 received MGA. Controls were fed 10 mg. of diethylstilbestrol daily, while the treatment groups received 0.4 mg. of MGA per head daily. With the exception of one trial, it was noted that the heifers fed MGA supplement consumed less feed per head daily. MGA increased gains an average of 4.9% over the controls (DES cattle) in the combined four trials. There was also an improvement in feed efficiency of 6.9% from feeding MGA. No riding was observed in either the MGA or DES group in trials II and III. In trial I, MGA heifers showed no riding, but there was considerable restlessness and riding in the DES group. Occasional riding was noted in both groups in trial IV. Two heifers in the MGA group were removed from the trial due to prolapsed vagina. Four other heifers showed minor relaxation of the reproductive organs. Carcass data indicated the two groups, DES and MGA, to be similar in all respects.

Ray et al. (1966) studied the effect of MGA on rate of gain, feed efficiency and carcass characteristics when fed to spayed heifers, intact heifers and steers. One-half of each group was fed the control ration and the other half received the same ration with MGA included at a rate equivalent to 0.4 mg. per animal daily. The addition of 0.4 mg. of MGA per animal daily had no effect on steer performance. Intact heifers appeared to benefit slightly from MGA, with the gain being 4% greater and feed efficiency improved by 2.5%. Intact

heifers receiving MGA gained almost as fast as steers and were equally as efficient. MGA appeared to have a negative effect on spayed heifers with a 9% reduction in rate of gain and a 5% increase in feed requirements. Intact heifers receiving MGA dressed about 1% higher than the other groups, with small differences observed between the remaining groups. There appeared to be no other carcass difference due to feeding MGA in this trial.

The physiological manner by which MGA exerts its favorable influence upon feedlot heifers is not known, but it may be due to more than a simple quieting effect resulting in less riding in the feedlot. One theory proposed for its physiological action which may have merit is that it stimulates cells within the ovaries to secrete larger quantities of natural estrogens and that these additional natural estrogens behave much like diethylstilbestrol in improving liveweight gains and feed efficiency (Burroughs, 1966; Ray et al., 1966).

This theory is further strengthened by Bloss et al. (1966). MGA treatment of spayed heifers had no significant effect on growth or feed efficiency. Sexually immature heifers also exhibited a lesser response in comparison to mature heifers. A comparison of the weight-gain response of MGA-treated heifers for the first and second period of a 198-day experiment indicated that the response of MGA was more pronounced, relative to control, ($P < .05$) during the final period. On this basis it was concluded that a greater response was obtained as heifers become more mature. These results, along with data on

follicular size, substantiate the hypothesis that MGA causes increased weight gains by allowing continuous endogenous estrogen secretion. However, more research is necessary in order to properly evaluate the benefits of this compound when administered to feedlot heifers.

Affect of Gonadal Hormones on Spayed Heifers

The practice of spaying heifers, as was pointed out earlier, usually results in a decreased rate of gain and increased feed requirements. Published information concerning the effect of administering hormones or hormone-like substances to spayed animals seems to be quite limited. This is probably because the work with spaying was done some time ago and not many hormonal compounds were available at that time.

Diethylstilbestrol fed to spayed heifers increased their gain up to that of the control lots for both wintering and fattening periods in an experiment conducted by Smith et al. (1958). This was in a test to study the effects of spaying, spaying plus DES, nonspaying and nonspaying plus DES on the performance of heifer calves fed a high-roughage ration followed by a fattening ration. For the two phases combined, the performance under all treatments was about the same, with small variations, except for the untreated spayed heifers which were the poorest performers. The authors emphasized the value of diethylstilbestrol for improving the performance of spayed heifers.

Clegg and Carroll (1956) improved the performance of spayed heifers with DES to almost equal the results of equal amounts of DES on intact heifers. Sixty milligrams of DES were implanted in spayed and nonspayed heifers along with spayed and nonspayed controls. The average daily gains on a 65% concentrate to 35% roughage ration were: spayed control, 1.80 lb.; spayed treated, 2.15 lb.; intact control, 1.87 lb.; and intact treated, 2.18 lb. The spayed controls did not exhibit the characteristic reduction in daily gain that is normally associated with spaying. The spayed animals did, however, respond to DES implanting. The increase of 19% compared favorably with a 16% increase from DES for nonspayed animals.

The limited research in this area indicates that spayed and intact heifers respond to diethylstilbestrol resulting in about the same rate of gain. Therefore, spaying does not appear to offer any advantage in gain when heifers are treated with DES. On the other hand, since spaying generally results in a lower rate of gain, it becomes more important that spayed heifers receive DES. The response to androgens by heifers spayed or treated with MGA does not appear to have been investigated.

METHOD OF PROCEDURE

This experiment was conducted to determine the effects of spaying and implanting with diethylstilbestrol and Synovex-H (200 mg. testosterone propionate and 20 mg. estradiol benzoate) on feedlot performance and certain carcass characteristics of heifers. Treatments consisted of a spayed and nonspayed group each with three implant treatments--control, diethylstilbestrol and Synovex-H. The experiment was conducted in two phases--a growing or wintering phase and a finishing phase.

Wintering Phase

The purpose of this phase of the experiment was to obtain heifer calves at weaning, perform the spaying operation, administer initial implant treatments and to winter under uniform conditions prior to initiating the finishing phase of the experiment. Spaying after weaning is a late age in comparison to a common age of a few weeks for castration of male calves. However, this age was considered to be the earliest practical one for spaying in a commercial herd. Records of performance up to at least time of weaning should be used in selecting heifer calves for replacements and herd expansion.

One hundred forty-four heifer calves were purchased for the experiment and wintered at two locations. Ninety-six calves were wintered at the Range Field Station, Cottonwood, and 48 were wintered at the Central Substation, Highmore. Calves for each location were purchased at local auction markets and averaged about 365 and 403 lb.,

respectively, at the two stations. They were purchased between November 19 and December 3 for the Cottonwood station and full-fed prairie hay with a protein supplement until the beginning of the experiment on December 11. The calves were ear tagged and vaccinated against blackleg and malignant edema during this preliminary period. Calves wintered at the Highmore station were purchased on November 12 and handled in a similar manner until starting the experiment on December 17.

Allotment to treatments was at random after stratifying into weight groups on basis of filled weights. A shrunk weight was taken following an overnight stand without feed and water (16-18 hr.) for the initial weight on experiment.

The calves were allotted into lots of 12 each with 8 and 4 lots at the Cottonwood and Highmore stations. One-half of the lots were spayed and four calves from each lot received the diethylstilbestrol or Synovex-H implants or served as controls. This design sacrificed feed consumption and feed efficiency data but was necessary because of space limitations.

Implant treatments were applied about 1 month after starting the trials using 24 mg. of diethylstilbestrol and a total of 200 mg. testosterone and 20 mg. estradiol in Synovex-H. It was intended to spay the heifers soon after allotment. This was done at the Highmore station, but weather conditions prevented the operation for about 6 weeks at the Cottonwood station.

The calves were full-fed prairie hay and a protein supplement. The protein supplement was soybean meal and was fed at 1.5 lb. daily at the Cottonwood station and 2.0 lb. daily at the Highmore station. The amount was varied at the two locations because of the differences in quality of the prairie hay. Hay was weighed and fed daily in amounts to satisfy the calves' appetite and yet prevent excessive waste. Trace mineral salt and dicalcium phosphate was offered free choice. Each was fortified with 1,000 mg. of chlortetracycline and 100,000 I.U. of vitamin A per pound.

Calves at each location had access to sheds with outside lots. The hay was fed once daily inside the sheds and the protein supplement in feed bunks in the outside lots. They were treated for grubs about 2 weeks after the start of the trial. The treatment consisted of a 4 oz. "pour-on" of 1% Vapona solution. Toxic signs of stiffness, scours and swollen eyes were observed in several of the treated heifers. Rapid recovery was shown in all but two at the Highmore station. Since this occurred early in the experiment, replacements were substituted.

The cattle were weighed at 28-day intervals during the trial to follow the progress of their performance. On April 13 and 14, 1965, the wintering phase was terminated and the calves were trucked to Brookings for the finishing phase of the experiment.

Finishing Phase

Upon arriving at the Brookings Experimental Feedlots, the cattle were weighed and allotted into 12 lots of 12 head except for 11 head in two lots since two losses occurred during the wintering trial. Allotment was on the basis of weight, wintering location, spaying and implant treatments. This allotment gave two lots with each implant treatment of spayed and nonspayed heifers for this phase of the experiment.

The lots used in this phase of the feeding trial were paved and measured 24 feet by 32 feet. They were without shelter and equipped with fence-line feed bunks and a water bowl connected to a continuous circulating water system.

The rations were composed of 1 part corn silage (wet basis) to 2 parts corn-protein supplement mixture. The corn-protein supplement mixture consisted of 92.5% rolled shelled corn and 7.5% soybean meal (44% protein). The corn was rolled moderately coarse. Vitamin A and chlortetracycline were added to supply 1,500 I.U. and 6 mg., respectively, per pound of the concentrate mix. The concentrate mix was mixed in a twin spiral mixer in 3,000-lb. batches and stored in bins at the feedlots.

The corn silage was of good quality made from well-eared corn. It was chopped moderately fine and stored in covered concrete stave silos. Trace mineral salt, dicalcium phosphate and ground limestone were offered free choice in a covered mineral feeder.

Representative samples of the rations fed were taken weekly throughout the trial and composited for analysis. Analysis showed the concentrate mixture contained an average of 12.4% protein on a 12% moisture basis. The corn silage contained 67% moisture and average 7.1% protein on a 12% moisture basis.

The cattle were fed once daily in open bunks in amounts to satisfy their appetites, but controlled to prevent excessive accumulation. They were started at a level of 2 lb. of concentrate, 1 lb. of corn silage and 10 lb. of alfalfa hay per head. The concentrate mix was raised 0.5 lb. per head daily with the corn silage being fed at the ratio of one part corn silage to two parts concentrate mix. The alfalfa hay was decreased at the rate of 1 lb. per head daily and eliminated in 10 days.

The cattle were reimplanted with the appropriate implants after 89 days on the finishing trial using the same levels as initially. A number of cases of vaginal prolapse occurred in the last one-half of the finishing phase. All except one case occurred following this second implantation. Some of these were removed from the trial and slaughtered. Others were sutured by a local veterinarian and remained on trial.

The cattle were weighed at 28-day intervals during this phase of the trial as was done in the wintering phase to follow their performance.

Due to the large number of animals on the trial, it was necessary to market the cattle in two groups. One replicate of 65

head was marketed after 188 days on the finishing phase and the other replicate of 71 head was marketed after 195 days. Final filled weights were taken early in the morning prior to being trucked about 75 miles to market. Individual weights were again taken at market for the final shrunk weight of the experiment. Eight heifers had been removed during the experiment. Results for the heifers removed were not included in the performance for the lots. An average amount of feed for each heifer was deducted from that fed to the lot for the time each heifer was in the lot in arriving at the final feed consumption and feed efficiency.

The cattle were followed through the slaughtering process at the packing plant and each carcass tagged. After 24 hr. in the cooler, the carcasses were ribbed and detailed carcass data obtained. Carcass grade, conformation grade, degree of marbling, maturity, estimated percent kidney fat, color score and firmness score were assigned by a federal grader. Tracings were made of the loin eye. Size of the rib eye and the depth of fat covering were determined from these tracings. Cold carcass weight was obtained by deducting 1.75% from the hot carcass weight. Dressing percent was calculated by dividing the cold carcass weight by the market weight.

The loss of a number of animals throughout the trial resulting in unequal subclass numbers necessitated the use of least squares method to compute the analysis of variance on the individual traits analyzed (Harvey, 1960). Feed consumption and feed efficiency data

were determined on a lot basis and were analyzed by conventional analysis of variance (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Wintering Phase

Weight gain data and the statistical analysis for the heifers during the wintering phase of the experiment are presented in tables 1 and 2. They are presented as the combined performance for each treatment at the two locations. Feed data are not presented since the heifers were separated into lots only on basis of spayed and non-spayed animals, and thus feed data are not available for the implant treatments. The wintering trial served primarily as a preliminary period to the finishing trial during which the heifers were spayed, initially implanted and wintered under uniform conditions.

Spaying of nonimplanted heifers resulted in a reduction in rate of gain. The spayed controls gained 0.11 lb. less daily than nonspayed controls, representing a 10.6% reduction in rate of gain. A reduction in gain from spaying was expected and agrees with previous work reported by Gramlich and Thalman (1930), Hart et al. (1940), Dinusson et al. (1950), Smith et al. (1958) and Clanton et al. (1966). The spaying was done, however, to serve as a control and to measure the response when hormones were administered to animals which had their gonadal hormone producing ability removed.

Diethylstilbestrol implants increased rate of gain of both spayed and nonspayed heifers with the response being slightly greater for the spayed group. The spayed heifers implanted with DES gained 0.22 lb. (22.7%) more daily than spayed controls. Nonspayed animals

implanted with DES gained 0.18 lb. (17.3%) more than nonspayed controls.

Synovex-H implants also increased daily gains of the heifers. Those spayed gained 0.21 lb. daily or 22.6% faster than spayed control animals. The response of 0.19 lb. daily or 18.3% over controls shown by nonspayed heifers to Synovex-H was only slightly less than the response shown by the spayed heifers.

The increases in daily gains from diethylstilbestrol and Synovex-H implant treatments were very similar for spayed and nonspayed heifers. The response shown by these calves fed a high-roughage ration to implanting is considered very good. Statistical analysis showed the response to implants to be statistically significant ($P < .05$). While the amount of increase in gain for the implants was similar, the percent increase was higher for the spayed animals. However, the rate of gain was still higher in the nonspayed animals. It would appear that spayed heifers, with or without the diethylstilbestrol or Synovex treatments, do not gain as well as intact heifers under conditions imposed upon them at this stage of the experiment. In addition, losses may result from the spaying operation as encountered in this experiment. There appeared to be essentially no difference between the two implant treatments.

Finishing Phase

Weight Gains

Weight gain data and statistical analysis for the heifers during the finishing phase are presented in tables 3 and 4. Animals

Table 1. Weight gains--wintering phase
(Cottonwood-125 days, Highmore-118 days)

Treatment	No. of heifers	Av. init. wt. lb.	Av. final wt. lb.	Av. gain lb.	Av. da. gain lb.
Spayed					
Control	23[a]	381.4	494.7	113.4	0.93
DES	23[a]	380.7	522.2	141.5	1.15
Syn.-H	24	381.1	520.8	139.7	1.14
Nonspayed					
Control	24	381.4	507.0	125.6	1.04
DES	24	381.6	529.2	147.6	1.22
Syn.-H	24	384.4	533.7	149.3	1.23

[a]One loss due to spaying operation

Table 2. Analysis of variance for weight gains
(Wintering phase)

Source	Degrees of freedom	Mean squares
Replicate	1	.004
Spaying	1	.115
Implant	2	.503*
Replicate X Spaying	1	.027
Replicate X Implant	2	.024
Spaying X Implant	2	.011
Error	126	.064

*($P < .05$)

were removed during the trial as shown in table 3. Results are presented only for the heifers completing the trial. An average feed intake was deducted for feed consumed when an animal was removed.

Weight gains during the finishing phase continued to follow the same trends as during the wintering phase. Spayed animals exhibited a reduced rate of gain. The spayed controls gained 0.29 lb. (13.5%) less daily than nonspayed controls. The decrease in weight gains was not statistically significant but is in agreement with results reported by several researchers previously cited. This lower rate of gain resulted in the spayed control heifers weighing 68 lb. less than nonspayed controls at the time of slaughter.

Heifers gained at a more rapid rate when implanted with diethylstilbestrol. The increase over controls amounted to 0.49 lb. (26.3%) and 0.19 lb. (8.8%) daily for spayed and nonspayed groups. However, rate of gain was essentially the same for the spayed and nonspayed heifers implanted with DES during the finishing phase of the experiment. These results show a greater advantage for DES with spayed animals. On the other hand, there was no advantage in weight gains from spaying when the cattle were implanted with DES. This is in agreement with the wintering phase of the experiment.

A more rapid rate of gain was also obtained from implanting Synovex-H. Heifers spayed and implanted gained 0.39 lb. (20.9%) more than spayed controls. The response from implanting of nonspayed animals in comparison to controls amounted to 0.15 lb. (7.0%) more daily. While the percent response was greater for spayed animals,

Table 3. Weight gains--finishing phase (192 days)

Treatment	No. of heifers	Av.[a] init. wt. lb.	Av.[a] final wt. lb.	Av. gain lb.	Av. da. gain lb.
Spayed					
Control	23[b]	494.7	851.7	357.0	1.86
DES	20[c]	521.0	972.8	451.8	2.35
Syn.-H	23[d]	522.6	952.0	430.4	2.25
Nonspayed					
Control	24	507.0	919.6	412.6	2.15
DES	24	529.2	976.3	447.1	2.34
Syn.-H	22[e]	537.6	978.4	440.8	2.30

[a]Shrunk weights
[b]23 heifers initially
[c]23 heifers initially, 2 removed because of vaginal prolapse and 1 removed because of founder.
[d]One loss, apparently from bloat
[e]Two removed because of vaginal prolapse

Table 4. Analysis of variance for weight gains (finishing phase--192 days)

Source	Degrees of freedom	Mean squares
Replicate	1	.239
Spaying	1	.541
Implant	2	1.325**
Replicate X Spaying	1	.040
Replicate X Implant	2	.001
Spaying X Implant	2	.259
Error	126	.087

**($P < .01$).

rate of gain differed only slightly between those spayed and not spayed as was true for DES implants.

Results of this phase of the experiment show little difference between implants of diethylstilbestrol and Synovex in stimulating weight gains of heifers. While spaying reduced rate of gain of non-implanted heifers, the depressing effect was overcome by either implant. This effect of the implant treatments was statistically significant ($P < .01$).

Feed Consumption and Feed Efficiency

Daily feed consumption and feed efficiency data and statistical analysis are presented in tables 5 and 6.

Feed consumption was less for spayed animals. This reduction occurred for all implant treatments but was slightly greater for the control group. Feed required per 100 lb. of gain was increased for spayed animals only when not implanted. Implanted cattle consuming slightly more feed when not spayed, but making essentially the same rate of gain as those spayed, had slightly higher feed requirements.

Diethylstilbestrol and Synovex-H implants resulted in increases in feed consumption for spayed and intact heifers. This effect of implant treatments was significant ($P < .05$). The increase was greater for spayed than for nonspayed heifers and slightly greater for DES than for Synovex-H.

Feed efficiency appeared to be improved by each of the implant treatments only when administered to spayed heifers. The increase in

Table 5. Feed consumption and feed efficiency (finishing phase--192 days)

	Spayed			Nonspayed		
	Con-trol	DES	Syn.	Con-trol	DES	Syn.
Av. da. ration, lb.						
Corn silage[a]	7.10	7.76	7.60	7.53	7.99	7.93
Corn silage[b]	2.66	2.91	2.85	2.82	3.00	2.98
Corn-prot. suppl.	14.23	15.54	15.24	15.06	16.02	15.90
Alfalfa hay	0.29	0.30	0.29	0.29	0.29	0.31
Total feed[c]	17.18	18.75	18.41	18.17	19.31	19.19
Feed per 100 lb. gain, lb.						
Corn silage[a]	382	331	339	353	346	345
Corn silage[b]	144	124	127	132	130	130
Corn-prot. suppl.	765	662	681	703	693	692
Alfalfa hay	16	13	13	13	12	13
Total feed[c]	925	799	821	848	835	835

[a]Weights based on an "as fed" moisture content.
[b]Weights based on a 12% moisture basis.
[c]Silage on 12% moisture basis.

Table 6. Analysis of variance for feed consumption and feed efficiency (finishing phase--192 days)

Source	Degrees of freedom	Mean squares			
Replicate	1	.0456[a]	0.1282[b]	140.1[c]	752.1[d]
Implant	2	.3728*	1.5712*	772.4*	2951.1*
Replicate X Implant	2	.0074	0.0179	24.3	66.1
Spaying	1	.3536	1.3737	30.1	126.7
Replicate X Spaying	1	.0457	0.2079	0.7	2.1
Implant X Spaying	2	.0146	0.0407	560.3	2394.8
Error	2	.0200	0.0437	63.1	365.1

[a]Mean square for corn silage consumption.
[b]Mean square for corn-protein suppl. mix consumption.
[c]Mean square for corn silage efficiency.
[d]Mean square for corn-protein suppl. mix efficiency.
*($P < .05$)

rate of gain over controls from implanting was greater for the spayed heifers. The lack of any improvement in feed efficiency even with an increase in rate of gain from DES administered to intact heifers has been reported by Whetzal et al., (1966).

Carcass Characteristics

Results and statistical analysis for the carcass characteristics are presented in tables 7, 8 and 9.

Increased rate of gain from implant treatments resulted in heavier cattle at time of slaughter since those on all treatments were marketed at the same time. This is a factor which will have an influence on some carcass characteristics.

Spaying did not appear to affect most carcass characteristics measured. However, the nonimplanted group making the lowest gain had a lower dressing percent and smaller rib-eye area. These reductions are likely a reflection of the lower rate of gain caused by spaying and the lighter weight of this group when marketed. Spayed animals showed a significantly ($P < .05$) higher maturity score indicating a younger animal.

Rate of gain as influenced by implant treatment was reflected in certain carcass characteristics. Cold carcass weight was significantly ($P < .01$) less for nonimplanted animals. This was true for both spayed and nonspayed groups with spayed animals showing the greatest reduction in carcass weight. Implanted groups had a larger rib-eye area than their controls. This would be associated quite closely with the heavier carcasses produced as a result of the

Table 7. Carcass characteristics

Characteristic	Spayed			Nonspayed		
	Con-trol	DES	Syn.	Con-trol	DES	Syn.
Cold wt., lb.	516.0	597.0	587.0	566.0	603.0	600.0
Dressing percent	60.5	61.2	61.6	61.5	61.8	61.4
Conformation score[a]	19.2	20.3	20.3	20.0	22.2	20.5
Marbling score[b]	6.9	6.2	6.3	6.3	6.0	5.5
Carcass grade[a]	20.2	19.9	19.8	20.0	19.6	19.2
Maturity[c]	24.0	23.5	23.1	23.4	23.2	23.0
Est. % Kid. fat	3.2	2.9	2.8	3.3	3.0	3.0
Rib-eye area, $in.^2$	9.57	10.99	11.15	11.05	12.38	11.57
Fat thick., in.	0.65	0.71	0.71	0.69	0.68	0.70
Color of lean[d]	5.4	5.2	5.1	4.9	5.1	4.6
Firmness of lean[e]	5.4	5.4	5.4	5.4	5.3	5.3

[a]Good = 17; Choice = 20. Graded to 1/3 grade.
[b]Moderate, 7; modest, 6; small, 5.
[c]A-, 24; A, 23; B+, 22.
[d]Very lt. ch. red, 6; lt. ch. red, 5; ch. red, 4.
[e]Firm, 6; moderately firm, 5.

Table 8. Analysis of variance for carcass characteristics

Source	d.f.	Mean squares					
		Cold carc. wt.	Dress %	Conform score	Marb. score	Carc. grade	Maturity
Replicate	1	10551	0.2114	3.9116	2.325	0.3585	6.2137
Spaying	1	20289	6.4523	2.3311	10.431	5.8793	3.7296*
Implant	2	47542**	3.4122	8.2766*	6.145**	3.7048	5.3570
Replicate X Spaying	1	1092	2.7088	0.7335	2.887	0.9089	0.0062
Replicate X Implant	2	287	1.6511	0.1054	0.038	0.2647	2.2814
Spaying X Implant	2	5946	4.1338	2.3129*	1.262	0.6257	0.7818
Error	126	3431	2.3188	0.7232	1.823	1.2946	0.4258

*($P < .05$)

**($P < .01$)

Table 9. Analysis of variance for carcass characteristics

Source	d.f.	Mean squares				
		Est. % kid. fat	Rib-eye area	Fat. thick.	Color lean	Firmness lean
Replicate	1	0.5038	0.748	.0310	0.8856	.0069
Spaying	1	0.7947	29.646	.0003	4.0051	.2947
Implant	2	1.8085*	19.085	.0152	1.0498	.1082
Replicate X Spaying	1	1.2979	0.338	.0403	0.03382	.5672
Replicate X Implant	2	0.0941	1.600	.0239	1.5968	.1238
Spaying X Implant	2	0.8020	3.260	.0159	0.8636	.1175
Error	126	0.2146	1.283	.0340	0.4249	.3861

*($P < .05$)

increased growth rate due to implant treatment. Conformation score was significantly ($P < .01$) higher for the implanted animals; however, over-all carcass grades appeared to be slightly less than or nearly equal to the controls. Implanted heifers had slightly lower maturity score indicating older animals, even though the animals on all treatments were about the same age.

Fat content of the carcasses appeared to be reduced by implant treatment. Marbling score was significantly ($P < .01$) higher for the control groups than the implanted groups. Estimated percent kidney fat was also significantly ($P < .05$) higher for the control animals. External fat covering, as measured over the rib eye at the 12th rib, appeared to be about equal for all groups. However, if this were adjusted to an equal carcass weight, the control groups would show a heavier fat covering. Color and firmness of the lean appeared to be about equal for all treatments.

Incidence of Vaginal Prolapse

A considerable amount of trouble was encountered in this experiment from vaginal prolapse. The condition was encountered for the most part during the last 2 months of the experiment. Only one heifer was affected before being reimplanted with diethylstilbestrol or Synovex-H. This problem was encountered only with implanted heifers but in both spayed and nonspayed groups.

Vaginal prolapses were encountered in seven spayed heifers implanted with diethylstilbestrol with two of these being removed from the experiment. Three nonspayed heifers implanted with DES

were affected. In the Synovex group, the problem was encountered in two spayed heifers and six nonspayed heifers. Two of these were removed from the experiment. Others exhibiting this condition were left on trial and marketed with the rest of the animals. Some of these cases required the care of a veterinarian in which the prolapse was replaced and the vulva sutured. This procedure did not appear to influence the performance of the particular animals involved. However, this is a rather troublesome problem for the person feeding heifers.

A problem with vaginal prolapse has been reported by some researchers but not by others. However, results of this trial show that it can be a serious problem at times, and it could offset beneficial effects obtained in gain and feed efficiency. It likely will be a lesser problem if implant treatment is administered over a shorter period of time such as only during the finishing phase.

SUMMARY

The objectives of this experiment were to test the effects of spaying and of implanting with diethylstilbestrol or Synovex-H on feedlot performance and certain carcass characteristics of heifers. The treatments consisted of a spayed and nonspayed group each with three implant treatments--control, diethylstilbestrol (24 mg.) and Synovex-H (200 mg. testosterone and 20 mg. estradiol). The experiment was conducted in two phases--a growing or wintering and a finishing phase.

One hundred forty-four heifer calves were purchased and wintered at two locations. They were stratified on basis of weight and randomly lotted to treatments. One-half of the heifers were spayed and the initial implants administered early in the wintering phase of the experiment. Rations fed were prairie hay ad libitum and a protein supplement.

After 118 and 125 days at each location, the calves were moved to a feedlot for the finishing phase of the experiment. A high-concentrate ration of corn, corn silage and protein supplement was fed for an average of 192 days. They were reimplanted with the appropriate implants after 89 days on the finishing trial using the same levels as initially.

Spaying of nonimplanted heifers resulted in a reduction in rate of gain. Spayed controls gained 10.6% and 13.5% less than nonspayed controls during the wintering and finishing phases. Feed data were not available for spayed and nonspayed groups during the wintering

phase. Feed required per 100 lb. gain was increased 9.1% for spayed controls over nonspayed controls during the finishing phase.

The lower rate of gain resulted in the spayed control heifers weighing 68 lb. less than nonspayed controls at the time of slaughter. Spaying did not appear to affect most of the carcass characteristics measured except the nonimplanted group making the lowest gain had a lower dressing percent and a smaller rib-eye area. Carcasses from spayed animals were scored significantly ($P < .05$) younger.

Response to the two implant treatments was very similar both for spayed and nonspayed groups. Implanting with diethylstilbestrol or Synovex-H significantly ($P < .05$) increased rate of gain during the wintering phase. The response to the implants was slightly greater for the spayed group, but they still gained less than those not spayed. The increase in weight gains over controls was 22% for the spayed group and 18% for the nonspayed.

Weight gains during the finishing phase continued to follow the same trends as during the wintering phase. Increases in rate of gain amounting to 23.6% and 7.9% ($P < .01$) from implanting spayed and nonspayed heifers were obtained with the rate of gain being essentially the same for both groups when implanted. Implants resulted in significant ($P < .05$) increases in feed consumption. Feed efficiency was improved by the implant treatments when administered to spayed heifers but little or no improvement was noted on nonspayed heifers.

Increased growth rate resulted in implanted cattle producing significantly ($P < .01$) heavier carcasses with a larger rib-eye area.

Conformation score was significantly ($P < .01$) higher for the implanted cattle with the over-all carcass grades being about the same for all treatments. Implants appeared to lower fat content of the carcass. Marbling score and estimated percent kidney fat were significantly ($P < .01$) higher for control animals, but fat covering over the 12th rib appeared to be about equal for all groups.

Considerable trouble was encountered from vaginal prolapse with both diethylstilbestrol and Synovex-H implants and with spayed and nonspayed heifers. In view of this and the small effects on feed efficiency and carcass value, the economic value of these implant treatments appears questionable for heifers when administered after weaning and again during drylot finishing as in this experiment.

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