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ABSTRACT

CANTO, ACILINO DO CARMO. Melengestrol Acetate and Diethylstilbestrol for Heifers Finished with Grain on Pasture. (Under the direction of MILTON BEE WISE).

An experiment was conducted to study the effects of (1) Melengestrol acetate (MGA), (2) Diethylstilbestrol (DES), and (3) Clover-grass versus Nitrated grass pastures on performance, carcass characteristics, and certain reproductive phenomena of beef heifers self-fed a grain-fat mixture on pasture. The basal ration consisted of 90% ground shelled corn plus 10% animal fat and was supplemented with minerals and an antibiotic. Treatments were: (A) nitrated grass with no hormone; (B) nitrated grass with 12 mg. DES implanted; (C) nitrated grass with 0.4 mg. MGA per head daily in the concentrate; (D) clover-grass with no hormone; and (E) clover-grass with 12 mg. DES implanted. Forty-eight Hereford heifer calves averaging approximately 588 pounds initially were assigned to three pasture plots with 16 animals per plot and fed *ad libitum* for a period of 169 days.

MGA increased gains an average of 0.32 pounds per day ($P < .01$) as compared to control heifers (A), but gain was not significantly increased over DES-treated heifhers (B).

DES-treated heifers gained significantly more ($P < .05$) than control heifers (A). Heifers grazing the clover-grass pastures gained 0.41 pounds more ($P < .01$) than the nitrated grass pasture groups. Heifers attaining the greatest gains consumed the least amount of concentrate and made more efficient use of the concentrate. Concentrate intake and efficiency of concentrate utilization were slightly increased in the MGA-treated heifers as compared to the control group (A). No significant effects of MGA and DES treatment were observed on carcass characteristics. The clover-grass groups had significantly ($P < .01$) thicker rinds and dressed significantly ($P < .01$) higher than the nitrated grass groups but no significant differences were observed in other carcass traits.

MGA effectively prevented estrus in 15 out of 16 heifers. MGA, DES and clover stimulated mammary development significantly ($P < .05$). MGA-treated heifers had significantly ($P < .01$) heavier ovaries. No difference was observed in the number of follicles 12 mm. and larger and the number of corpora lutea.

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MELENGESTROL ACETATE AND DIETHYLSTILBESTROL FOR
HEIFERS FINISHED WITH GRAIN ON PASTURE

by

ACILINO DO CARMO CANTO

A thesis submitted to the Graduate Faculty of
North Carolina State University at Raleigh
in partial fulfillment of the
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Master of Science

DEPARTMENT OF ANIMAL SCIENCE

RALEIGH

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To my parents, for their continuous encouragement, this thesis is gratefully dedicated.

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INTRODUCTION

Heifers accounted for about one-third of the total fed cattle slaughtered in the United States in 1967. While fed cattle marketings have risen in recent years, the number of yearling steers on hand has been relatively stable (there were 12.6 million beef steers on farms on January 1, 1968 - about 0.1 million head less than four years earlier), however, the number of beef heifers on farms rose 0.7 million head to a total of 9.3 million at the beginning of this year (Livestock and Meat Situation, 1968).

Many cattle feeders discriminate against heifers for fattening because of the disturbance caused by estrus. One estrous animal can adversely affect an entire group and may contribute to reduced performance in the feedlot. Sexual receptivity also produces a stress period of two or more days during which the estrous animal does not feed properly, is restless and disturbed, with the result that weight gain and feed efficiency are likely reduced during this time. Another objection of the feeders is that heifers for fattening purposes sell for less than steers of the same weight and quality.

The packers objections are that heifers have a lower dressing percentage and more fat trim when the carcasses are processed.

Since an increasing portion of the beef consumed in the U. S. is being derived from heifers, intensive work is being done with the purpose of evaluating methods of increasing efficiency of beef production from heifers.

As a means of improving gains and feed efficiency in feedlot heifers, a simple, economical, non-surgical method of inhibiting estrus has been sought. During the past decade attention has been directed toward the use of hormone or hormone-like compounds for improving the performance of feedlot cattle. As reviewed by the National Research Council (N.R.C., 1966), numerous studies have been conducted with various estrogenic and androgenic compounds, however, little attention has been given to the possible use of progestogen compounds. This may be due to the fact that the progestogens have not generally been considered anabolic, and only recently have potent and orally synthetic progestogens become available. Theoretically oral progestogens offer a means of producing the tranquil behavior characteristic of gestation, but without the lowered dressing percent and other objectionable features of pregnancy. It was also postulated that elimination of the stress of cyclic heat, together with the uninterrupted influence of endogenous estrogens of intact animals, for the protein anabolic effect, could produce gains and feed conversion in heifers more nearly equal to those of fattening steers.

This experiment was conducted to study the effect of:

(1) melengestrol acetate (MGA), a newly developed orally-active progestogen agent,

(2) diethylstilbestrol (DES), an estrogenic substance, and

(3) nitrated grass *vs*. clover-grass pastures

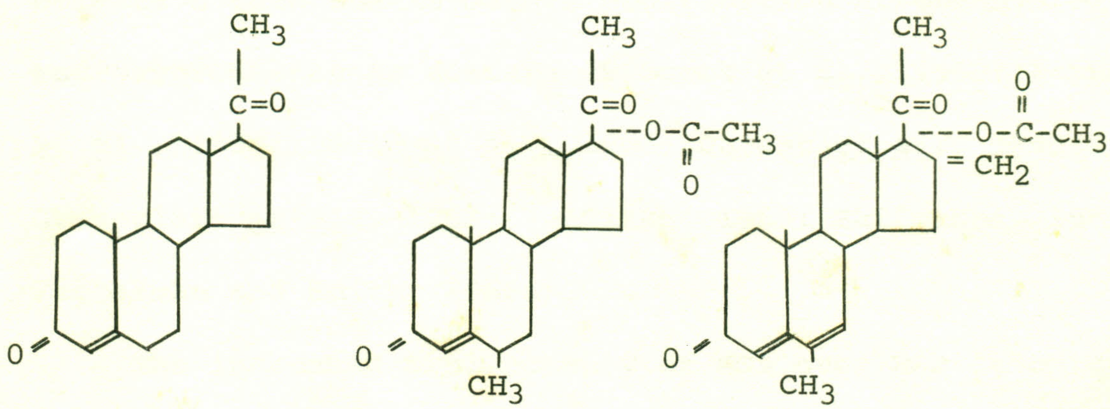
on performance, carcass characteristics and certain reproductive phenomena in beef heifers self-fed a grain-fat mixture on pasture.

REVIEW OF LITERATURE

Chemistry of MGA

The chemical formula of melengestrol acetate (MGA) has been established as $C_{25}H_{32}O_4$ with a molecular weight of 396 (MGA Technical Manual, 1966).

The compound has been described as a white to yellowish-white crystalline powder, non-hygroscopic, soluble in most organic solvents such as benzyl-alcohol, dimethylacetamide and chloroform, and almost insoluble in water (0.0054 mg. per ml.). Its structural formula is 17-acetoxy-6-methyl-16-methylenepregna-4, 6-diene-3, 20-dione. Structurally, melengestrol acetate is closely related to both progesterone, the naturally occurring steriod produced by the corpus luteum, and to medroxyprogesterone acetate (MAP), a compound used in synchronizing estrus in cattle, as shown in Figure 1.



Progesterone   Medroxyprogesterone acetate (MAP)   Melengestrol acetate (MGA)

Figure 1. Chemical structures of some progestogens

Mode of Action of MGA

The biological action of MGA closely resembles that of progesterone and MAP. The unique advantage of MGA over the other progestogens is its apparently high biological potency in ruminants, especially when administered orally.

It is generally regarded that progesterone is essentially ineffective when administered orally. If this is true, then the oral activity of MAP must be due to either the addition of the 6α-methyl group or the 17α-acetoxy group, or a combined effect of the two. The differences in biological potency due to structural differences between MAP and MGA have been studied. The 6-dehydro and the 16-methylene modifications each increase oral activity several fold, with the greatest increase resulting from the 16-methylene substitution. The later modification is also more effective than the 16-methyl modification of 6-dehydro-medroxyprogesterone acetate (Babcock *et al.*, 1958; Barnes *et al.*, 1959; David *et al.*, 1963; Duncan *et al.*, 1964; Greenblatt *et al.*, 1963; VanBlake, 1963; Zaffaroni, 1960; Zimbelman and Smith, 1966a).

The increased oral potency of MGA over MAP is unique to ruminants. Biological evaluation in laboratory animal tests indicated only a two to four fold increase in potency

(Duncan *et al*., 1964). In cattle, given orally it was found to have 300 to 900 times the potency to inhibit ovulation and in sheep at least 150 times (Zimbelman, 1963b).

In deference to biological potency, the modes of biological activity of progesterone, MAP and MGA are believed to be similar.

In a normal estrous cycle, release of the follicle stimulating hormone (FSH) which is produced by the anterior pituitary causes growth and development of ovarian follicles. The follicles are surrounded by a layer of theca interna cells, to which has been attributed estrogen production. In turn, these estrogens stimulate the onset of estrus, the receptive period, which lasts for about 10 to 18 hours in the heifer. As the level of estrogens increases the level of FSH decreases and the level of luteinizing hormone (LH) from the anterior pituitary increases. About 10 to 12 hours after the end of estrus, ovulation of a mature follicle occurs under the influence of the high level of LH, which also initiates the growth of the luteal tissue to form the corpus luteum. The corpus luteum serves as a transitory gland and is formed by hypertrophy and hyperplasia of the granulosa cells in the cavity formed by the rupturing of the follicle. Under the influence of LH, the corups luteum begins secreting progesterone. This hormone inhibits the maturation of follicles and stimulates uterine changes so that the organ becomes capable of receiving and nourishing the potentially fertilized ovum. If conception occurs, the corpus luteum remains active throughout the greater portion of gestation; if conception does not occur, the corpus luteum remains active for approximately 17 to 19 days, after which time regression occurs. Simultaneously, follicular development progresses rapidly, and the cycle is repeated.

The basic interaction between the pituitary and the ovary are shown in a somewhat oversimplified form in Figure 2 (Hansel, 1961).

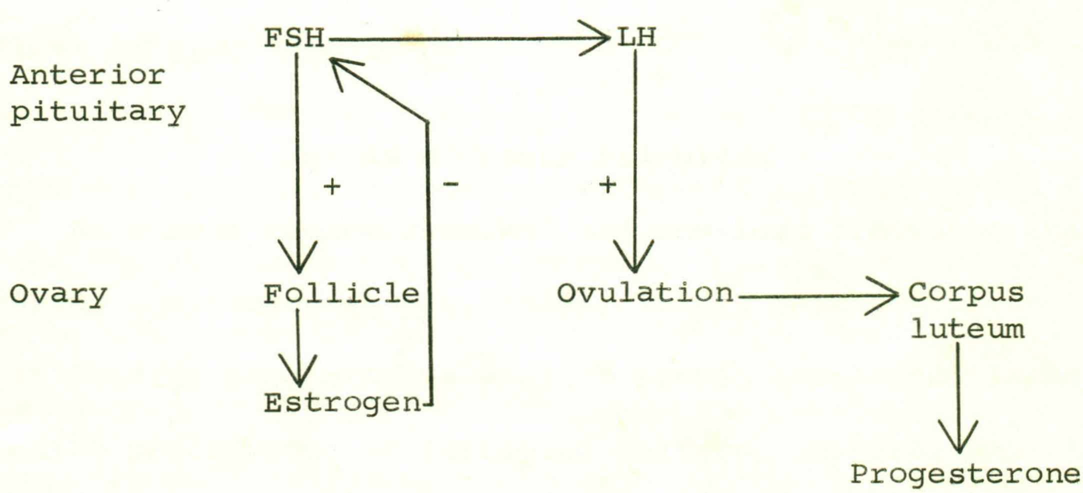


Figure 2. Interrelations between the anterior pituitary and ovary (Hansel, 1961)

Administration of progestogens interrupts this normal estrous cycle (Ulberg *et al*., 1951). Production of FSH by the anterior pituitary, however, is apparently not completely inhibited since mature follicles are found in the ovaries of treated heifers (Zimbelman and Smith, 1966b). In fact, progestogen treatment allows the development and persistence of follicles which are typical of the mature follicle. It is theorized that these persisting mature follicles result in significant levels of a rather constant amount of estrogen production. This estrogenic state is believed to be the reason for the improvement in rate of gain and feed utilization in MGA treated heifers. This is further evidenced by the lack of response of steers and spayed heifers to MGA (Bloss *et al*., 1966).

MGA as a Growth Stimulant

As a more economic method and one less traumatic than spaying (Dinusson *et al*., 1950), it has been postulated that feeding progestogens would suppress estrus and improve feedlot performance of fattening heifers. Several experiments have confirmed this theory.

Bloss *et al*. (1966) conducted several experiments to study the effects of one of these new-orally active progestogens, MGA on the feedlot performance of heifers.

Increased gains and feed efficiency were reported in MGA-treated heifers compared to controls. Sexually mature heifers from which ovaries were removed and which received MGA within the apparent optimal dosage range, showed no improvement in weight gains or feed efficiency. However, intact heifers receiving 0.4 milligrams of the hormonal substance per animal daily were reported to gain almost as fast as steers, and to be equally as efficiency (Ray et al., 1967).

Burroughs et al. (1966) reported that the feeding of MGA at levels of 0.2, 0.35 and 0.5 mg. per head per day to non-pregnant heifers during a five-months finishing period, resulted in 5% greater feed consumption, 15% greater liveweight gains ($P < .05$) and 9% better feed conversion as compared with control heifers. Also, feedlot performance of heifers receiving the three levels of MGA compared favorably with one another and similarly to heifers fed diethylstilbestrol (DES).

Newland and Henderson (1966) reported a significant ($P < .05$) increase in liveweight gains over stilbestrol-treated heifers, when heifers received 0.35 mg. of MGA daily in the feed.

Matsushima _et al_. (1966) reported a series of three tests involving some 1,520 feedlot heifers, with 764 serving as controls (received 10 mg. of stilbestrol per head per day) and 756 heifers receiving 0.4 mg of MGA per head daily in the feed. They stated that the MGA-treated heifers gained from 6% to 15.2% more than the control heifers and averaged 12 pounds more gain. They also reported that heifers receiving MGA were from 3 to 18% more efficient in utilizing feed.

Young _et al_. (1967) reported a slight but non-significant ($P < .05$) improvement in total gain, average daily gain, and feed efficiency when heifers received 0.20, 0.40 and 0.60 mg. of MGA per head daily. Average daily gain for control heifers was 0.85 kg., while the 0.20, 0.40 and 0.60 mg. levels averaged 0.88, 0.86 and 0.84 kg. per head daily, respectively. This indicates that the possible optimum level would be between 0.20 and 0.40 mg.

O'Brien and Baumgardner (1967) and O'Brien _et al_. (1968) studying the effect of MGA on the growth and reproductive physiology of fattening heifers reported that the feeding of 0.3 mg. of MGA per head per day significantly ($P < .01$) improved rate of gain during a 140-day feeding period. It was calculated to be an increased gain of 21%

over the controls. They also reported an improvement of 11% in feed conversion in heifers receiving the MGA treatment.

It has been theorized that MGA and DES have an additive effect when fed together. Experiments conducted by Henderson (1967) show that the two hormones (MGA and DES) fed together increase daily gains in heifers as much as the total increase of the two fed separately. Henderson reported that heifers receiving no hormones gained 2.05 pounds daily; those fed DES alone gained 2.21 pounds; those fed only MGA gained 2.30 pounds; and those heifers getting both DES and MGA gained 2.40 pounds daily. Similar trials conducted with steers showed no effect from MGA when fed separately or in combination with DES.

Differences among untreated controls, MGA, and DES treated heifers, with respect to carcass characteristics, have been shown to be relatively small, with some groups showing slight but not significant superiority in some but not all respect. These results, at this time, suggest little or no drug related effect (Bloss et al., 1966; Newland and Henderson, 1966; Burroughs et al., 1966; Matsushima et al., 1967; Young et al., 1967; Ray et al., 1967; O'Brien, 1967b; O'Brien and Baumgardner, 1967; O'Brien et al., 1968).

Control of Estrus and Ovulation with MGA

The treatment of prepuberal females with melengestrol acetate (MGA) has been shown to improve growth response and feed efficiency slightly, however, this improvement was much less than in puberal animals (Bloss *et al.*, 1966). This suggests that increased growth and improved feed conversion of heifers fed MGA may be a joint effect of relief from the stress imposed by estrus, plus an uninterrupted supply of endogenous estrogen from large and persistent ovarian follicles (O'Brien *et al.*, 1968).

The effects of MGA on reproductive characteristics have been studied. It has been reported that treatment of steers, heifers and bulls with diethylstilbestrol (DES) caused an increase in size of the adrenal gland (N.R.C., 1966). Adrenal weights of heifers treated with MGA were increased when ovaries were present (Zimbelman and Smith, 1966b). Adrenal weights of intact heifers receiving 0.44 mg. daily were significantly ($P < .05$) greater than those of spayed heifers at the same dose, indicating that ovaries are necessary for increased adrenal size. When adrenal weights were converted to a basis of grams per unit of carcass weight, differences between groups were no longer significant (Bloss et al., 1966). They suggested that the greatest portion of the increased adrenal weight was related to increased body size and not to a more specific effect on the adrenal gland. Since estrogens in cattle have been shown to increase adrenal size (N.R.C., 1966), this also is suggested as evidence of increased follicular size (Bloss *et al.*, 1966). Another indication of increased estrogenic secretion by these persisting follicles was an increased tendency for cervical mucous smears to show a typical fern pattern (Zimbelman, 1965; and Zimbelman and Smith, 1966b).

Even though the various responses discussed have indicated evidence of hyperestrogenicity, the animals did not present signs of estrus during the feeding period. Also, no gross changes in general body conformation and no vaginal prolapses, as noted in estrogen-treated heifers (N.R.C., 1966), have been reported in MGA treatment of heifers (Bloss *et al.*, 1966).

Suppression of ovarian cycles by injecting progesterone for two to three weeks was demonstrated in the ewe by Dutt and Casida (1948) and in the cow by Ulberg *et al.* (1951).

Dutt and Casida (1948), O'Mary *et al.* (1950), Robinson (1956, 1960), Denny and Hunter (1958), Braden *et al.* (1960), Wagner *et al.* (1960) and Lishman and Hunter (1961) have demonstrated that five to 10 mg. of progesterone in oil, per head daily, will suppress estrus in ewes during the breeding season.

Ulberg _et al_. (1951) gave different amounts of progesterone in oil subcutaneously to heifers for periods ranging from one to 28 days. Doses of 3.125 and 6.25 mg. per day did not suppress follicular development and estrus, whereas doses of 12.5 mg. and greater did suppress these phenomena. The size of the follicles at the time of the last injection of progesterone was influenced by the dosage level. While 50 mg. per day was injected, follicles were not greater than one to 1.5 cm. in diameter. However, after 12.5 mg. doses, follicles up to three cm. in diameter were observed. Lamond (1964) reported the same effects in beef heifers. Effective suppression of estrous cycle was accomplished by Ulberg and Lindley (1960) with 12.5 mg. of progesterone daily; by Avery _et al_. (1962) with 50 mg. of progesterone daily; and by Lamond (1962, 1964) with doses varying from 50 mg. every two days to 20 mg. daily.

During the last decade several experiments have been conducted on the use of progesterone analogues, especially those that can be given orally, in suppressing ovarian cycles. The materials are thought to inhibit ovulation in a manner similar to progesterone.

Hansel et al. (1961) obtained suppression of estrous cycles in Hereford cows with 0.5 to 1.0 grams of MAP per cow per day. Anderson et al. (1962) and Zimbelman (1963a) found that doses of 150 mg. of MAP per cow per day were satisfactory in heifers.

VanBlake et al. (1963) fed another progestational compound, 6-chloro-Δ-dehydro-17-acetoxyprogesterone (CAP), to dairy heifers and cows, and obtained satisfactory estrus suppression. In heifers fed 12 mg. per head daily, estrus did not occur until six to nine days after the final feeding.

Melengestrol acetate (MGA) has been reported to inhibit estrous cycles and ovulation in heifers when administered intravenously at doses of 0.4 mg. per head per day (Zimbelman and Smith, 1966a). Daily oral doses ranging from 0.15 to 8.0 mg. per head per day have been reported to inhibit both estrus and ovulation in ewes (Zimbelman, 1963a; O'Brien, 1967a; O'Brien and Miller, 1967) and in heifers (Zimbelman and Smith, 1963; Darwash et al., 1965; Zimbelman and Smith, 1966a, b; Burroughs et al., 1966; Newland and Henderson, 1966; Matsushima et al., 1966; Bloss et al., 1966; O'Brien, 1967b; O'Brien and Baumgardner, 1967; Ray et al., 1967; and O'Brien et al., 1968).

Follicular growth of heifers fed MGA, based on palpation and measurement at slaughter have been reported by Zimbelman and Smith (1966b). These data indicated that heifers treated with MGA had significantly ($P < .05$) greater amounts of follicular fluid during the period of ovulation inhibition than did heifers which represented various stages of the normal estrous cycle. This was later confirmed by Young et al. (1967), who reported that follicular fluid expressed as a percentage of total ovarian weight was significantly ($P < .01$) increased from 32.8% for the controls to 54.9%, 51.1% and 52.2% for the 0.20, 0.40 and 0.60 mg. groups, respectively. Also, follicular development appeared to be greatest within the same dosage range at which maximum weight gain stimulation was achieved (Zimbelman and Smith, 1966b). Data have also been reported by Zimbelman (1965) on the follicular development of heifers during a 100-day (or longer) period following a single injection of MAP. These data also indicate that significant follicular development occurred and that there was an increased relationship between the percent of a group with corpora lutea and the percent with a detectable follicle.

O'Brien et al. (1968) reported that MGA-treated heifers had heavier ovaries, but the total number of Graafian follicles was not significantly increased over controls. However, follicles 12 mm. and larger in diameter were more numerous ($P < .01$) in the MGA-treated groups. Sixteen of 32 treated heifers had from two to five follicles each which were 12 mm. or larger.

Young *et al.* (1967) reported that significant increases in weight of the reproductive tracts ($P < .01$) and ovaries ($P < .05$) were observed in heifers treated with MGA.

O'Brien and Baumgardner (1967) reported that heifers fed MGA had 1.71 percent more follicles per ovary (21.97 versus 21.60); 80 percent ($P < .01$) more follicles 12 mm. and larger per ovary (0.81 versus 0.45); 15.9 percent larger ovaries (7.37 versus 6.20 gm.); and 74.53 percent fewer corpora lutea per ovary (0.15 versus 0.58) in comparison to the negative controls.

Zimbelman and Smith (1966b) also reported that as the incidence of a detectable corpus luteum decreased from 76% to 10%, the incidence of a detectable follicle increased from 56% to 91% in MGA-treated heifers.

Clover-Grass versus Nitrated-Grass Pastures

Several studies have been conducted to evaluate the utilization of grass-legume and nitrogen-fertilized grass pastures for finishing beef cattle.

Mott et al. (1952) found that steers grazing birdsfoot trefoil-bluegrass pastures averaged 37 pounds more liveweight gain per acre than steers on nitrogen-fertilized bluegrass pasture. Blaser et al. (1956) reported higher average daily gains from legume-grass pastures but obtained higher beef gains per acre from nitrated-tall fescue. Duncan et al. (1958) reported a 66 pounds liveweight gain per acre on a nitrated-grass-legume pasture over grass-legume pasture. Heinemann and VanKeuren (1958) also reported higher steer gains per acre from legume-grass pastures as compared to nitrogen-fertilized grass pastures on irrigated land under Washington conditions. They also reported that the grass-legume cattle attained a nine percent higher appraisal value off pasture and graded half a grade higher than the grass cattle which graded standard with very few grading low-good.

Sullivan et al. (1959) reported an increased beef yield per acre on grass-legume pastures under grazing; however, the total beef yield per acre from forage alone was higher for grass swards fertilized with nitrogen. Grass-legume tended to produce slightly higher gains per animal than nitrated-grass pastures. Steers on nitrated-grass pastures produced carcasses of slightly inferior grade than those on grass-legume pastures. Steers on grass-legume pastures had also a higher dressing percentage than those on nitrated-grass pastures.

Research at the North Carolina Agricultural Experiment Station (Wise et al., 1965) has demonstrated that a satisfactory way to increase returns from a cattle fattening program is to include high quality pasture as a major feed ingredient. This high quality pasture can be obtained by using a ladino clover-orchard grass combination. Increased gains have been obtained by feeding ground shelled corn at a level of about 0.8 to 1.0 percent of the body weight of steers grazing those clover-grass pastures.

Mayo and MacDonald (1958), at Indiana, reported that steers fed grain while grazing on legume-grass pastures made a daily gain of 0.32 pounds more than animals grazing leume-grass pastures with no grain supplement. In this comparison, 309 steers on pasture for 159 days returned an average of 356 pounds of gain per acre without grain, whereas 132 steers on pasture for 155 days returned an average of 460 pounds of gain per acre with grain.

In a bulletin summarizing 12 years of research with grain fed to cattle on pasture, Wise et al. (1965) reported that the addition of animal fat to ground shelled corn was a satisfactory method of limiting concentrate intake.

Several studies showed that a mixture of 90 percent ground shelled corn and 10 percent animal fat (stabilized yellow grease) was consumed by grazing steers at a level of 0.8 to 1.0 percent of their body weight. Fat was added by heating it to approximately 160°F and slowly pouring it onto the ground shelled corn in an upright mixer.

EXPERIMENTAL PROCEDURE

Forty-eight Hereford heifer calves averaging 14 months of age and 588 pounds in body weight were used in the experiment. On April 3, 1967 the animals were ranked in descending order of body weight and randomly assigned by trios to three pasture plots with sixteen animals per plot. Plots I and II were composed of nitrated orchard grass (*Dactylis glomerata*) pasture. These pastures received nitrogen fertilization on the basis of 120 pounds per acre annually in two equal applications. Plot III was composed of a mixed pasture containing clover (*Trifolium repens* var. *Ladino*) and orchard grass (*Dactylis glomerata*). All pastures received fall applications of 500 pounds of 0-9-27 fertilizer per acre annually. Each pasture plot was divided into two sub-plots and the animals were rotated on the sub-plots every 28 days. The plots were clipped periodically in order to provide high quality forage at all times.

Half of the heifers in groups I and III were randomly assigned to receive a 12 milligram implant of Diethylstilbestrol (DES) in the ear on the first day of the experiment. The other halves did not receive any hormonal treatment.

The sixteen heifers in group II received 0.4 milligram of Melengestrol acetate (MGA) daily in the concentrate ration.

Thus the experiment was composed of five treatments consisting of: nitrated grass with no hormonal treatment (A); nitrated grass with 12 mg. implant of stilbestrol (B); nitrated grass with 0.4 mg. of MGA daily, added to the concentrate (C); clover-grass pasture with no hormonal treatment (D); and clover-grass pasture with 12 mg. implant of stilbestrol (E). The resulting experimental design is shown schematically in Table 1.

Table 1. Design of the experiment

Nitrated grass + concentrate			Clover-grass + concentrate	
Plot I		Plot II	Plot III	
No hormone	12 mg. DES	.4 mg. MGA	No hormone	12 mg. DES
A[a]	B	C	D	E
8[b]	8	16	8	8

[a]Treatment designation

[b]Number of animals per treatment

Heifers in all treatments received the basal concentrate mixture consisting of 90 percent ground shelled corn and 10 percent animal fat. The animal fat was used to limit the concentrate intake. Chlortetracycline (Aureomycin) was added at a level of 10 mg. per pound of concentrate. The concentrate was fed *ad libitum* and mineral mixtures were provided in two separated boxes, one containing two parts defluorinated rock phosphorus plus one part trace mineralized salt, and a second box containing plain white salt.

The animals were maintained on their respective rations for 169 days. Records on body weight were taken at bi-weekly intervals.

Two samples were taken from each of two different batches of the supplemental ration of treatment C and the level of MGA was assayed in the laboratories of the Upjohn Company. The purpose of these assays was to be sure that the heifers in treatment C were receiving the hormonal material at the intended level of 0.35 to 0.50 mg. per head per day. Results of the assays are presented in Table 2.

MGA used in the experiment was MGA Premix-100 (containing 100 milligrams of the active material, melengestrol acetate, per pound of premix). To facilitate incorporation of the material with the concentrate in treatment C, a blend consisting of 747 pounds of ground shelled corn and three pounds of the MGA Premix-100 was made. This blend contained 0.4 mg. of MGA in each pound. The MGA-corn blend was eventually mixed with the rest of the concentrate ration. Two pounds of Aureomycin was added to the final mixture and the ration was composed as illustrated in Table 3.

Table 2. MGA assays of supplement samples from treatment C

Mixing date	MGA (mg./lb.)		Found as
	Theory	Found	% of theory[a]
4-3-67	0.4	0.378	94.5[a]
	0.4	0.505	126.0
5-4-67	0.4	0.313	78.0
	0.4	0.341	85.0

[a]All samples were "in compliance". Samples were considered "in compliance" when they assayed within 70 to 120 percent of theory.

Table 3. Composition of supplemental ration in treatment C

Ingredient	Pounds per ton
Ground shelled corn	1,576
MGA - corn blend	222
Animal fat	200
Aureomycin	2

A shed with aluminum roof and open on all sides provided shade and the feed bunks and water tanks were located under this shelter. MGA was removed from the ration in treatment C seven days prior to slaughter and the basal concentrate ration without MGA was continued until the last day of the experiment.

The criteria used to evaluate the treatment combinations were average daily gain, daily feed intake, feed per pound of gain, pounds of shrink to market, carcass grade, carcass weight, dressing percent, cutability group (yield grade), rind thickness, ribeye area, marbling score, incidence and intensity of estrus, mammary development, teat length, teat weight, combined ovarian weight, follicles on both ovaries (12 millimeters and larger in diameter), and corpora lutea on both ovaries. All data, except daily feed intake, feed per pound of gain, and incidence and intensity of estrus were subjected to statistical analysis.

Performance Data

The heifers were weighed intially and every 14 days during the course of the feeding period. At the end of the feeding period, a final weight was taken just prior to transporting to market. After traveling 80 miles by truck a shrunk live weight was obtained. The difference in the final weights and the shrunk weights was established as the shrink to market. The final weights and initial weights were used in determining average daily gain.

The amount of the concentrate ration fed to each lot was recorded when added to the feed bunk and on the last day of the feeding period the remaining feed was weighed and subtracted from the total amount to arrive at the amount of concentrate consumed. The average concentrate consumption per lot per day was obtained by dividing the total amount of concentrate consumed in each lot by the number of days of the feeding period. The average concentrate consumption of each individual heifer was calculated dividing the average concentrate consumption per lot per day by the number of animals in each lot. Feed per pound of gain was obtained by dividing the average daily concentrate intake by the average daily gain.

Carcass Data

Carcasses were weighed immediately after slaughter and these weights adjusted to standard cold carcass weights. Dressing percentages were obtained by dividing the cold carcass weight by the shrunk live weight. All carcasses were chilled in the slaughter plant approximately 48 to 64 hours before carcass data were obtained.

Carcass Grading

All carcasses were graded by an experienced grader according to United States Department of Agriculture Standards. The grades were divided into a high, average and low portion to allow for more precision in detecting treatment differences. Each third of a grade was assigned a numerical value with average good being assigned a value of 10, low good 9, high good 11, low choice 12, average choice 13, etc.

Ribeye Area and Rind Thickness

Each carcass was ribbed between the 12th and 13th rib and tracings were made of the *Longissimus dorsi* (ribeye) muscle and the subcutaneous (rind) fat. The ribeye area was determined in square inches by use of a compensating polar planimeter. Rind thickness was obtained by constructing three lines across the ribeye area an equal distance apart and perpendicular to the long axis of the ribeye muscle. These lines were then connected to the outer edge of the rind fat. The lengths of the three lines were averaged and taken as the rind thickness.

Cutability Group

As defined by the U.S.D.A. Consumer and Marketing Service (1965) cutability group is the indicated percentage of trimmed, boneless, major retail cuts to be derived from the carcass. There are five cutability groups applicable to all classes of beef, denoted by numbers 1 through 5, where cutability group 1 represents the highest degree of cutability. The cutability group of each carcass was determined on the basis of the following regression equation: Cutability group = 2.50 + (2.50 x rind thickness in inches) + (0.20 x percent kidney, pelvic, and heart fat) + (0.0038 x hot carcass weight in pounds) - (0.32 x ribeye area in square inches). Hot carcass weight was calculated as 102 percent of cold carcass weight. The kidney, pelvic and heart fat includes the kidney knob (kidney and surrounding fat), the lumbar and pelvic fat in the loin and round and the heart fat in the chuck and brisket areas. The amount of these fats was subjectively evaluated and expressed as a percent of the carcass weight (Department of Agricultural Marketing Service, 1963).

Special Measures

Incidence and Intensity of Estrus

Starting May 25 and continuing for 30 days during the feeding period, all heifers were checked for incidence and intensity of estrus. The criterion used to judge whether or not an animal was in estrus was the fact that the animal would stand for others to mount. Observations were made twice a day at 6 a.m. and 5 p.m.

Mammary Development

A subjective udder development score was placed on live animals on the 140th day of the experiment. This subjective score was based on a numerical scale from 1 through 5 with the value 5 representing the greatest mammary development. These scores were placed by three experienced persons as the heifers were walking in front of them.

Teat Length and Teat Weight

At slaughter all four teats of each heifer were measured in millimeters while still attached to the udder and an average measure of teat length was obtained. After measuring, these teats were surgically removed from the udder, weighed, and the total weight for the four teats recorded.

Corpora Lutea and Follicles

Both ovaries of each heifer were recovered and the number of corpora lutea was recorded by counting the corpora lutea on both ovaries. Also all follicles that had diameters of 12 millimeters or more were recorded. After recording the number of corpora lutea and follicles 12 millimeters and larger both ovaries were placed in a normal saline solution and packed in ice for return to the laboratory. Later they were trimmed and weighed. The combined ovarian weights were recorded.

Statistical Analysis

The statistical procedure used to evaluate treatment differences was the Analysis of Variance. Comparisons among treatment means were made using the Tukey's w - procedure (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Treatment means are presented in this section of the text and individual data are presented in the appendix.

Performance Data

Results of performance of the heifers are summarized in Table 4. Individual data for initial weight, average daily gain, final weight, and shrunk weight of heifers are shown in Appendix Tables 4, 5, 6, and 7, respectively.

The feeding of 0.4 mg. of melengestrol acetate (MGA) daily significantly ($P < .01$) increased daily gains over the control heifers (1.83 vs. 1.51 lbs. per day), however, this increase was not significantly greater than gains of the stilbestrol-treated heifers on the nitrated grass (1.83 vs. 1.78 lbs. per day). Most rapid gains were made by heifers grazing clover-grass pasture and implanted with 12 mg. of stilbestrol. A significant ($P < .01$) difference was revealed by the analysis of variance and Tukey's w-procedure in favor of the two clover-grass groups (D and E) over the nitrated grass groups (A and B). Even though no significant difference was found by the analysis of variance among treatments A, B and C, analysis of the data by the Tukey's w-procedure revealed a significant ($P < .05$) increase in total weight gain in favor of the MGA and the DES-treated groups (C and B) over the control group (A).

Concentrate intake did not follow the same trends as average daily gains. Heifers attaining the greatest gains (clover-grass plus 12 mg. DES implant and clover-grass alone) consumed the least amount of concentrate. This smaller amount of concentrate consumed may be explained by the fact that the clover-grass pastures were of higher quality encouraging the animals to eat more of the pastures thereby decreasing the amount of concentrate consumed. The values for concentrate intake per heifer per day appearing in Table 4 are identical for groups A and B and also for D and E, since they are an average calculated from the groups that were fed together. Heifers on pastures containing clover also tended to make more efficient use of the concentrate portion of the ration. Feed intake was slightly increased and feed efficiency improved in the MGA-treated heifers, however, differences in feed consumption and feed efficiency were not statistically significant. Heifers on the control group (A) had the poorest feed efficiency in the experiment, whereas the heifers on the clover-grass groups (D and E) had the best conversion.

Table 4. Performance data for finishing heifers receiving various hormone treatments in a grain-on-pasture program

Item	Treatment				
	A	B	C	D	E
Number of heifers	8	8	16	8	8
Average initial weight, lb.	591	583	587	589	588
Average final weight, lb.	846[c]	881[d]	894[de]	926[ef]	942[f]
Average total gain/animal, lb.	225	298	307	337	354
Average daily gain, lb.	1.51[c]	1.78[d]	1.83[d]	2.01[e]	2.10[e]
Shrunk weight, lb.[a]	821	839	855	884	902
Shrunk, lb.	25	42	39	42	40
Percent shrink	3.0	4.8	4.4	4.5	4.2
Concentrate intake/day, lb.[b]	8.00	8.00	8.35	7.73	7.73
Concentrate/gain	5.30	4.50	4.54	3.85	3.67

[a]Feedlot to market shrink - 80 miles by truck

[b]Concentrate consisted of 90% ground shelled corn plus 10% animal fat. The values above are an average for 16 animals. Groups A and B were fed together, as were groups D and E

[c,d,e,f]Values followed by the same superscript are not significantly different at the $P < .05$ level

The percentage shrink was higher in the animals with higher weights. The highest percent shrink was found in heifers on nitrated-grass receiving 12 mg. DES implant (B), followed by group D (clover-grass alone). The control group (A) presented the smallest percent shrink.

The results reported herein are in general agreement with findings by other workers that clover-grass pastures support greater daily gains in finishing cattle compared to nitrogen-fertilized grass pastures. High weight gains and favorable feed efficiencies among animals grazing legume-grass pastures have been reported by Mott _et al_. (1952), Blaser _et al_. (1956), Duncan _et al_. (1958), Heinemann and VanKeuren (1958), Sullivan _et al_. (1959), Wise _et al_. (1965), and many others.

The treatment of steers with stilbestrol on clover-grass pastures has been reported to improve gain and feed efficiency (Sullivan _et al_., 1959; Wise _et al_., 1965). Since the report by Dinusson _et al_. (1950) that stilbestrol improved rate of gain and feed efficiency of feedlot heifers, it has been confirmed by many other workers (N.R.C., 1966). Also, after the findings by Dinusson _et al_. (1950) that spaying was not a satisfactory method of improving feedlot gains and feed efficiency of heifers, it was postulated that feeding progestogens would suppress estrus and improve feedlot performance of fattening heifers. Raun et al. (1965) reported that the feeding of chlormadinone acetate (CAP) to fattening heifers increased gain 13.3% as compared to negative controls and 4.1% when compared to DES-treated heifers.

Melengestrol acetate treatment of feedlot heifers has been shown to improve performance and feed efficiency when compared to control heifers. Bloss et al. (1966) reported a gain increase of 9.4% when heifers received 0.44 mg. melengestrol acetate (MGA) in the ration daily as compared with control heifers. In another group of mature heifers, MGA fed at a level of 0.37 mg. per head per day provided an 18% improvement in weight gain, which was significantly different ($P < .05$) from that of controls. They also reported that there was a tendency for intact treated heifers to consume slightly more feed than the controls. All MGA-fed heifer groups, except those that were spayed, showed improved feed efficiency ranging from 1.6 to 10.2% better than controls.

Burroughs et al. (1966) reported that the feeding of MGA at levels of 0.20, 0.35 and 0.50 mg. per head daily resulted in 5% greater feed consumption, 15% greater liveweight gains ($P < .05$) and 9% better feed conversion as compared with control heifers. Also, feedlot performance of heifers receiving the three levels of MGA compared similarly to heifers receiving a high level of 20 mg. of DES per head per day.

Newland and Henderson (1966) reported that MGA significantly ($P < .05$) increased daily gains over stilbestrol-fed heifers (2.04 versus 1.83 pounds per day). However, this increase was not consistent enough to be significant over the control heifers receiving no hormones (1.96 pounds per day). Feed efficiency followed the pattern of daily gains in general, although the control heifers were most efficient. The faster gains in the MGA-treated groups apparently resulted from a higher intake of feed, both on a daily basis and as a percent of their body weight.

Matsushima et al. (1967) reported the results of four trials involving 2,106 feedlot heifers, with 1.057 serving as controls (received 10 mg. stilbestrol in the feed per head daily) and 1,049 receiving melengestrol acetate (0.4 mg. per head per day). They found that the MGA-treated heifers gained from 6.0% to 15.2% more than the control heifers and averaged 16 pounds more gain. In all four trials there was a response from MGA in feed efficiency. Heifers receiving MGA were from 3 to 18% more efficient in utilizing feed.

Young et al. (1967) reported a slight but non-significant ($P < .05$) improvement in total gain, average daily gain, and feed efficiency when heifers were treated with MGA. O'Brien and Baumgardner (1967) and O'Brien et al. (1968) reported that the feeding of 0.3 mg. of MGA per head per day significantly ($P < .01$) improved rate of gain of heifers (21% increase over the controls) during a 140-day feeding period. These workers also reported an improvement of 11% in feed conversion in heifers fed MGA. In another study O'Brien (1967b) reported increased gains of 8% over controls when heifers received 0.4 mg. MGA daily in the feed.

Henderson (1967) reported that heifers fed MGA gained 2.30 pounds per day compared to 2.05 pounds daily for heifers serving as negative controls and 2.21 pounds daily for heifers receiving DES in the feed.

The results of the experiment reported herein agree with the literature reviewed that MGA fed at a level of approximately 0.4 mg. per head per day will improve rate of gain and feed conversion of heifers as compared to untreated controls.

Carcass Data

Treatment means of carcass characteristics are presented in Table 5. Individual data for carcass weight, carcass grade, dressing percent, rind thickness, ribeye area, marbling

Table 5. Carcass data for finishing heifers receiving various hormone treatments in a grain-on-pasture program

Item	Treatment				
	A	B	C	D	E
Average carcass weight, lb.	479^{g}	505^{h}	516^{h}	558^{i}	571^{i}
Carcass grade[a]	10.8	10.0	10.5	10.9	10.9
Marbling score[b]	10.0	9.5	9.6	10.5	10.6
Dressing percent[c]	59.7^{g}	60.1^{g}	60.3^{g}	63.0^{h}	63.3^{h}
Rind thickness, mm[d]	17.7^{g}	17.9^{g}	19.2^{g}	23.1^{h}	21.3^{h}
Ribeye area, sq. in.[e]	9.85	10.66	10.27	10.62	11.20
Yield grade[f]	3.52	3.36	3.67	4.16	3.79

[a]Middle standard = 7, high std. = 8, low good = 9, middle good = 10, etc.

[b]Marbling score based on a scale from 1 to 28 with 1 representing devoid of marbling and 28 representing highly abundant marbling. See Appendix Table 2

[c]Carcass weight (cold)/shrunk weight

[d]Average of three measures - between ribs 12 and 13

[e]Cross-sectional area, Longissimus dorsi muscle at 12th rib

[f]Scale of 1 to 5 with 1 representing highest percent of lean cuts

[g,h,i]Values followed by the same superscript are not significantly different at the $P < .05$ level

score and cutability scores (yield grades) are presented in Appendix Tables 8, 9, 10, 11, 12, 13, and 14, respectively.

Carcass traits appeared to be unaffected by melengestrol acetate. Statistical analysis revealed no significant differences among treatment means for carcass grade and marbling score. Marbling scores were 10.0, 9.5, 9.6, 10.5 and 10.6 and carcass grades were 10.8, 10.0, 10.5, 10.9, and 10.9 for groups A, B, C, D, and E, respectively (Table 5). Data for carcass weight generally reflected the results obtained for final live weight and total gain. Heifers having the heavier carcasses were also heavier before slaughter and made the most gain.

Dressing percent was also unaffected by the progestogen in the feed. MGA-treated heifers dressed 60.3% compared to 59.7% for the control group (A) and 60.1% for the DES-treated group (B). Statistical analysis showed a highly significant ($P < .01$) difference in dressing percent in favor of the clover-grass groups (D and E), compared to the nitrated-grass groups.

MGA-treatment resulted in a slight but non-significant difference in rind thickness as compared to the control heifers and DES-treated heifers. Rind thickness on the nitrated-grass groups was 17.7, 17.9, and 19.2 mm. for groups A, B, and C, respectively. Heifers grazing the clover-grass pastures had significantly ($P < .01$) thicker rinds as compared to the nitrated-grass groups. Even though the heifers in treatment D (clover-grass) had slightly thicker rinds than treatment E, there was no significant difference between the two groups grazing clover-grass pastures.

Ribeye area was slightly but non-significant increased by feeding 0.4 mg. MGA. It followed about the same pattern as the rind thickness with the heifers on the clover-grass treatments presenting the largest ribeye areas. Even though these differences were not statistically significant, the consistency of the association suggests that the differences may be real.

Cutability group scores (yield grades) were not significantly different but heifers on the clover-grass pastures presented higher cutability group scores showing that heifers in those groups yielded the lowest percentage of trimmed, boneless, major retail cuts.

Heinemann and VanKeuren (1958) reported that cattle grazing grass-legume pastures attained a 9% higher appraisal value off pasture and graded half a grade higher than cattle grazing nitrogen-fertilized grass which graded standard with very few grading low-good. Sullivan _et al_. (1959) reported that steers on nitrated-grass pastures produced carcasses of slightly inferior grade than those on grass-legume pastures. Steers on grass-legume pastures had also a higher dressing percentage than those on nitrated-grass pastures. Blaser et al. (1956) also reported that higher liveweight gains from orchard grass-ladino clover pastures would be expected to increase dressing percent and thus the carcass grade and value.

Numerous reports (Clegg and Cole, 1954 and Andrews et al., 1954) have indicated a lowering of carcass grade as a result of subcutaneous treatment of steers with diethylstilbestrol. Dinusson et al. (1950) and other workers have reported no significant differences in carcass characteristics of steers of heifers treated with DES. Kastelic et al. (1956) reported that the results of four trials failed to provide evidence that the feeding of DES had any consistent influence on carcass characteristics as measured by carcass weight, grade, the fat, lean and bone content of the 9-10-11 rib cut, the area of the cross section of the Longissimus dorsi muscle and thickness of fat over the ribeye muscle. Many reports indicate that estrogen treatment reduces carcass grade by reducing fat and increasing lean (Clegg and Carroll, 1957; Deans et al., 1956; Ogilvie et al., 1960; Wilson et al.,

1963) which may be the result of an improved efficiency of protein conversion (N.R.C., 1966).

Reduced carcass grade in heifers treated with stilbestrol have been reported by Newland and Henderson (1966). They reported that although not significant ($P < .05$), the control heifers graded approximately one-third of a grade higher than the hormone-treated groups. This was mainly due to the significantly higher ($P < .05$) marbling score of the controls.

The lack of differences in carcass grades, marbling scores and dressing percent of MGA-fed heifers compared to controls is in agreement with previously reported research results (Bloss et al., 1966; Newland and Henderson, 1966; Burroughs et al., 1966; Matsushima et al., 1967; Young et al., 1967; Ray et al., 1967; O'Brien, 1967b; O'Brien and Baumgardner, 1967; O'Brien et al., 1968).

Special Measurements Data

Treatment means for special measurements data are presented in Table 6. Individual data for udder development scores, teat length, teat weight, number of corpora lutea per animal, number of follicles 12 mm. and larger per animal, and combined ovarian weights are presented in Appendix Tables 15, 16, 17, 18, 19 and 20, respectively.

Table 6. Special measurements data for finishing heifers receiving various hormone treatments in a grain-on-pasture program

Item	Treatment				
	A	B	C	D	E
Observed heat, %[a]	100.0	100.0	6.0	75.0	87.5
Udder development score[b]	1.50[g]	2.13[h]	2.94[i]	2.38[h]	2.88[i]
Teat length, mm[c]	29.2[g]	35.7[h]	34.0[h]	35.3[h]	39.3[i]
Teat weight, gm.[d]	18.0[g]	25.3[h]	27.2[h]	23.9[h]	37.1[i]
Corpora lutea[e]	1.0	0.6	0.7	1.0	1.0
Follicles, 12 mm and +[f]	0.9	0.5	0.9	0.6	0.8
Combined ovarian weight, gm.	13.4[g]	13.7[g]	16.8[h]	15.2[h]	13.6[g]

[a]Percent of heifers observed in heat during a 30-day period

[b]Subjective udder development score placed on live animals on 140th day of the experiment and based on a scale from 1 to 5 with 5 representing greatest udder development.

[c]Average length of the four teats

[d]Average weight of the four teats

[e]Average number of corpora lutea per animal (both ovaries)

[f]Average number of follicles (12 mm. and larger) per animal (both ovaries)

[g,h,i]Values followed by the same superscript are not significantly different at the ($P < .05$) level

The feeding of 0.4 mg. MGA per head per day effectively prevented the incidence of estrus in treatment C. Overt signs of estrus were observed in only one of the 16 heifers receiving the MGA treatment, while control heifers (treatment A) and DES-treated heifers (treatment B) cycled normally. Heifers on the clover-grass pastures did not present the expected results with respect to the incidence of estrus. It was observed that two of the eight heifers in treatment D and one of the eight heifers in treatment E did not present signs of estrus. This is not fully understood since it has been reported that cover has a certain amount of estrogenicity (Bickoff et al., 1958, 1960; Engle et al., 1957; Cheng et al., 1952, 1953) and heifers in treatment E received a 12 mg. DES implant. MGA-treated heifers presented the highest udder development scores, followed by the heifers in treatment E (clover-grass plus 12 mg. DES implant). The control group presented the lowest udder development scores. DES-treated heifers had higher udder development scores than control (A) heifers.

Teat weight and teat length followed about the same pattern observed in udder development. Heifers in treatment E had the largest and heaviest teats ($P < .01$). MGA-treated heifers had significantly ($P < .05$) larger and heavier teats as compared to the controls (treatment A). There was a significant ($P < .05$) increase in teat weight and teat length in heifers on the clover-grass pastures (D and E).

MGA-treated heifers had 14.5% fewer corpora lutea than control heifers (A), and the clover-grass groups (D and E). Means were 0.7 and 1.0 for MGA-treated heifers and A, D and E groups, respectively. The percentage of animals with corpora lutea in the MGA-treated group is higher than the findings in the literature. This may be due to the fact that MGA treatment was withdrawn seven days prior to slaughter, and it could be due to the synchronization of estrous cycle in those animals as was observed by Dziuk _et al_. (1966) 36 and 72 hours after treatment was removed.

The number of follicles 12 mm. and larger was higher in the MGA-treated heifers as compared to the B, D, and E treatments. Ovaries were trimmed and weighed, but follicular fluid and corpora lutea weights were not determined. Combined ovarian weight of MGA-treated heifers averaged 24.4% heavier ($P < .01$) than controls (A) and 22.6% heavier ($P < .01$) than DES-treated heifers (B), (16.8 vs. 13.4 and 13.7 gm. for MGA-, controls and DES-treated heifers, respectively). Enlargement of ovaries in the MGA-treated heifers is attributed to enlargement of or multiple follicles as reported by Zimbelman and Smith (1966b).

It has been demonstrated that stilbestrol will cause mammary development in virgin heifers (Walker _et al_., 1941). Stimulation of the mammary tissue is one of the true physiological effects resulting from estrogen treatment (N.R.C., 1966). Dinusson _et al_. (1950) reported that all heifers receiving DES treatment showed pronounced mammary and teat development not exhibited in the control groups. The teat and udder development 90 days after the beginning of treatment was comparable to that seen in late gestation in beef heifers. Bell _et al_. (1957) reported that teats of wethers treated with DES lengthened and teats of two animals contained a fluid substance similar in appearance to milk.

Teat length and teat weight data in this study support the results of udder development scoring. All groups that presented higher udder development also had heavier and longer teats as compared to the control heifers (treatment A).

Results of counting the corpora lutea per animal are in accord with findings in the literature that external progesterone causes regression of the corpus luteum in treated animals. Zimbelman _et al_. (1959) reported that daily injections of 0.4 mg. of crystalline progesterone per pound of body weight appeared to cause some suppression of normal corpus luteum growth of bred ewes but no evidence of regression was obtained from study either of the hystological structure or of the weights at different stages. Loy <u>et</u> <u>al</u>. (1960) applied one mg. of progesterone per pound of body weight in a single injection on day one of the estrous cycle and found that it caused significant differences in corpora lutea weight, proportion of functional luteal cells, and progestogen concentration between treated and control corpora lutea on day 14. It had a detrimental effect on the corpora lutea.

The effects of injecting progesterone in starch suspension on day 35, 42 and 49 of pregnancy were reported by Zimbelman <u>et</u> <u>al</u>. (1961). Animals from both groups (treated and controls) were slaughtered on day 56 of pregnancy. Progesterone had no significant effect on corpora lutea weight. The mean weights for treated animals was 4.85 gm. as compared to 5.41 gm. for the controls. However, Ray <u>et</u> <u>al</u>. (1961) reported a highly significant ($P < .005$) decrease in corpus luteum size from treatment of heifers with exogenous progesterone. VanBlake <u>et</u> <u>al</u>. (1963) reported that a rapid and almost complete regression of the corpora lutea was noted within a few days of the beginning of treatment of dairy heifers with CAP. This was particularly noticeable when the level of hormone fed was above 0.025 mg. per pound of body weight. CAP appeared to cause more rapid luteal regression than MAP.

Zimbelman and Smith (1966b) reported that after two weeks of treatment of heifers with 0.4 mg. MGA per head daily, the incidence of a detectable corpora lutea decreased from 75% in the beginning to 47%. After three weeks it was further decreased to 10%. Of eight detected corpora at 22 to 24 days, five formed from an ovulation during treatment. These results confirmed previous data (Zimbelman and Smith, 1966a) indicating that 0.4 mg. MGA daily inhibited ovulation in most heifers.

O'Brien (1967a) reported that the feeding of MGA to ewe lambs resulted in a decreased number of corpora lutea per ewe as compared to control animals. O'Brien (1967b) and O'Brien and Baumgardner (1967) reported that the feeding of 0.246 mg. MGA per head per day to heifers caused a 74.5% reduction in the number of corpora lutea per ovary (0.15 vs. 0.58) in comparison to negative controls (O'Brien et al., 1968).

Data on the follicular growth of heifers fed MGA based on palpation and measurement at slaughter, have been reported previously by Zimbelman and Smith (1966b). These data indicated that heifers treated with MGA had significantly greater amounts of follicular fluid during the period of ovulation inhibition than did heifers that represented various stages of the normal estrous cycle. Follicular development appeared to be greatest within the same approximate dosage range at which the maximum weight gain stimulation was achieved. Data have also been reported by Zimbelman (1965) on the follicular development of heifers during a 100-day (or longer) period following a single injection of medroxyprogesterone acetate (MAP). These data also indicated that significant follicular development occurred and that there was an increased relationship between the percent of a group with corpora lutea and the percent with a detectable follicle. From research with pre-puberal ewe lambs (O'Brien, 1967a; O'Brien and Miller, 1967) it appeared that oral MGA suppressed follicular development. However, in another experiment with heifers, O'Brien and Baumgardner (1967), O'Brien _et al_. (1967b) and O'Brien _et al_., (1968) reported that heifers fed MGA had 80% ($P < .01$) more follicles 12 mm. and larger per ovary (0.81 vs. 0.45) and had 15.9% larger ovaries (7.37 vs. 6.20 gm.) in comparison to the negative controls. Young _et al_. (1967) reported that weight increase in ovaries of heifers receiving the MGA treatments were significant ($P < .05$) as compared to controls. Follicular fluid expressed as a percentage of total ovarian weight was significantly ($P < .01$) increased from 32.8% for the controls to 54.9%, 51.1% and 52.5% for the 0.20, 0.40 and 0.60 mg. groups, respectively.

It was also reported by Dziuk *et al.* (1964) that the treatment of ewes with MAP at doses of 40 or 60 mg. daily caused follicular growth during the normal follicular stage of the estrous cycle.

The results reported herein are in agreement with the literature reviewed that MGA fed at a level of approximately 0.4 mg. per head per day suppresses estrus, promotes the development of larger follicles and increases follicular fluid as reflected by increased ovarian weights. These observations on estrous cycle suppression and follicular development tend to substantiate the theory that increased growth and improved feed conversion appears to be a joint effect of relief from the stress of cyclic heat plus an uninterrupted supply of endogenous estrogen from large and persistent ovarian follicles.

SUMMARY AND CONCLUSIONS

This experiment was conducted to study the effects of (1) melengestrol acetate (MGA), (2) diethylstilbestrol (DES), and (3) clover-grass vs. nitrated grass pastures on performance, carcass characteristics and certain reproductive phenomena of beef heifers self-fed a grain-fat mixture on pasture.

Heifers on all treatments received the same basal ration consisting of 90% ground shelled corn and 10% animal fat. Chlortetracycline (Aureomycin) was added at a level of 10 mg. per pound of concentrate. Mineral mixtures were provided in two separated boxes, one containing two parts defluorinated rock phosphorus plus one part trace mineralized salt, and a second box containing plain white salt. Treatments consisted of: nitrated grass with no hormonal treatment (A); nitrated grass with 12 mg. of DES implanted (B); nitrated grass with 0.4 mg. of MGA daily added to the concentrate (C); clover-grass with no hormonal treatment (D); clover-grass with 12 mg. of DES implanted (E). Forty-eight Hereford heifer calves averaging 14 months of age and weighing approximately 588 pounds initially were assigned to three pasture plots with 16 animals per plot and fed <u>ad libitum</u> for a period of 169 days.

MGA increased gains an average of 0.32 lb. per day ($P < .01$) as compared to control heifers (A) but gain was not significantly increased over DES-treated heifers (B). DES-implanted heifers (B) gained significantly ($P < .05$) more than control heifers (A). Heifers grazing the clover-grass pastures gained 0.41 lb. more ($P < .01$) than the nitrated grass pasture groups. Heifers attaining the greatest gains consumed the least amount of concentrate and tended to make more efficient use of the concentrate portion of the ration. Concentrate intake and efficiency of concentrate utilization were slightly increased in the MGA-treated heifers (C) as compared to the control group (A).

Results of carcass evaluation based on carcass grade, dressing percent, rind thickness, ribeye area, marbling score and cutability indicated no significant effect of MGA- and DES-treatments on carcass characteristics. The clover-grass groups (D and E) had significantly ($P < .01$) thicker rinds and dressed significantly ($P < .01$) higher than the nitrated grass groups, but no significant differences were observed in other carcass traits.

MGA effectively prevented estrus in 15 out of 16 heifers while all heifers in the control and DES-treated groups continued to cycle normally. MGA, DES and clover stimulated mammary development, exhibited as larger udders and longer and heavier teats ($P < .05$). MGA-treated heifers had significantly ($P < .01$) heavier ovaries. Lack of differences in the number of follicles 12 mm and larger and the number of corpora lutea may be due to the fact that MGA was withdrawn from the ration seven days prior to slaughter.

On the basis of the research reported herein the following conclusions and suggestions are presented. MGA fed at the approximately 0.4 mg. per head daily increased gains over control heifers. This improvement in gains was comparable to gains made by heifers implanted with 12 mg. of DES. MGA-treatment also prevented estrus and increased ovarian weights of heifers. Prevention of estrus and elimination of attendant management problems will benefit cattle producers who feed heifers for market. The results of the comparison of clover-grass to nitrated grass indicate that clover is of considerable value in stimulating gains of grazing heifers. These results also support the theory that clover has some estrogenic activity.

Still more research is needed to fully substantiate these results and to reveal other methods of further improving liveweight gains of heifers on pastures.

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APPENDICES

Appendix A. Tables

Appendix Table 1. Abbreviations used in the appendix

Abbreviation	Full meaning
d.f.	Degrees of freedom
DES	Diethylstilbestrol
F	Variance ratio
MGA	Melengestrol acetate
mg	Milligrams
mm	Millimeters
MS	Mean square
SS	Sum of squares
Source	Source of variation in statistical analysis
$\bar{x}$	Mean
**	Statistically significant (probability less than 0.01)
*	Statistically significant (probability less than 0.05)

Appendix Table 2. Marbling scoring system

Amount of marbling		Number designation
Abundant	+	28
Abundant	0	27
Abundant	-	26
Moderately abundant	+	25
Moderately abundant	0	24
Moderately abundant	-	23
Slightly abundant	+	22
Slightly abundant	0	21
Slightly abundant	-	20
Moderate	+	19
Moderate	0	18
Moderate	-	17
Modest	+	16
Modest	0	15
Modest	-	14
Small	+	13
Small	0	12
Small	-	11
Slight	+	10
Slight	0	9
Slight	-	8
Trace	+	7
Trace	0	6
Trace	-	5
Practically devoid	+	4
Practically devoid	0	3
Practically devoid	-	2
Devoid		1

Appendix Table 3. Experimental design[a] with heifer identification numbers

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
47	32	30	22	20
34	40	5	18	27
39	42	24	28	16
35	43	46	14	36
10	15	37	19	7
21	2	17	31	13
49	38	48	4	8
44	6	41	33	26
		1		
		25		
		45		
		11		
		23		
		9		
		29		
		3		

[a]In all tables this arrangement is applicable

Appendix Table 4. Initial weights of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
670	675	650	660	670
625	630	630	625	640
615	610	630	610	610
605	605	625	605	605
580	565	610	595	565
555	555	605	555	555
555	535	605	550	540
525	485	580	510	520
$\bar{x}$ 591	$\bar{x}$ 583	575	$\bar{x}$ 589	$\bar{x}$ 588
		560		
		555		
		545		
		535		
		510		
		510		
		670		
		$\bar{x}$ 587		

Appendix Table 5. Average daily gain and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
1.69	1.89	2.07	1.83	2.01
1.72	1.48	1.95	2.46	1.95
1.57	1.75	1.75	2.37	2.40
1.45	1.98	1.80	1.98	2.28
1.54	1.95	1.95	1.75	1.51
1.33	1.92	2.16	1.83	2.37
1.69	1.21	2.01	2.10	2.49
1.07	1.95	1.39	1.63	1.75
$\bar{x}$ 1.51	$\bar{x}$ 1.78	2.07	$\bar{x}$ 2.01	$\bar{x}$ 2.10
		1.69		
		1.63		
		1.92		
		1.66		
		1.51		
		1.80		
		1.72		
		$\bar{x}$ 1.83		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	4.6896		
Treatments	4	1.6430	0.4107	5.79**
Error	43	3.0466	0.0709	

Tukey's w-procedure ($P < .05$)

A	B	C	D	E
1.51	1.78	1.83	2.01	2.10

Appendix Table 6. Final weights and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
955	995	1000	970	1010
915	880	960	1040	970
880	905	925	1010	1015
850	940	930	940	990
840	895	940	890	820
780	880	970	865	955
840	740	945	905	960
705	815	815	785	815
$\bar{x}$ 846	$\bar{x}$ 881	925	$\bar{x}$ 926	$\bar{x}$ 942
		845		
		830		
		870		
		815		
		765		
		815		
		960		
		$\bar{x}$ 894		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	297,645.40		
Treatments	4	45,873.50	11,468.4	1.96
Error	43	251,771.90	5.855.2	

Tukey's w-procedure (P $<$ .05)

A	B	C	D	E
846	881	894	926	942

Appendix Table 7. Shrunk weights and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
910	960	960	945	965
880	830	920	995	920
835	855	885	950	960
805	905	880	900	950
800	845	910	845	790
730	835	930	825	910
790	705	900	865	920
660	775	790	750	800
$\bar{x}$ 801	$\bar{x}$ 839	880	$\bar{x}$ 884	$\bar{x}$ 902
		795		
		800		
		820		
		785		
		740		
		775		
		910		
		$\bar{x}$ 855		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	1,898,990.0		
Treatments	4	49,654.2	12,413.55	0.29
Error	43	1,849,335.8	43,007.81	

Appendix Table 8. Carcass weights and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg.DES
A	B	C	D	E
543	589	569	592	612
532	500	555	628	598
509	516	538	606	601
473	560	524	577	616
459	516	563	535	505
451	495	577	531	569
466	420	556	525	563
395	441	480	466	505
$\bar{x}$ 479	$\bar{x}$ 505	519	$\bar{x}$ 558	$\bar{x}$ 571
		475		
		485		
		509		
		465		
		446		
		446		
		543		
		$\bar{x}$ 516		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	148,622.67		
Treatments	4	47,430.16	11,857.54	5.04**
Error	43	101,192.51	2,353.314	

Tukey's w-procedure ($P < .05$)

A	B	C	D	E
479	505	516	558	571

Appendix Table 9. Carcass grades and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
13	11	12	11	14
10	10	11	13	10
10	11	10	12	14
12	12	10	10	10
10	11	10	10	10
11	9	12	10	10
10	8	10	11	9
10	8	8	10	10
$\bar{x}$ 10.75	$\bar{x}$ 10.00	10	$\bar{x}$ 10.88	$\bar{x}$ 10.88
		10		
		10		
		12		
		12		
		9		
		11		
		11		
		$\bar{x}$ 10.50		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	85.67		
Treatments	4	4.42	1.105	0.93
Error	43	81.25	1.889	

Appendix Table 10. Dressing percentages and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
59.67	61.35	59.27	62.65	63.42
60.45	60.24	60.33	63.11	65.00
60.96	60.35	60.79	63.79	62.60
58.76	61.88	59.55	64.11	64.84
57.38	61.07	61.87	63.31	63.92
61.78	59.28	62.04	64.36	62.53
58.99	59.57	61.78	60.69	61.20
59.85	56.90	60.76	62.13	63.13
$\bar{x}$ 59.73	$\bar{x}$ 60.08	59.00	$\bar{x}$ 63.02	$\bar{x}$ 63.33
		59.75		
		60.63		
		62.07		
		59.24		
		60.27		
		57.55		
		59.67		
		$\bar{x}$ 60.29		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	178.6460		
Treatments	4	103.1632	25.791	14.70**
Error	43	75.4828	1.755	

Tukey's w-procedure ($P < .05$)

A	B	C	D	E
59.73	60.08	60.29	63.02	63.33

Appendix Table 11. Rind thickness (in millimeters) and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
14.0	26.6	19.0	35.0	18.3
23.0	13.3	29.0	21.0	15.0
15.3	16.0	19.0	24.0	22.0
22.5	26.5	14.5	19.0	35.0
16.0	24.3	20.5	23.0	15.0
19.0	16.3	23.0	21.0	24.0
18.0	10.0	16.0	19.0	13.0
14.0	10.0	16.0	23.0	28.0
$\bar{x}$ 17.7	$\bar{x}$ 17.9	19.2	$\bar{x}$ 23.1	$\bar{x}$ 21.3
		12.0		
		23.2		
		23.0		
		22.8		
		19.0		
		16.0		
		14.8		
		$\bar{x}$ 19.2		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	1,469.90		
Treatments	4	176.00	44.00	1.50
Error	43	1,263.90	29.39	

Appendix Table 12. Ribeye area (in square inches) and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
11.58	11.34	10.49	9.51	11.85
11.38	11.85	12.26	12.37	12.31
10.71	10.65	9.02	10.64	14.41
8.37	11.67	8.45	11.08	10.30
9.33	9.80	11.20	9.17	9.91
9.20	9.92	10.86	11.64	9.82
9.45	9.65	10.53	10.17	11.29
8.79	10.38	9.59	10.36	9.68
$\bar{x}$ 9.85	$\bar{x}$ 10.66	9.91	$\bar{x}$ 10.62	$\bar{x}$ 11.20
		12.30		
		10.59		
		8.26		
		9.78		
		10.21		
		9.18		
		11.72		
		$\bar{x}$ 10.27		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	73.0162		
Treatments	4	8.3629	2.0907	1.39
Error	43	64.6433	1.5030	

Appendix Table 13. Marbling scores and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
16	12	14	10	17
8	8	9	15	8
8	12	8	13	20
14	13	8	9	8
8	13	8	8	9
10	7	14	8	8
8	6	8	12	7
8	5	6	9	8
$\bar{x}$ 10.0	$\bar{x}$ 9.5	8	$\bar{x}$ 10.5	$\bar{x}$ 10.6
		8		
		8		
		14		
		14		
		7		
		10		
		10		
		$\bar{x}$ 9.6		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	492.980		
Treatments	4	9.355	2.3387	0.21
Error	43	483.625	11.2470	

Appendix Table 14. Cutability group scores and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
2.83	4.43	3.83	5.88	3.51
3.73	2.59	4.16	3.60	2.87
3.14	3.22	4.21	4.42	2.87
4.43	4.11	3.87	3.70	5.57
3.31	4.24	3.70	4.52	3.47
3.84	3.41	4.17	3.48	4.52
3.66	2.49	3.34	3.80	2.85
3.20	2.37	3.45	3.87	4.67
$\bar{x}$ 3.52	$\bar{x}$ 3.36	3.67	$\bar{x}$ 4.16	$\bar{x}$ 3.79
		2.09		
		3.93		
		4.70		
		4.11		
		3.46		
		3.50		
		2.94		
		$\bar{x}$ 3.67		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	26.5590		
Treatments	4	0.3758	0.09395	0.15
Error	43	26.1832	0.60891	

Appendix Table 15. Udder development scores and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
1	1	3	4	3
2	2	4	2	3
2	3	2	4	4
2	3	2	3	2
2	3	4	2	1
1	2	1	1	3
1	1	3	1	5
1	2	3	2	2
$\bar{x}$ 1.5	$\bar{x}$ 2.1	3	$\bar{x}$ 2.4	$\bar{x}$ 2.9
		2		
		3		
		3		
		3		
		3		
		3		
		5		
		$\bar{x}$ 2.9		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	53.920		
Treatments	4	11.358	3.3395	3.54*
Error	43	40.562	0.9433	

Tukey's w-procedure ($P < .05$)

A	B	D	E	C
1.5	2.1	2.4	2.9	2.9

Appendix Table 16. Teat length (in millimeters) and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
32.75	37.75	37.75	32.50	30.75
29.75	30.00	34.25	33.50	48.50
32.75	43.25	28.50	49.25	40.75
37.00	33.00	32.50	35.50	58.25
27.25	36.25	36.00	45.25	30.25
23.25	34.00	24.00	31.25	34.00
26.75	32.75	40.75	31.00	44.25
24.25	38.50	27.75	24.50	29.00
$\bar{x}$ 29.22	$\bar{x}$ 35.69	41.25	$\bar{x}$ 35.34	$\bar{x}$ 39.47
		37.75		
		38.00		
		35.50		
		32.00		
		26.50		
		33.75		
		37.50		
		$\bar{x}$ 33.98		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	2,271.2448		
Treatments	4	648.6409	162.1602	4.30*
Error	43	1,622.6039	37.7350	

Tukey's w-procedure ($P < .05$)

A	C	D	B	E
29.22	33.98	35.34	35.67	39.47

Appendix Table 17. Teat weights (in grams) and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
20.2	24.5	39.3	22.0	28.0
22.1	25.8	30.9	26.6	45.7
18.0	33.0	29.0	36.0	31.4
23.0	28.0	26.0	20.0	77.9
15.5	26.0	25.6	28.8	13.5
15.0	24.0	15.5	18.1	30.0
17.7	20.0	33.3	22.5	46.4
12.5	21.2	21.4	16.8	24.0
$\bar{x}$ 18.0	$\bar{x}$ 25.3	25.4	$\bar{x}$ 23.9	$\bar{x}$ 37.1
		28.4		
		28.0		
		21.8		
		25.5		
		23.0		
		28.5		
		33.0		
		$\bar{x}$ 27.2		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	6,227.35		
Treatments	4	1,553.27	388.318	4.55*
Error	43	3,674.08	85.444	

Tukey's w-procedure ($P < .05$)

A	D	B	C	E
18.0	23.9	25.3	27.2	37.1

Appendix Table 18. Number of Corpora lutea per animal and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone A	12 mg. DES B	0.4 mg. MGA C	No hormone D	12 mg. DES E
0	1	0	1	1
1	1	2	2	1
1	1	0	1	2
1	1	1	1	0
1	1	1	1	1
1	0	1	0	1
1	0	0	1	1
2	0	1	1	1
$\bar{x}$ 1.0	$\bar{x}$ 0.6	1	$\bar{x}$ 1.0	$\bar{x}$ 1.0
		0		
		1		
		0		
		1		
		1		
		0		
		1		
		$\bar{x}$ 0.7		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	14.6700		
Treatments	4	1.3575	0.3394	1.10
Error	43	13.3125	0.3096	

Appendix Table 19. Number of follicles 12 mm and larger per animal and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
2	0	2	0	1
1	0	2	0	1
1	0	0	1	0
2	1	0	1	3
0	0	1	1	0
1	1	0	0	0
0	1	1	1	1
0	1	1	1	0
$\bar{x}$ 0.9	$\bar{x}$ 0.5	1	$\bar{x}$ 0.6	$\bar{x}$ 0.8
		1		
		1		
		0		
		1		
		2		
		0		
		1		
		$\bar{x}$ 0.9		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	25		
Treatments	4	1	0.25	0.45
Error	43	24	0.56	

Appendix Table 20. Combined ovarian weights (in grams) and analysis of variance of heifers receiving various hormone treatments in a grain-on-pastures program

Nitrated grass			Clover-grass	
No hormone	12 mg. DES	0.4 mg. MGA	No hormone	12 mg. DES
A	B	C	D	E
11.87	13.65	13.65	16.40	13.27
13.73	19.05	28.89	11.83	12.10
14.59	10.66	16.83	20.20	14.57
14.47	13.13	11.59	15.48	15.07
15.22	17.51	16.14	13.22	15.20
13.16	11.07	14.80	18.59	9.78
12.89	11.89	15.43	13.70	16.99
11.58	12.57	18.37	12.20	11.45
$\bar{x}$ 13.44	$\bar{x}$ 13.69	13.04	$\bar{x}$ 15.20	$\bar{x}$ 13.55
		12.38		
		12.08		
		22.13		
		25.28		
		20.66		
		13.14		
		14.42		
		$\bar{x}$ 16.80		

Analysis of Variance

Source	d.f.	SS	MS	F
Total	47	663.4216		
Treatments	4	102.1066	25.5266	1.96
Error	43	561.3150	13.05	

Tukey's w-procedure ($P < .05$)

A	E	B	D	C
13.44	13.55	13.69	15.20	16.80

Appendix B. Summary in Portuguese

Um experimento foi conduzido para estudar es efeitos de (1) Acetato de melengestrol (MGA), uma progesterona sintética; (2) Stilbestrol (DES) um estrogenio sintético; e (3) capim + legume vs. capim fertilizado com Nitrogenie em: ganho de pêso, caracteristicas da carcassa e certos fenomenos relacionados com o sistema reprodutivo de novilhas da raca Hereford recebendo uma mistura consistindo de 90% milho moido e 10% gordura animal, em regime de pastoreio. Esta mistura de milho e gordura animal foi suplementada com misturas minerais e Aureomicina.

Os tratamentos foram distribuidos da seguinte maneira: (A) capim, sem tratamento hormonal; (b) capim com 12 mg de DES implantados na orelha; (C) capim com 0.4 mg de MGA por animal por dia incorporado na ração; (D) capim + legume sem tratamento hormonal; e (E) capim-legume com 12 mg de DES implantados na orelha. Quarenta e oito animais de 14 mêses de idade e pesando inicialmente 588 libras (267 kilos) foram distribuidos em três pastagens com 16 animais por pastagem e recebendo a ração concentrada <u>ad libitum</u> por um período de 169 dias.

MGA aumentou ganho de pêso uma média de 0.32 lb por dia (P <.01) comparado com o tratamento A, porém êste aumento

não foi suficiente para ser significante sôbre tratamento B. Novilhas implantadas com DES (B) ganharam mais ($P < .05$) que as do groupo A. Animais pastando na combinação capim-legume ganharam 0.41 lb. mais ($P < .01$) do que animais pastando em capim nitrogenado. Animais ganhando mais, consumiram menos concentrado e fizeram melhor e mais eficiente uso do concentrado. Aumento em consumo e eficiência em utilização do concentrado foi pequeno no grupo C comparado com grupo A. Não foram encontradas diferenças significativas em caracteristicas de carcassa dos grupos A, B ou C. MGA suprimiu estrus em 15, de 16 animais. MGA, DES e legume estimularam o desenvolvimento mamário refletido em maiores ubres, mais longas e mais pesadas tetas ($P < .05$). Animais em grupo C tinham os ovarios mais pesados ($P < .01$). Falta de diferenças no número de folículos 12 mm e maiores e no número de corpora lutea pode ser devido ao fato de que MGA foi retirado da ração 7 dias antes da coleta de dados.

Baseados nos resultados desta investigação, as seguintes conclusões e sugestões são apresentadas: MGA (0.4 mg por animal por dia) aumentou ganho de pêso comparado com os animais em tratamento A. Êste aumento foi comparável com ganhos feitos por nevilhas recebendo 12 mg de DES implantes. MGA também suprimiu o periodo de cio e aumentou o pêso dos ovários das novilhas. A supressão do período estral reduz o trabalho de manejo e irá beneficiar os produtores que engordam novilhas para o mercado. Os resultados da comparação de capim recebendo Nitrogênio e capim + legume indicam que legume é de considerável valôr, estimulando ganhos de novilhas em sistema de pastoreio. Êsses resultados tambem vêm a suportar a teoria de que legume (trevo) possui uma certa atividade estrogênica.