STUDY PLAN FS-RM 1706-25

BENEFITS OF REST MARCH-OCTOBER TWO YEARS OUT OF THREE

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(PROJECT 1706, STUDY NO. 25)

This study conforms to the general objectives for range and wildlife habitat ecology and management research in project 1706 Tucson, Arizona for the period 1971-1980. Specifically a major objective is to maintain relatively stable livestock production under a system of grazing that meets acceptable standards of maintenance or production of vegetation for all essential functions. Constant stocking at a moderate level is prescribed. Cattle numbers will not be increased during the study period either to utilize extra herbage or to increase beef production. The values of vigorous perennial grass stands for erosion control and for their ability to retard shrub invasion are considered to rival their importance as forage for livestock. High yields of forage are considered as valuable for range improvement as for livestock production. Years of high production, for example, may provide opportunities to rest range units ahead of schedule or to bring about desired vegetation changes by burning, spraying, reseeding or other cultural methods. However, decisions to change or manipulate the vegetation will be based on evaluation of anticipated effects on wildlife and recreation as well as on anticipated changes in forage and livestock production.

Problem Reference

 This study falls primarily within the scope of problem analysis number two "Developing better grazing systems for semi-desert ranges. The determination of animal weight changes, however, is considered to fall under problem number 3 which deals with the relation of animal weights to differences in vegetation.

Objective

The primary objective of the study is to compare changes in the density, species composition, and herbage yield of herbaceous vegetation on ranges rested March-October 2 years out of 3 with concurrent changes on ranges grazed year-long. The secondary objective will be to evaluate the response of cattle to the two grazing systems.

Literature

Research of the literature reveals conflicting reports on the benefits of rotation-deferment grazing system. Heady (1961) concluded that year-long grazing at reasonable stocking rates was the best way to manage California annual type range. Likewise, McIlvain and Shoope (1969) evaluated specific systems of rotation at Woodward, Oklahoma and found that none of the five were superior to season long grazing. On the other hand Merrill (1969) on the Edwards Plateau reports benefits from rotations that rest the range four months out of 16. Heady's view that year-long grazing amounts to partial deferment every year if grazing is proper conflicts with the views of Hormay and Talbot (1961) and Ellison (1960) who concluded that selective grazing could not be avoided so long as the range was grazed. Thus, the literature contains numerous statements in support of the idea that some form of rotation should be good, but these statements are in conflict with many reported results of field tests in which rotation did not produce beneficial results.

Basis For March-October Rest 2 Years Out of 3

This study will be based primarily on the findings of study 1706-11 recently completed on the Santa Rita Experimental Range. The results of this study are reported in the manuscript "Response of Semidesert Grasses to Seasonal Protection from Grazing." The study evaluated 15 schedules of rest and grazing ranging from continuous year-long grazing to year-long rest two years out of three on 20ft x 20ft plots from 1962 to 1969. Three four-month rest periods: spring (March-June), summer (July-October) and winter (November-February) were defined. Protection in each season was applied (a) one year in three, (b) 2 years in three, and three years in four. Longer protection periods, spring-summer (March-October) and year-long were applied one year in three and two years in three. Finally, one set of plots was protected every winter and one set, the control, was grazed continuously year-long. Major findings were:

1. The density and herbage yield on Santa Rita threeawn and of perennial grasses other than Rothrock grama increased generally from 1962 to 1969 on both rested and grazed plots.

2. Density and yields of Rothrock grama and yields of annual grasses fluctuated greatly from year to year and ended about where they started. They were not affected by rest schedules.

3. Winter rest did not increase density or yield of perennial grasses when applied one or two years out of three, three years out of four, or every year.

4. Spring rest did not increase perennial grass yield or density when applied one or two years in three or three year in four.

5. Summer rest one or two years in three, or three years in four did not consistently increase yields of annual or perennial grasses generally or density of Rothrock grama. Density of perennial grasses other than Rothrock grama apparently increased under summer rest three years out of 4.

6. Year-long rest one or two years in three did not increase density or yield of Rothrock grama or yields of annual or perennial grasses generally. Year-long rest either one or two years out of three improved the stand of Santa Rita threeawn, and plots rested two years out of three produced the second greatest density gains on grasses other than Rothrock grama.

7. Spring-summer rest did not increase density or yield of Rothrock grama which behaved somewhat as an annual, or yield of annual grasses, but it did help perennial grasses other than Rothrock grama. Spring-summer rest two years out of three was consistently better than continuous grazing for Santa Rita threeawn.

8. Of the 15 schedules tested, spring-summer rest 2 years out of 3 produced the greatest improvement in perennial grasses. Increases in perennial grass density were related positively to the percentage of time protected. However, March to October protection two years out of three produced greater gains than would be anticipated on the basis of percent of time ungrazed.

General Features of the Grazing System

A three-pasture grazing system based on the findings of the above study is planned. Essential features of the system are:

1. Pastures will be rested March-October 2 years out of 3 on a rotating schedule.

2. The number of cattle to be grazed in a 3-pasture set will be the total that would be carried on the three pastures if each were grazed year-long.

3. The stocking rate will be same each year and will be based on the 10-year (1959-1968) average stocking needed to use 40% of the perennial grass herbage.

4. During each grazing period all of the cattle in a 3-pasture set will be in the same pasture.

5. During the winter all cattle will be in the pasture that has had its first spring-summer rest and that will be rested again the following spring and summer.

The rotation schedule for a three year cycle might be:

Year Grazing Period Pasture

 A B C

1 Mar-Oct Graze Rest Rest

 Nov-Feb Rest Rest Graze

2 Mar-Oct Rest Rest Graze

 Nov-Feb Graze Rest Rest

3 Mar-Oct Rest Rest Graze

 Nov-Feb Rest Graze Rest

This system provides rest from March-October 2 years out of 3 with each unit rested 67% of the time. The schedule is a working guide that cannot always be followed to the letter. In the event of a severe forage scarcity in one unit of a set, cattle may have to be moved before or after the scheduled date to avoid severe overgrazing or excessive losses in animal weight. The strategy in such situations will be to continue to keep the herd together and adjust moving dates to equalize forage use. The planned schedule will be resumed when forage production returns to normal. The procedure for adjusting grazing period is explained in Appendix I.

Anticipated Benefits of the System

The grazing system departs radically from the convention of grazing range units during the growing season every year. We believe that the system is feasible however, and that it has several practical advantages in addition to beneficial effects on perennial grasses.

1. The amount of labor required to look after cattle will be reduced. This advantage stems from the fact that all cattle in each 3-pasture set normally will be in 1 pasture instead of 3. This means that fewer waters and fences will have to be watched and less travel by truck or horse will be needed to care for the animals. This advantage should outweigh the extra effort required to move the herd from the winter unit to the spring-summer unit around March 1. The fall move will not involve extra work as it will be made at roundup time.

2. This system will not result in consistent overuse because the forage crop in a given pasture will support the combined herd for only 1/3 of the year. During the 4 month winter period, for example, the entire summer's herbage production will be available. During the March-October period, herbage consumed March-June also will be primarily that produced during the preceding summer. And, from July-October cattle will be feeding on current growth. Thus, in all three periods cattle will essentially be consuming a full years production during a four month period.

3. During the period March-June cattle will have ample carryover herbage during the time when forage is most often scarce. Proteins, minerals, or vitamin supplements can be provided if needed but energy should not be a limiting factor except in years of severe forage scarcity.

4. The quality of forage during the summer growing season should be equal to that under year-long grazing because grazing during the spring period (March-June) should remove much of the drier herbage that might otherwise obscure or dilute the new summer growth. This is especially important because the summer growing season is the only time when cattle consistently make rapid gains.

5. The system allows two rest periods for each grazing period. Perennial forage plants therefore have ample time to recover even if grazing is at times heavy. Our experience on the Santa Rita indicates that while 40% utilization on the average is a good rule of thumb occasional heavy use does not result in permanent damage if grasses have a chance to recover.

6. The system should be especially beneficial on areas near water where the forage stand has been weakened by persistent close grazing over a period of years. Rest periods will allow the forage plants to accumulate dry herbage. The accumulated old growth in turn will reduce the frequency of regrazing of preferred plants on areas of natural livestock concentration. In other words cattle entering a range that has been rested during two spring-summer periods will find the forage no more palatable near water than some distance away. This follows from results of a previous study in which it was found that the degree of use near water was reduced appreciably if that water had not been open to livestock during the preceding summer growing season.

7. The grazing schedule will provide opportunities for range improvement by prescribed burning, other methods of shrub control, or range reseeding without interfering with the basic grazing schedule.

8. The system provides opportunities for flexibility to meet forage scarcity in times of drought. During times of serious forage scarcity the cattle can be moved to another pasture before or after the scheduled date to reduce the need for supplemental feeds, or avoid serious reductions in livestock numbers.

The results of the seasonal deferment study supported findings from a number of other studies in that little benefit was gained by resting for only part of a normal growth or grazing period. This suggests that we may have avoided effective rest schedules in the past because we wished to maximize beef production and felt it important to harvest forage efficiently and uniformly every year. Hopefully, this grazing system will provide rest periods that are long enough, frequent enough and so timed that increased vigor and adequate reproduction of forage plants will be insured.

Methods of Study

The study will be extensive and somewhat demonstrational and will be conducted on the Santa Rita Experimental Range. The amount of data collected will be the minimum needed to determine differences in vegetation response between continuous year-long grazing and March-October rest 2 years out of 3.

Study Pastures (Map Attached [not included in digital file])

The study will involve 3 sets of 4 pastures each. Each set will be composed of 3 "rest" pastures and one that is grazed year-long every year.

Pasture Set 1. The rest pastures (25, 6A, and 6B) will be stocked with 172 cows. About half of the cows will be Herefords of the same breeding as those in the year-long pasture (2N). The remainder will be crossbreds (Barzona). Six to eight Hereford bulls will be with the cows from March-October. The year-long pasture (2N) will be stocked with 40 Hereford cows year-long plus 2 bulls March-October.

Pasture Set 2. The rested pastures (1, 21, and 22) will be stocked as scheduled with 52 Hereford cows. One or two Hereford bulls will be with the cows approximately March-October. The year-long pasture (8) will be stocked year-long with 20 cows plus 1 bull from March-October.

Pasture Set 3. The rested pastures (3, 5S, and 12B) will be stocked with 90 cows as scheduled. Four or five bulls will be with the cows from March to October. The year-long pasture (5N) will be grazed year-long by 40 Hereford cows plus 2 bulls from March-October.

Grazing Schedule

Only 6 of the 12 study pastures will be grazed at a time (3 year-long pastures and 3 of the 9 rest pastures). The scheduled plan of grazing for these pastures for a 6-year period starting March 1, 1972 is:

Period Pastures

 6A, 21, 5S 2S, 22, 3 6B, 1, 12B 2N, 8, 5N

Nov 72 - Feb 73 Graze Graze

Mar-Oct 1973 Graze Graze

Nov 72 - Feb 74 Graze Graze

Mar-Oct 1974 Graze Graze

Nov 72 - Feb 75 Graze Graze

Mar-Oct 1975 Graze Graze

Nov 72 - Feb 76 Graze Graze

Mar-Oct 1976 Graze Graze

Nov 72 - Feb 77 Graze Graze

Mar-Oct 1977 Graze Graze

Nov 72 - Feb 78 Graze Graze

Watering and Salting

All waters in each pasture will be open except that only 1 or 2 waters will be open when cattle are being weighed and for at least 3 days before weighing starts. Permanent salt grounds will be established and salt maintained at these approximate locations throughout the study period.

Experimental Design

The character and distribution of the 12 pastures available for the study and the kinds of data available on them do not permit the use of either a randomized block or completely random design. Three of the pastures (5N, 2N, and 8) will be grazed year-long to serve as controls. Of the 9 rest pastures, 3 will be grazed March-October of the first year, 3 in the second year and 3 in the third year to evaluate possible year-by-grazing interactions. Differences among units in elevation, size, abundance of mesquite and average rainfall are relatively large. Because of these differences among pastures, grazing effects on each pasture will be evaluated mainly by comparing vegetation changes during the study period with past records from the same pasture.

Eight of the pastures (1, 8, 2N, 3, 5N, 5S, 6B, and 12B) were involved in grazing studies that provided annual measurements of forage production and vegetation cover from 1957 to 1966 at permanently marked sampling plots. The sampling network for these pastures is intact (except for pasture 6B) and will be used to record changes in the same variables for this study. Realignment of the fence between 6B and 15 changes in water locations have disturbed the sampling scheme in 6B but 7 of the original sites are useable and will be employed in the new study.

Pasture 6A was used to study the effect of opening and closing waters on production of utilization of forage near water from 1960 to 1966. This sampling network too is intact and will be used to determine whether March-October rest 2 years out of 3 improved forage conditions near water where use is always heavy.

Pasture 2S has not previously been a study pasture and its shape and size have been changed by fencing off the east end to form pastures 21 and 22. Ten 100 ft transects will be established for measuring forage production and utilization. [Annual herbage production and utilization data since 1954 are available from 6 paced transect locations. Records from these will be continued to evaluate changes in this pasture.]

Pastures 21 and 22 are new. Ten 100-foot sampling sites similar to those used in pastures 1 and 8 will be established in each pasture. Responses in these pastures will be compared mainly with those in pasture 8 another mesquite infested pasture but one that is grazed year-long. Changes during the study in pasture 1, a mesquite-free pasture, will be compared with its past record and

with the performance of 8, 21 and 22.

Vegetation Records

Details for taking data are listed in Appendix III. Additional details may be found in study plans for studies 9, 12, and 15.

Perennial grass production by species will be the primary measure of grazing treatment effect.

Herbage production will be the primary measure of grazing treatment effect. Herbage production will be estimated on all permanent transects each fall in year-long pastures and in the fall following spring-summer rest in rested units.

Perennial grass density by species will be recorded in 1972 and at 3-year intervals thereafter on selected transects (Appendix II).

Utilization will be estimated on all transects following each season of grazing on rested pastures and annually in June in year-long pastures.

Animal Weights

Average weights of cows will be determined monthly by use of the automatic scale in the year-long pastures and in the pastures grazed seasonally. Calf weights at sale or weaning time will also be obtained from each herd. Weights of Herefords and crossbreds, both cows and calves, will be computed separately.

Analysis of Data

Since year-to-year fluctuations in forage production often obscure treatment effects, regressions that depict herbage yield per unit of rainfall during the pre-treatment period will be compared with similar regressions based on data taken during the study period.

Regressions derived from past records of herbage production and rainfall for several of the study pastures have been computed. These regressions relate average perennial grass production in the pasture to rainfall. Where possible other bases for groupings will be evaluated. In pastures 2N, 3, 5N, 5S, 6B and 12B for example, transects may be grouped by distance from water, soil texture, and presence or absence of mesquite. Distance from water is of particular interest because areas near water should be especially benefitted by the rest schedule. The responses of major species to the grazing treatments will be evaluated individually. Rothrock grama, which behaves somewhat as an annual, may react differently than will such longer lived species as Arizona cottontop, black grama or tall threeawns.

Estimated Cost

Forage production and utilization estimates will require about 20 man days field time each fall. Most of the field work must be done in September and October when student help is not available. If field work is done from Tucson, truck mileage and rental at current GSA rates will range from $200 to $350 per year depending on whether the job is done by 2 or 1 men. Density records which will be taken in July and August every 3rd year and can be done mainly by student

help. These records will require about 2 man months field time per measurement.

Average weights of cows will be recorded monthly in the 6 pastures that are grazed. With two weighing systems each weighing can be accomplished in about 6 days. To weigh 2 consecutive days in each unit will require 3 trips to the field during each weighing period. Mileage costs will run about $300. Film, batteries, developing and equipment repair costs will run $50 to $75 per month.

Annual project costs operating costs for the study there will be:

 Truck mileage $500 - $650

 Supplies and Equipment $600 - $900

 Total $1100 - $1550

Responsibility

Field phases of the study will be carried out mainly by Don Ward, Range Scientist. He will be assisted on the animal weight work by Pablo Lucero, maintenance worker. Cattle will be moved by the cooperator.

The project leader will be responsible for the overall supervision and execution of the study and will participate in field work as needed during the peak data collection period. Other permanent project personnel will likewise lend a hand as needed.

During the data collection period the study will require about 70% of Wards time and about 15% of the time of the project leader and about 10% of Cable's time. Data reduction will be current and in a form that can be readily analyzed by machine when the study is completed.

Duration of Study

The study is expected to run 6 years. One set of 4 pastures will be in the system starting in March 1972. The other two sets of pastures will be incorporated into the study when the essential fencing and water development can be completed and when pastures now in other studies can be released. November 1, 1972 is the target date.

Past results indicate that response to changes in grazing treatments may be slow or fast. If rainfall is favorable responses may be rapid and significant treatment effects may become apparent in 2 or 3 years. On the other hand, a series of poor rainfall years can override treatment effects. Thus, strong responses may be evident in as few as 3 years but 6 years or more may be needed for a truly sound evaluation.

Publication

If results are positive and conclusive they will be released in one or more of the following forms:

1. U.S.D.A. Handbook

2. Article in Journal of Range Management

3. One or more articles in livestock journals.

Appendix I

Rational for Moving Herds Before or After the Scheduled Date

Evidence from many grazing studies indicates that average year-long use of around 40% will maintain a relatively vigorous stand of perennial grasses. Even under flexible stocking, however, utilization may be expected to vary somewhat because the while average use of a range over a 10-year period may be 40%, utilization may run as high as 60 or 70% in drought years and drop as low as 15 or 20% in years of abundant forage production. The fact that ranges do recover after heavy use in low forage years indicates that occasional heavy use can be tolerated.

The average utilization of perennial grasses over a period of years is expected to be around 40%. However, because we plan to stock with a constant number of animals and because our primary concern in the study is to observe planned schedules of rest, livestock numbers will not be adjusted to meet the 40% use objective in a given year. Cattle will ordinarily remain in the assigned pasture for the assigned period. It is recognized however, that because of great year-to-year fluctuations in forage production it may not always be possible to adhere strictly to the assigned grazing schedule.

Movement of the herd may be postponed if utilization at the end of a grazing period is relatively light and if forage production is deficient in units scheduled to be grazed next. This kind of adjustment is feasible if forage production is high in the summer-grazed unit, but low either in the unit scheduled for grazing November-February, the unit scheduled for grazing March-June or both or if forage production in the winter-grazed unit is great enough to offset part or all of the forage deficiency from March to June in the unit to be grazed March-October. Such adjustments compensate for differences among pastures in forage produced during the same summer.

Advance adjustments to compensate for forage scarcity from July to October are not feasible not only because cattle remain in the same unit from March through October but because there is no way to predict forage yield.

The herd may be moved ahead of schedule to the unit next scheduled for grazing if utilization of perennial grasses in a grazed pasture becomes uniformly heavy before the end of the scheduled grazing period or if the scarcity of forage is obviously hurting the cattle.

From the utilization standpoint, cattle will not be moved ahead of schedule until average utilization for the pasture exceeds 60% of the current years herbage production. This level of use is 50% greater than the average use objective (40%) for the study. However, one of the basic concepts of resting the range March to October 2 years out of 3 is that perennial grasses will not be permanently damaged by occasional close grazing if scheduled rest periods provide adequate opportunity for recovery. In some cases cattle may be permitted to continue to graze a unit after perennial grasses are used in excess of 60% if the cattle appear to be doing well. This could happen in May or June if there is an adequate crop of mesquite leaves, blossoms, and beans or other browse and the cattle no longer are dependent on the perennial grasses.

Records from 1957 to 1968 for the study pastures indicate that pasture set number 1 (6A, 2S, and 6B) would have carried 180 animal units with a 10-year average utilization of 40%. By the same standard pasture set number 2 (21, 22 and 1) would have carried 54 animal units and pasture set number 3 (5S, 3, and 12B) 90 animal units. To carry these herds for a 4-month season (1/3 year) and meet a 40% use objective would require estimated year-long capacities of 60, 18, and 30 animal units for the pastures in sets 1, 2, and 3 respectively. However, since 60% utilization is to be allowed in emergencies, estimated carrying capacity for 40% use for pasture set 1, 2, and 3 could be as low as 40, 12, and 20 animal units, respectively. These are the threshold numbers that were used to see how the proposed grazing system might have worked if it had been applied

to the study pastures during the 1957 - 68 period.

Under the schedule, cattle grazed during the winter, (November-February) consume forage produced during the preceding summer. Likewise, cattle in the spring-summer unit graze from March 1 to June 30 mainly on forage produced the previous summer then graze mainly on current summer production from July-October. Thus, cattle during each 4-month period have use of a full summer's production of herbage. Table 1 lists for each season (1957-68) the pasture number and the number of herd days forage over or under the 60% use level.

Table 1. Herd days grazing over or under number required to carry herd in scheduled pastures for assigned 4-month periods assuming 60% use on perennial grasses.

Year Pasture November-December March-June July-October

 Set Pasture Herd Days Pasture Herd Days Pasture Herd Days

 Over Under Over Under Over Under

57-58 1 2S 12 6A 116 6A 132

58-59 6B 168 2S 30 2S 40

59-60 6A 105 6B 186 6B 43

60-61 2S 36 6A 30 6A 148

61-62 6B 348 2S 18 2S 58

62-63 6A 24 6B 6 6B 169

63-64 2S 45 6A 12 6A 18

64-65 6B 132 2S 37 2S 55

65-66 6A 24 6B 43 6B 184

66-67 2S 18 6A 40 6A 107

67-68 6B 123 2S 108 2S 138

Average 1 130 31 71 18 109 56

57-58 2 22 20 21 20 21 41

58-59 1 259 22 40 22 51

59-60 21 50 1 427 1 113

60-61 22 20 21 20 21 31

61-62 1 210 22 30 22 51

62-63 21 50 1 51 1 154

63-64 22 30 21 30 21 20

64-65 1 189 22 20 22 51

65-66 21 50 1 274 1 184

66-67 22 10 21 10 21 107

67-68 1 210 22 10 22 110

Average 2 156 32 122 20 83 33

57-58 3 3 54 5S 18 5S 209

58-59 12B 78 3 98 3 74

59-60 5S 360 12B 98 12B 49

60-61 3 96 5S 43 5S 74

61-62 12B 36 3 24 3 49

62-63 5S 6 12B 12 12B 37

63-64 3 0 0 5S 85 5S 98

64-65 12B 18 3 79 3 25

65-66 5S 66 12B 103 12B 43

66-67 3 24 5S 183 5S 442

67-68 12B 114 3 18 3 29

Average 3 113 20 86 39 154 41

The data in Table 1 was used to answer such questions as: (1) How often would forage have been deficient in all three pastures so that there would be no place to move? (2) How often would it have been necessary to violate the rule that the unit grazed during spring and summer should not be grazed during the preceding winter? (3) How often would it have been necessary to deviate from the rule that each pasture be rested two full March-to-October-periods out of three? and (4) How often was it necessary to continue grazing the spring-summer unit on into the fall because of a known forage shortage either in the winter unit or in the unit scheduled for grazing March-June.

Forage production in all pastures was so low in 1962 that forage shortages with no apparent place to move occurred late in the spring of 1963 in all 3 pasture sets (Figs. 1, 2, 3 [not included in digital file]). In 1963, the data indicated 70-day shortages (April 20 to June 30) in pasture sets 1 and 3, and a 22 day shortage (June 9-30) in pasture set 2. An additional 37 day shortage (May 20 - June 30) occurred in pasture set 3 in 1966. Thus apparent forage shortages occurred in only 2 of the 33 4-month grazing periods in pasture set 3 and in 1 of 33 periods in sets 1 and 2.

Violation of the rule that spring-summer units should not be grazed during the preceding winter were indicated in 1963 and 1966 in pasture sets 1 and 2 and in 1963, 1964, and 1967 in pasture set 3. In most cases the extra grazing period was only one or two months. Only in pasture set 2 was it necessary to begin grazing as early as December.

In several cases it was necessary to graze either at the beginning or end of a scheduled March-October rest period. Grazing would have begun in September or October of 1962 and 1965 pasture sets 1 and 2 and in 1962-63 and 1966 in set 3. Grazing during the fore part of the March-October period was necessary in 1965 in pasture set 1 (60 days). In set 2 grazing in March was necessary in 61, 64, 65, and 67 but in no case did the period extend into April. In pasture set 3 grazing was necessary in March in 1962 and in March and April of 1966.

Finally, there were several years in which grazing on the spring-summer unit was continued on into the fall to offset foreseeable forage shortages in either the winter or spring. This happened in 1961, 1964, and 1967 in set 1; in 1961 and 1964 in set 2; and in 1962 and 1965 in set 3.

Strict observance of 60% use as the signal to move cattle would have advanced or delayed movement of the herd about 1/3 of the time. Many of these deviations probably would not have been necessary in practice because occasional utilization in excess of 60% can be tolerated if the cattle are not hurt by sticking to the schedule. These results show that spring-summer rest 2 years out of 3 could have been applied with only minor deviations from the schedule.

One apparent feature of the system is that, within a given 3-pasture set, extra, unscheduled periods of grazing most often occur on the unit with the highest average forage production thereby giving the low producing units extra periods of rest. Presumably, the long term tendency of this feature is to equalize productivity among units because the average length of time grazed is greatest on the highest producing unit and least on the lowest yielding unit. If initial differences among units are the result of differences in range condition that will respond to improved grazing management the long range effect of this self-balancing tendency should be good. On the other hand, if differences in actual and potential forage production among units are large the best unit may eventually suffer unless positive steps are taken to equalize grazing pressure among units.Appendix II

Procedures for Taking Data

Identification and Marking of Plots

All study plots will include a line intercept transect marked at each end and at the 50 foot point by iron stakes not less than « inch in diameter and at least 4 inches high and a steel fence post to serve as a witness stake. In all cases the 100 foot line transect is considered to lie in the center of a 100 foot by 200 foot plot. The manner in which data is taken will not be the same in each pasture. For pastures that were in previous studies (Study Nos. 9, 12 and 15) the procedures for estimating herbage production and utilization will be the same as those used during the previous study. In pasture 2S the procedure will be similar to that followed in Study No. 9 but there will only be one transect or plot at each sample site. The procedure in pastures 21 and 22 will be similar to that of Study 12. In pasture 6A procedures will be those of Study no. 15. In general these procedures are:

Herbage Production Pastures 2N, 3, 5N, 5S, 6B, 12B and 2S - The herbage estimate at each transect will consist of two individual estimates on 8ft by 24ft permanent plots centered over the transect with the long axis lying along the transect. At each transect the plot that extends from 0 to 24 feet will be number one and the one from 50 to 74 feet will be number two. Herbage estimates will be made as soon as possible after the close of the summer growing season. Forage (Plots for Pasture 2S: 1972 - 5 9.6 foot plots, 1973 - 2 192 sq ft plots , 1974 - not measured, 1975 - 2 192 sq ft plots, 1976 - 5 9.6 foot plots.)

Herbage Production Pastures 1, 8, 21 and 22 - The herbage production estimate at each location will consist of five individual estimates on permanent 1ft by 9.6 ft plots located at the 10, 30, 50, 70 and 90 foot marks along the right hand side of a 100 foot tape stretched parallel to the line transect and 10 feet to the right of it, as one looks along the transect from the 0 end. A sixth plot will be estimated then clipped to provide a basis for adjusting ocular estimates. The plots to be clipped will be those located along the left side of the tape. The schedule for clipping will be to clip the 0 to 9.6 foot plot the first year, the 10 to 19.6 foot plot the second year, and so forth. All herbage estimates will be made as soon as possible after the close of the growing season. To facilitate relocation of the herbage production transect, which is not now marked, each of the transects to be used in this study will be marked at the 0, 50, and 100 foot points at the time the first measurement is made in pastures 1 and 8. In pastures 21 and 22 all transects will be new so the central transect and the offset transect will be established at each location at the first measurement. Steel fence posts near the 0 end of the central transect will aid in locating the plots for remeasurement.

Herbage Production on Special Transects Pasture 6A and 6B These transects were established in Study 15 at points ranging from 100 yards from permanent water. They are identified by a witness stake (3/4" x 3/4" angle iron 2" tall) 25 feet from the 0 end of the transect and with metal stakes at the 0-, 50- and 100-foot marks. Herbage estimates are made along these transects on 1-foot by 9.6-foot plots beginning at 10-, 30-, 50, 70, and 90-feet along the transect on the right hand side as viewed from the 0 end. One temporary plot will be clipped and estimated in the immediate vicinity of the permanent transect.

Utilization

Utilization on a permanent plot will be made by the ungrazed plant method described by Roach, but the following modification. Each plant will be classified as: ungrazed, partly grazed or fully grazed as set forth in "Instructions For Determining Utilization of Perennial Grasses on The Santa Rita Experimental Range" as revised 9/30/57. The 100 plant sample will be taken entirely within the 100 x 200 foot plot centered over the permanent transect.

Density Measurement

Density counts, which will be taken in 1972 and each third year, thereafter will be made on transects listed in the following table. The basic belt transect will be a 1-foot strip lying to the right of the transect line as viewed from the 0 end. Individual perennial grass plants will be recorded by species. For species that are particularly abundant, however, as in some cases for Rothrock grama or slender grama or curly mesquite a narrower strip may be used (6 inches by 100 ft or in extreme cases 3 inches x 100 ft). As a general guide the full one-foot-wide transect will be used unless the number of plants of a given species exceeds 100 on a narrower unit (i.e. if 100 Rothrock plants are counted on a 3" strip that will be sufficient, if the number is less than 100 on a 3" strip a 6" strip is indicated, etc.).

Schedule of Measurements

A tabular schedule of measurements (1972-78) follows. On year-long pastures, production and utilization will be measured every year. On seasonally rested units forage will be measured only after spring-summer rest and utilization will be measured at the end of the grazing period. Density will be measured in 1972, 1975 and 1978 on all units.

Table 1. --- Permanent Belt Transects To Be Used For Density Measurements (1)

Pasture Transect Numbers References

1 1, 3, 4, 5, 13, 14, 15, 17, 18, 20 Study 12

8 2, 3, 4, 5, 7, 8, 9, 12, 13, 14 Study 12

6A 11, 12, 13, 14, 15 (Huerfano S 70 deg. E) Study 15

6A 16, 17, 18, 19, 20 (Huerfano S) Study 15

6A 1, 2, 3, 4, 5 (East Tank N 67 deg. W) Study 15

6A 36, 37, 38, 39, 40 (Red Tank S) Study 15

6A 41, 42, 43, 44, 45 (East Tank N 69 deg. W) Study 15

6B 51, 52, 53, 54, 55 (Huerfano N 75 deg. W) Study 15

6B 56, 57, 58, 59, 60 (Huerfano n 45 deg. W) Study 15

6B 1E, 1W, 2E, 2W, 3E, 3W, 4E, 4W, 5E, 5W Study 9

5N 1E, 1W, 2E, 2W, 8E, 8W, 10E, 10W, 11E, 11W Study 9

5S 1E, 1W, 2E, 2W, 4E, 4W, 5E, 5W, 10E, 10W Study 9

2N 1E, 1W, 2E, 2W, 4E, 4W, 10E, 10W, 11E, 11W Study 9

3 1E, 1W, 4E, 4W, 7E, 7W, 8E, 8W, 10E, 10W Study 9

12B 4E, 4W, 5E, 5W, 7E, 7W, 10E, 10W, 11E, 11W Study 9

2S 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

21 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

22 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

(1) Belt transects for density will in all cases be the 1-foot wide strip along the right hand side of the transect as viewed from the 0 (zero) end.