

**Equipment Needed:** To plan and carry out a safe burn, equipment needed will usually include at least one or more drip torches, relative humidity gage, wind meter, spray equipment, and wet feed sacks.

**Follow-up Deferment:** After the burn, the pasture should generally be deferred for a period, depending on range condition and the producer's goals for improvement.

**Special Considerations:** When using prescribed burning on land infested with juniper or other plants high in oil, dry brush piles and large green trees should be removed near fireguards before the burn. Otherwise, they can explode and produce firebrands that can travel several hundred feet and ignite other land.

**Warning:** When the practice is not carried out properly, fire can escape to adjoining property. If smoke crosses highways, it can cause traffic accidents and death. If weather conditions are not as prescribed in the burning plan, the practice should not be carried out.

**Where to Get Help:** For technical assistance in planning and carrying out prescribed burning, contact your local office of the U.S. Department of Agriculture's Soil Conservation Service.

## What Shall We Do about Grazing Systems Studies?

Donald A. Jameson

There are many grazing management research questions that can only be answered by large scale grazing studies; one such question is addressed in so-called "grazing systems" research. There are two major difficulties in applying standard research procedures to such studies.

1. In a replicated grazing systems experiment with large pastures, the replication effect is usually greater than the treatment effect. Instead of having a single set of treatments which are replicated 2 or 3 times, we effectively have 2 or 3 different studies, none of which are replicated at all.

2. In years of lower than usual rainfall, fixed grazing schedule treatments with fixed heavy stocking rates must be interrupted. Only the lighter stocking rates can be applied with fixed grazing schedules in such years, and with light stocking rates there is usually no difference between different grazing systems.

Thus, two critical elements in standard experimental design, (1) replications and (2) fixed treatments, are difficult if not impossible to apply in large-scale grazing studies.

**An alternative approach is to use** sequential or adaptive methods of research and analysis. In this approach, the animals, soil, and vegetation are monitored and grazing adjustments made as needed. This is what good range managers do all the time; the problem is to see how range researchers can use these methods.

An adaptive system requires that some measurements or other observations be taken at intervals; a predictive model is used to supply information between measurements. We might not think that we are using a model, but we do. For example, suppose that we measure something about the range on June 1, and don't remeasure it until July 1. Anything that we can say about the range between these measurement periods comes from our concept or "model" of how the range

will perform during this time. Although models may be very complex, the model used in this case may simply say that everything remains the same during the rest of June as it was on June 1. Without a model we would have to measure continuously to know what's going on. To keep our understanding about the range at a satisfactory level, we can use either better models or better measurements. The combination of models and measurements we call "monitoring." As a result of monitoring, needed changes in management can be made in an "adaptive management" scheme. Changes in grazing based on residual plant biomass is one example of management based on monitoring.

**The adaptive management method seems like** a good idea, but perhaps a little near-sighted if used exactly as described in the previous paragraph. Suppose we try this method to make adjustments in grazing schedules; as it turns out, the simple-minded adaptive approach is perfectly acceptable if:

1. The statistical errors in the measurements and models are not strongly skewed from a normal distribution.
2. The cost or penalty for a given degree of undergrazing is about the same as for the same degree of overgrazing.
3. The changes in plant and animal performance from an undergrazed condition to an overgrazed condition follow the same pathway (but are opposite in direction) as the changes from an overgrazed condition back to an undergrazed condition.

In pastures managed as a single species, particularly if coupled with a supplementation program, the three conditions described above are reasonable, and the adaptive approach shouldn't get us into too much trouble. Under these conditions, we can use simple observations of vegetation and animal performance to make adjustments to grazing schedules and stocking rates. In a lot of vegetation types, such as the shortgrass plains, this method will be very useful.

On the other hand, we don't have to think too hard to realize that the three required conditions for adaptive management as described above don't always apply to range-

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lands. For example, forage responses which depend heavily on rainfall most likely will not be normally distributed, but will have a skewed distribution because periods below the mean rainfall are more common than periods of above mean rainfall. As another example, the time required to shift from plant species that are "decreasers" to species that are "increasers" may be much less than the time required to shift from "increasers" to "decreasers". Since we cannot develop recommendations based on fixed grazing schedules even in the simplest cases, and can't use the simpler forms of adaptive management in many vegetation communities, we often seem to be at a loss in approaching grazing systems research.

**There are at least two things that might be done** in the difficult problem situations:

(a). Find or develop biological indicators for the range system that meets the three required conditions listed above for adaptive management. According to the principles of production economics, these indicators should be used to guide the manager toward stocking rates that are greater than those yielding the maximum gain per animal, but less than those which yield maximum gain per acre. Appropriate indicators might include animal responses such as fecal nitrogen or length of grazing time between animal rest periods. On the other hand, the indicators may be derived from plant responses; intuition (backed up by a few hundred studies about clipping and grazing effects on plant growth) suggests that management based on observations of plant roots might be appropriate. A major problem with the root approach is that we presently do not have good methods for observing roots; all of our existing methods are very costly and have high sampling error. We're not even sure what it is about the root system that is meaningful as a grazing management indicator, but recent research on this question is at least providing some clues.

A good root measurement program would also address the problem of predicting the impact of this year's grazing on next year's range performance, and thus provide an "early

warning" of impending changes in range performance. It is clear that observations only on top growth don't get a handle on this question.

(b). Use a stochastic dynamic programming model that considers all of the uncertainty, possible management corrections, and measurements which will be encountered throughout the length of the planning period (2 years, 10 years?), and compare the results to a decision model in which the uncertainty of future events is ignored. In general, ignoring the uncertainty of future events requires the same three conditions as mentioned earlier for the simpler approaches to adaptive management. If a computational approach that considers uncertainty of future events yields the same decision as a simpler approach that ignores uncertainty, we then know that the simpler approach is appropriate. A research program can be designed to determine if the two approaches yield the same or different results; if the results are equivalent, we can say that "certainty equivalence" applies. If we can ignore future uncertainty, the computational load ranges from trivial to reasonable, and could be done under many management situations. If the three required conditions don't apply and the more complex approach must be used, the computational load ranges from uncomfortable to unbearable and probably won't be done by managers.

**It seems like the best immediate approach** in grazing systems research is to (1) quit wasting our resources trying to find desirable fixed schedule grazing systems, and (2) emphasize grazing trials that use flexible scheduling and flexible stocking rates based on the things we currently know how to observe. Where this doesn't work, we should design research programs to include (a) suitable biological indicators for adaptive management and (b) computational methods that consider the uncertainty of future events. Until we make some fundamental progress in these areas, range researchers must merely bow to experienced range managers and wish them well.

## Associate Editorship—*Journal of Range Management*

**Nominees are being sought** for 2 associate editorships which will be open in the coming year. Associate editors serve for 2 years with an optional 2-year renewal. Areas of expertise especially needed at present are brush management and range improvements, economics, sampling methodology in range research, and soils. Candidates selected will work with an associate editor for 3 months before taking over complete responsibility in February 1987.

**Nominees should have** a strong and current background in research, be capable writers, and have had successful experience as reviewers. Associate editors are responsible for conducting the review of manuscripts and for accepting or rejecting manuscripts. The average yearly load is 20-30 manuscripts.

**Nominations should be submitted before 15 September 1986**, to the Editor, *Journal of Range Management*, 2760 West Fifth Avenue, Denver, CO 80204. The individual making the nomination should give his own name, the name, address, telephone number, and current position of the nominee as well as a description of his qualifications for the associate editorship. The nominator should ascertain that the individual would be willing to serve if selected. An Editorial Replacement Committee will select the associate editors subject to the approval of the Board of Directors.

The Society's journal both reflects the state of the profession and influences the course of the profession. Selection as an associate editor is, therefore, an honor and a responsibility.