Chapter 18

Cattle Ranch Management

18.1 A Static Model of Ranch Management

Linear programming has been used for many years to help make management decisions in beef feedlot and dairy cattle operations. In this chapter we discuss a LP model applied to range cattle ranching. The main problem of this type of farm operation is the decision about the stock of animals versus the available quantities of feed during the year. Cattle ranching is a dynamic enterprise requiring a sequence of decisions overlapping several production cycles. In order to keep the problem relatively simple, however, we begin with a static specification of the problem and turn to a multistage formulation in a further section.

A second motivation for discussing this problem is that it is suitable for illustrating the adaptive process of formulating a reasonable plan. We must emphasize that the specification of a linear programming model is never a one-shot deal. Often, what seem plausible and intuitive relations turn out to be too restrictive and require modification.

The model discussed here is based on a hypothetical beef cattle ranch on annual range in San Luis Obispo county in California. It was originally formulated by Weitkamp, Clawson, Center, and Williams of the Cooperative Extension Service and the University of California at Davis. The year is divided into five periods or seasons based upon the changing pattern of forage availability and animal feed requirements as reported in table 18.1.

Table 18.2 gives daily and seasonal nutrient requirements of the cattle units in pounds of dry matter and crude protein. Dry matter (a measure of feed quantity) and crude protein (a measure of feed quality) are used in this model because they are readily available. More correct indicators of nutrient content such as total digestible nutrients, metabolizable energy, digestible energy, and digestible crude protein can easily be substituted when available. The assumption is that the ranch is stocked with a herd of cattle with fixed composition: cows, calves (90 percent of calf crop), heifers (20 percent replacement), and bulls (1/20 of cows). The animal products include calves, native (home-bred) steers, and purchased steers.

The ranch is divided into several land units depending on terrain and soil

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conditions. There are 3,000 acres of unimproved range that will be grazed “as
is”; 1,000 acres of improvable range that can be treated with three management
alternatives: graze as is, fertilize, and seed with legumes and fertilize; 1,000
acres of brushland that can either be grazed as is or cleared; 75 acres of irrigated
pasture that can either be grazed all five seasons, or grazed in seasons 1, 3, 4,
and 5 while producing hay in season 2; 25 acres are cultivated with alfalfa for
hay that can either be fed to the ranch cattle or sold. Hay production is a
typical farming operation on many ranches and is included in the model as a
product alternative on irrigated pasture and alfalfa land. Supplemental feeding
of brood cows, which is necessary for satisfactory calf production, is included
as two purchase options in the form of liquid protein supplement and oat hay.
Ranch-produced pasture and alfalfa hay are also available for supplementing the
cows’ diet.

A detailed definition of the activities and constraints is as follows:

**Activities**

land management alternatives (acres):

\[
x_1 \equiv \text{irrigated pasture, graze in seasons 1, 3, 4, 5, hay in season 2}
\]
\[
x_2 \equiv \text{irrigated pasture, graze in all five seasons}
\]
\[
x_3 \equiv \text{unimproved range, graze as is}
\]
\[
x_4 \equiv \text{improvable range, graze as is}
\]
\[
x_5 \equiv \text{improvable range, fertilize}
\]
\[
x_6 \equiv \text{improvable range, seed and fertilize}
\]
\[
x_7 \equiv \text{brushland, graze as is}
\]
\[
x_8 \equiv \text{brushland, graze after clearing}
\]
\[
x_9 \equiv \text{alfalfa hay}
\]
\[
x_{10} \equiv \text{alfalfa ranch hay, season 1, tons}
\]
\[
x_{11} \equiv \text{alfalfa ranch hay, season 4, tons}
\]
\[
x_{12} \equiv \text{alfalfa ranch hay, season 5, tons}
\]
\[
x_{13} \equiv \text{irrigated pasture ranch hay, season 1, tons}
\]
\[
x_{14} \equiv \text{irrigated pasture ranch hay, season 4, tons}
\]
\[
x_{15} \equiv \text{irrigated pasture ranch hay, season 5, tons}
\]
\[
x_{16} \equiv \text{purchased liquid protein, season 1, pounds}
\]