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RANGELAND MANAGEMENT SERIES

# Estimating the Cost of Replacing Forage Losses on Annual Rangeland

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Valuable forage is often lost on annual rangelands because of wildfires, cultivation, road construction, and excavation. Estimating the cost of such losses cannot be based on traditional grazing rental rates for livestock because the impact on forage production is more far reaching than the impact of grazing. All residual dry matter (RDM) is removed and, except in the case of fire, the soil profile is disturbed. In addition to the loss of the current year's forage, the next 2 years of forage production could be impacted, along with the length of adequate forage-growing periods and species composition.

For example, after a fire or disturbance has removed all vegetation, forage production will be about 50 to 70 percent of the amount on an undisturbed site in the following season, and the species composition will shift primarily to forbs, which are lower in biomass production. The second growing season after the disturbance, forage production will be about 20 percent less than on undisturbed sites. Only in the third growing season will forage production be similar on both sites (Hervy 1949; Zavon 1982; McDougald and Frost 1989a, 1989b). After a high-intensity fire that leaves white ash, less than 25 percent as much forage will be produced on the burned site than on an unburned site for each of the next 3 years, and possibly longer, if reseeding is not conducted (Frost 1988). To appraise the impact of this disturbance on annual rangeland forage production, it is necessary to assess the impact on the site.

## Finding Ecological Site Descriptions

Ecological site descriptions (ESDs) are gradually being developed for California rangelands. Once approved, the ESDs are posted on the USDA NRCS Ecological Site Information System Web site, http://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=ESD. USDA NRCS staff can help you learn how to use this site. If you are not familiar with your local NRCS office, their phone number can be located in the Government section of your phone book or by searching the NRCS Web site for local offices.

Alternatively, many ESDs for California rangelands are available at the California Rangeland Research and Information Center's Web site. To identify which ESD covers your disturbed area you must know the soils at the site. You can determine the soils on the University of California's online soil survey by following these steps:

**Step 1:** Determine which rangeland soil(s) are present at the disturbance site using the California Soil Resource Lab soil survey for California, http://casoilresource.lawr.ucdavis.edu/drupal/node/27.

**Step 2:** Find the ESDs for the rangeland soils at the California Rangelands Research and Information Center Web site, http://californiarangeland.ucdavis.edu/California%20Vegetation/Ecological%20Sites/ESD%20Web/esd.soil.conversion.htm.

**Step 3:** Open the PDF file for the ESD and scroll down to "Annual Production by Plant Type" in the Plant Communities section. Here you will find production estimates for a favorable, unfavorable, and normal year. These estimates are based on long-term averages.

## Using the Soil Data Mart to Determine Range Productivity

**Step 1:** Go to the Soil Data mart Web site, http://soildatamart.nrcs.usda.gov/.

**Step 2:** Select state.

**Step 3:** Select county.

**Step 4:** Select survey area.

**Step 5:** Select generate reports.

**Step 6:** Select the soil series or soil mapping unit from the list. Use the shift key to select several consecutive soils. Use the control key to select several nonconsecutive soils.

**Step 7:** Select range productivity and plant composition from the drop-down menu.

**Step 8:** Generate reports. You should receive a file listing the unfavorable, normal, and favorable productivity for the range site that cover the selected soil(s).

## Estimating forage consumed or lost during the year of disturbance

To estimate forage loss you need to know the amount of forage lost, expected or actual annual production, RDM standard, and acreage of the disturbed area. In addition, the grazing efficiency must be taken into consideration.

### Amount of Forage Lost

If you were grazing before or during the time of the disturbance, the amount of forage lost can be determined by measuring the standing crop in an adjacent area that was grazed at the same time and intensity as the disturbed area. If you have reached your RDM standard before the disturbance and removed livestock, the RDM standard is the amount of forage lost. If the area has not been grazed this growing season, the amount of forage lost is equal to the amount produced on the disturbed area.

### Expected or Actual Production

The actual forage production for the site and amount of forage lost can be determined by clipping of plots (Cook and Stubbendieck 1986; Herrick et al. 2005) or the comparative yield method (Haydock and Shaw 1975). The estimated forage production for the pasture can also be determined from ecological site descriptions (see sidebar) or from old range site descriptions published by USDA Natural Resources Conservation Service (NRCS) at the Soil Data Mart Web site (see sidebar). Local NRCS and UC Cooperative Extension offices may also have long-term average forage production for some sites.

### RDM Standards

Adequate amounts of RDM, the dry plant material left on the ground from the previous year's growth, must be left at the end of the grazing season to protect the site and to provide a favorable microenvironment for the following year's forage production (Clawson et al. 1982). Therefore, the difference between the amount of forage produced on a site and the RDM is the amount available for rangeland management ( for a more complete discussion of RDM, including determining RDM standards, see Bartolome et al. 2006). RDM standards vary based on the percentage of slope and the percentage of woody cover (Bartolome et al. 2006), with steeper slopes requiring more RDM left to protect the site.

In this publication RDM guides for California's foothill and coastal rangelands are reported for three vegetation types: dry annual grassland, annual grassland/hardwood rangeland, and coastal prairie. Dry annual grasslands are defined as an annual-plant-dominated site with average annual rainfall less than 12 inches. Oak and shrub canopy is typically less productive than in other types. Annual grassland/hardwood rangeland has an average annual rainfall between 12 and 40 inches and consists of an annual plant understory with variable oak or shrub canopy. Coastal prairie commonly includes perennial grasses, variable woody overstory, and annual rainfall above 35 inches. RDM guidelines have been developed for several slope and canopy cover classes for each of these vegetation types (table 1).

### Grazing Efficiency

Available forage is the total annual forage production minus the RDM standard. However, some of the total annual forage is lost to wildlife grazers, trampling, and decomposition. On gentle terrain only about half of the available forage is consumed by livestock; therefore, the grazing efficiency is 50 percent (Heitschmidt and Stuth 1991; Valentine 2001). As slope increases, grazing efficiency is further decreased (Holechek et al. 2004; George et al. 2007). On steep slopes livestock generally do not use forage far from a trail or water source. Table 1 shows RDM and grazing efficiency for each grassland type by slope and woody cover.

## Supplemental Feeding

The nutritional value of forage varies during the year. Supplemental feeding is may be required to make up for nutrients lost during the seasons and to meet the nutritional requirements of livestock at different stages of production (pregnancy, lactation, growth, etc). On California's annual rangelands, dry forage during summer and early fall lacks protein, phosphorus, and Vitamin A. In the fall and early winter, new forage growth is high in moisture, but the energy it can supply is often inadequate for desired livestock performance. Feed supplements are then provided in the form of dry concentrated feed, liquids, or blocks formulated to provide a source of protein (or nonprotein nitrogen), phosphorous, Vitamin A, and, sometimes other minerals (e.g., copper and magnesium). At the beginning of the new forage season, protein and energy are most often supplemented in the form of hay if adequate forage was not left from the previous growing season. Oat hay can supply an adequate amount of energy, but it is a poor source of protein and Vitamin A. Alfalfa hay, on the other hand, is a good source of all these nutrients (table 2).

## Determining the Value of Forage Lost

The value of forage lost can be calculated using two Excel spreadsheets (Forage Replacement Worksheet and Prior Grazing Forage Replacement Worksheet) available at the Web site, http://ucanr.org/sites/forageloss. The calculations take into account the forage productivity of the site, the reduction in productivity due to a disturbance, the RDM standard necessary to protect the site, the grazing efficiency of grazing livestock, and the number of acres affected. In addition, the final worksheet in each file calculates the cost of replacing lost forage with comparable hay. Current local costs must be entered for hay as delivered. In addition, a cost of feeding hay has been included in the calculations. Ahola and Jensen (2009) calculated the current cost of feeding hay at $13.40 per ton.

The only difference between the two spreadsheets is whether the pasture had been grazed during the growing season before the fire or disturbance had occurred. If there had been no grazing during the growing season, the Forage Replacement Worksheet should be used. If grazing occurred during the growing season, the Prior Grazing Forage Replacement Worksheet should be used; this spreadsheet takes into account the amount of forage still available for grazing during the growing season with an entry labeled "Standing Crop." All other information to be entered is the same in both spreadsheets.

Three examples are presented below to clarify how to use the spreadsheets. Each example uses the same type of rangeland for the fire to illustrate the differences between the management of the ranch. The land affected by the fire in all three examples is

- annual grassland type
- 42 acres fairly flat with scattered trees (0 to 10% slope; 0 to 25% woody cover)
- 45 acres gentle rolling oak woodland (10 to 20% slope; 50 to 75% woody cover)
- 31 and 32 acres steep hills with oaks and chaparral (> 40% slope; 25 to 50% woody cover on one hillside, 50-75% woody cover on another)
- ESD (Ecological Site Description): Gravely Loam Foothills, normal year forage production.

Oat hay was fed as the supplement when the pasture was used in summer or fall, and alfalfa hay was fed when the pasture was used in spring. Oat hay is comparable, in terms of TDN, to late dry forage, although it is higher in protein content (see table 2). Alfalfa hay is comparable to green forage in TDN, protein content, and phosphorous. If the reduced forage production on a site is less

than the RDM standard, that site is ignored when calculating usable forage.

## Example 1

The fire occurred during the spring while the pasture was being grazed. Using the Prior Grazing Forage Replacement spreadsheet enter the "Standing Crop," "Forage Production," and "No. acres" burned for each land type in the Beginning Inventory worksheet (see the spreadsheet tabs). To determine the standing crop, adjacent, unburned sites were clipped for each land type. Since the grazing occurred in the growing season, alfalfa hay would be purchased as a supplement. Spreadsheet entries are presented in tables 3 through 5.

The year the fire occurs, there is a loss of 10 tons of forage. The first and second growing season there is a loss of 18 and 9 tons, respectively, for a total of 37 tons. With alfalfa hay currently being delivered at $150 per ton, the total value of forage lost is $6,097 for the three years (table 6).

## Example 2

In this scenario the pasture is again grazed in the adequate green forage period when the quality of forage is comparable to alfalfa hay. At the time of the fire the pasture had already been grazed to the proper RDM levels (depending on slope and tree cover, this example ranged from 300 to 700 pounds per acre), so no usable forage was lost at that time; again, the Prior Grazing Forage Replacement spreadsheet should be used. The standing crop is the RDM standard since grazing had concluded when RDM standards were reached. The impact of the fire will be apparent only in the following two growing seasons. Spreadsheet entries for this example are presented in tables 7 through 9.

Since grazing had already occurred to the RDM levels, there is no forage loss in the current year, and subsequent years will again have a loss of 18 and 9 tons, respectively, for a total of 27 tons. To compensate for this loss, 27 tons of alfalfa hay must be purchased, delivered, and fed at a delivered cost of $150 per ton, for a total of $4,208.88 (table 10).

## Example 3

In this case, the pasture is typically grazed in the late summer or early fall, so no grazing had occurred at the time of the fire. Use the Forage Replacement spreadsheet and enter the data under "Forage Production" and "No. acres" (tables 11 through 13). All of the current year's forage was lost, amounting to 35 tons. This would be a loss of 18 and 9 tons, respectively, in the subsequent 2 years, a total of 63 tons of lost forage. Since the pasture was grazed in the late summer, oat hay is the equivalent supplement to be fed. The current cost of oat hay delivered is $95 per ton, giving a total loss of $6,790.72 (table 14).

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## Measurement Conversion Table

| U.S. Customary | Conversion factor for U.S. Customary to Metric | Conversion factor for Metric to U.S. Customary | Metric |
|---|---|---|---|
| acre (ac) | 0.4047 | 2.47 | hectare (ha) |
| bushel (bu) | 0.035 | 28.37 | cubic meter (m3) |
| ounce (oz) | 28.35 | 0.035 | gram (g) |
| pound (lb) | 0.454 | 2.205 | kilogram (kg) |
| ton (T) | 0.907 | 1.1 | metric ton (t) |
| pound per acre (lb/ac) | 1.12 | 0.89 | kilogram per hectare (kg/ha) |
| ton per acre (T/ac) | 2.24 | 0.446 | metric ton per hectare (t/ha) |

**Table 1.** Minimum RDM standards and grazing efficiencies.

| Site | Site description | RDM standard (lb/acre) | Grazing efficiency (%) |
|---|---|---|---|
| 1 | Dry Annual Range 0–10% slope | 300 | 50 |
| 2 | Dry Annual Range 10–20% slope | 400 | 40 |
| 3 | Dry Annual Range 20–40% slope | 500 | 20 |
| 4 | Dry Annual Range >40% slope | 600 | 10 |
| 5 | Annual Grassland/Hardwood Range 0–10% slope, 0–25% woody cover | 500 | 50 |
| 6 | Annual Grassland/Hardwood Range 0–10% slope, 25–50% woody cover | 400 | 50 |
| 7 | Annual Grassland/Hardwood Range 0–10% slope, 50–75 woody cover | 200 | 50 |
| 8 | Annual Grassland/Hardwood Range 0–10% slope, 75–100% woody cover | 100 | 50 |
| 9 | Annual Grassland/Hardwood Range 10–20% slope, 0–25% woody cover | 600 | 40 |
| 10 | Annual Grassland/Hardwood Range 10–20% slope, 25–50% woody cover | 500 | 40 |
| 11 | Annual Grassland/Hardwood Range 10–20% slope, 50–75 woody cover | 300 | 40 |
| 12 | Annual Grassland/Hardwood Range 10–20% slope, 75–100% woody cover | 200 | 40 |
| 13 | Annual Grassland/Hardwood Range 20–40% slope, 0–25% woody cover | 700 | 20 |
| 14 | Annual Grassland/Hardwood Range 20–40% slope, 25–50% woody cover | 600 | 20 |
| 15 | Annual Grassland/Hardwood Range 20–40% slope, 50–75 woody cover | 400 | 20 |
| 16 | Annual Grassland/Hardwood Range 20–40% slope, 75–100% woody cover | 250 | 20 |
| 17 | Annual Grassland/Hardwood Range >40% slope, 0–25% woody cover | 800 | 10 |
| 18 | Annual Grassland/Hardwood Range >40% slope, 25–50% woody cover | 700 | 10 |
| 19 | Annual Grassland/Hardwood Range >40% slope, 50–75 woody cover | 500 | 10 |
| 20 | Annual Grassland/Hardwood Range >40% slope, 75–100% woody cover | 300 | 10 |
| 21 | Coastal Prairie 0–10% slope, 0–25% woody cover | 1,200 | 50 |
| 22 | Coastal Prairie 0–10% slope, 25–50% woody cover | 800 | 50 |
| 23 | Coastal Prairie 0–10% slope, 50–75% woody cover | 400 | 50 |
| 24 | Coastal Prairie 0–10% slope, 75–100% woody cover | 200 | 50 |
| 25 | Coastal Prairie 10–20% slope, 0–25% woody cover | 1,500 | 40 |
| 26 | Coastal Prairie 10–20% slope, 25–50% woody cover | 1,000 | 40 |
| 27 | Coastal Prairie 10–20% slope, 50–75% woody cover | 500 | 40 |
| 28 | Coastal Prairie 10–20% slope, 75–100% woody cover | 250 | 40 |
| 29 | Coastal Prairie 20–40% slope, 0–25% woody cover | 1,800 | 20 |
| 30 | Coastal Prairie 20–40% slope, 25–50% woody cover | 1,200 | 20 |
| 31 | Coastal Prairie 20–40% slope, 50–75% woody cover | 600 | 20 |
| 32 | Coastal Prairie 20–40% slope, 75–100% woody cover | 300 | 20 |
| 33 | Coastal Prairie >40% slope, 0–25% woody cover | 2,100 | 10 |
| 34 | Coastal Prairie >40% slope, 25–50% woody cover | 1,400 | 10 |
| 35 | Coastal Prairie >40% slope, 50–75% woody cover | 700 | 10 |
| 36 | Coastal Prairie >40% slope, 75–100% woody cover | 350 | 10 |

*Source:* Bartolome et al. 2006.

**Table 2.** Dry matter percentage, total digestible nutrients (TDN) percentage, protein content, and phosphorous percentage for oat and alfalfa hay and range forage

| Feed | Dry matter (%) | TDN (%) | Protein content (%) | Phosphorous (%) |
|---|---|---|---|---|
| alfalfa hay | 90 | 60 | 17 | 0.22 |
| oat hay | 90 | 54 | 9 | 0.21 |
| late dry forage | 90 | 45 | 3 | 0.15 |
| early green forage | 30 | 20 | 6 | 0.08 |
| early green forage | 90 | 60 | 18 | 0.25 |
| late spring forage | 60 | 45 | 10 | 0.18 |
| late spring forage | 90 | 60 | 15 | 0.25 |

**Table 3.** Example 1: Sample Prior Grazing Forage Replacement spreadsheet, beginning inventory

| Beginning Inventory | | Standing crop (lb/acre) | Forage production (lb/acre) | RDM (lb/acre) | Grazing efficiency | No. Acres | Usable forage lost (lb) | Normal production usable forage (lb) |
|---|---|---|---|---|---|---|---|---|
| Site | | | | | | | | |
| 5 | Annual Grassland/Hardwood Range 0–10% slope, 0–25% woody cover | 700 | 2,000 | **500** | **0.5** | 42 | **4,200** | **31,500** |
| 11 | Annual Grassland/Hardwood Range 10–20% slope, 50–75% woody cover | 1,000 | 2,000 | **300** | **0.4** | 45 | **12,600** | **30,600** |
| 18 | Annual Grassland/Hardwood Range >40% slope, 25–50% woody cover | 1,200 | 2,000 | **700** | **0.1** | 31 | **1,550** | **4,030** |
| 19 | Annual Grassland/Hardwood Range >40% slope, 50–75% woody cover | 1,100 | 2,000 | **500** | **0.1** | 32 | **1,920** | **4,800** |
| | | **Total pounds of usable forage lost** | | | | | **20,270** | |
| | | **Total tons of usable forage lost** | | | | | **10.135** | |

*Note:* In the spreadsheet, enter the standing crop, forage production, and the number of acres. The columns in bold are calculated by the spreadsheet.

**Table 4.** Example 1: First growing season

| First Growing Season | | Forage production (lb/acre) | Potential forage production | RDM (lb/acre) | Grazing efficiency | No. Acres | Usable forage available (lb) | Usable forage lost (lb) |
|---|---|---|---|---|---|---|---|---|
| Site | | | | | | | | |
| 5 | Annual Grassland/Hardwood Range 0–10% slope, 0–25% woody cover | **2,000** | **0.6** | **500** | **0.5** | **42** | **14,700** | **16,800** |
| 11 | Annual Grassland/Hardwood Range 10–20% slope, 50–75% woody cover | **2,000** | **0.6** | **300** | **0.4** | **45** | **16200** | **14,400** |
| 18 | Annual Grassland/Hardwood Range >40% slope, 25–50% woody cover | **2,000** | **0.6** | **700** | **0.1** | **31** | **1550** | **2,480** |
| 19 | Annual Grassland/Hardwood Range >40% slope, 50–75 woody cover | **2,000** | **0.6** | **500** | **0.1** | **32** | **2240** | **2,560** |
| | | **Total pounds of usable forage lost** | | | | | | **36,240** |
| **Total tons of usable forage lost** | | | | | | | | **18.12** |

*Note:* The data is carried forward from beginning inventory; all columns are calculated by the spreadsheet.

**Table 5.** Example 1: Second growing season

| Second Growing Season | Site | Forage production (lb/acre) | Potential forage production | RDM (lb/acre) | Grazing efficiency | No. Acres | Usable forage available (lb) | Usable forage lost (lb) |
|---|---|---|---|---|---|---|---|---|
| 5 | Annual Grassland/Hardwood Range 0–10% slope, 0–25% woody cover | **2,000** | **0.8** | **500** | **0.5** | **42** | **23,100** | **8,400** |
| 11 | Annual Grassland/Hardwood Range 10–20% slope, 50–75% woody cover | **2,000** | **0.8** | **300** | **0.4** | **45** | **23,400** | **7,200** |
| 18 | Annual Grassland/Hardwood Range >40% slope, 25–50% woody cover | **2,000** | **0.8** | **700** | **0.1** | **31** | **2,790** | **1,240** |
| 19 | Annual Grassland/Hardwood Range >40% slope, 50–75 woody cover | **2,000** | **0.8** | **500** | **0.1** | **32** | **3,520** | **1,280** |
| | | **Total pounds of usable forage lost** | | | | | | **18,120** |
| | | **Total tons of usable forage lost** | | | | | | **9.06** |

*Note:* The data is carried forward from beginning inventory; all columns are calculated by the spreadsheet.

**Table 6.** Example 1: Substitution value

| | |
|---|---|
| **Beginning tons lost** | **10** |
| **Tons lost, first growing season** | **18** |
| **Tons lost, second growing season** | **9** |
| **Total tons lost** | **37** |
| Cost to feed hay (per ton) | $13.40 |
| Cost of replacement forage delivered (per ton) | $150.00 |
| | |
| **Total cost of replacement forage** | **$6,097.27** |

*Note:* Enter the cost of replacement forage delivered. The columns in bold are calculated by the spreadsheet.

**Table 7.** Example 2: Beginning inventory

| Beginning Inventory | Site | Standing crop (lb/acre) | Forage production (lb/acre) | RDM (lb/acre) | Grazing efficiency | No. Acres | Usable forage lost (lb) | Normal production usable forage (lb) |
|---|---|---|---|---|---|---|---|---|
| 5 | Annual Grassland/Hardwood Range 0–10% slope, 0–25% woody cover | 500 | 2,000 | **500** | **0.5** | 42 | **0** | **31,500** |
| 11 | Annual Grassland/Hardwood Range 10–20% slope, 50–75% woody cover | 300 | 2,000 | **300** | **0.4** | 45 | **0** | **30,600** |
| 18 | Annual Grassland/Hardwood Range >40% slope, 25–50% woody cover | 700 | 2,000 | **700** | **0.1** | 31 | **0** | **4,030** |
| 19 | Annual Grassland/Hardwood Range >40% slope, 50–75% woody cover | 500 | 2,000 | **500** | **0.1** | 32 | **0** | **4,800** |
| | | **Total pounds of usable forage lost** | | | | | **0** | |
| | | **Total tons usable forage lost** | | | | | | **0** |

*Note:* In the spreadsheet, enter the standing crop, forage production, and the number of acres. The columns in bold are calculated by the spreadsheet.

**Table 8.** Example 2: First growing season

| First Growing Season | | Forage production (lb/acre) | Potential forage production | RDM (lb/acre) | Grazing efficiency | No. Acres | Usable forage available (lb) | Usable forage lost (lb) |
|---|---|---|---|---|---|---|---|---|
| Site | | | | | | | | |
| 5 | Annual Grassland/Hardwood Range 0–10% slope, 0–25% woody cover | **2,000** | **0.6** | **500** | **0.5** | **42** | **14,700** | **16,800** |
| 11 | Annual Grassland/Hardwood Range 10–20% slope, 50–75% woody cover | **2,000** | **0.6** | **300** | **0.4** | **45** | **16,200** | **14,400** |
| 18 | Annual Grassland/Hardwood Range >40% slope, 25–50% woody cover | **2,000** | **0.6** | **700** | **0.1** | **31** | **1,550** | **2,480** |
| 19 | Annual Grassland/Hardwood Range >40% slope, 50–75% woody cover | **2,000** | **0.6** | **500** | **0.1** | **32** | **2,240** | **2,560** |
| | | **Total pounds of usable forage lost** | | | | | | **36,240** |
| | | **Total tons of usable forage lost** | | | | | | **18.12** |

*Note:* The data is carried forward from beginning inventory; all columns are calculated by the spreadsheet.

**Table 9.** Example 2: Second growing season

| Second Growing Season | | Forage production (lb/acre) | Potential forage production | RDM (lb/acre) | Grazing efficiency | No. Acres | Usable forage available (lb) | Usable forage lost (lb) |
|---|---|---|---|---|---|---|---|---|
| Site | | | | | | | | |
| 5 | Annual Grassland/Hardwood Range 0–10% slope, 0–25% woody cover | **2,000** | **0.8** | **500** | **0.5** | **42** | **23,100** | **8,400** |
| 11 | Annual Grassland/Hardwood Range 10–20% slope, 50–75% woody cover | **2,000** | **0.8** | **300** | **0.4** | **45** | **23,400** | **7,200** |
| 18 | Annual Grassland/Hardwood Range >40% slope, 25–50% woody cover | **2,000** | **0.8** | **700** | **0.1** | **31** | **2,790** | **1,240** |
| 19 | Annual Grassland/Hardwood Range >40% slope, 50–75% woody cover | **2,000** | **0.8** | **500** | **0.1** | **32** | **3,520** | **1,280** |
| | | **Total pounds of usable forage lost** | | | | | | **18,120** |
| | | **Total tons of usable forage lost** | | | | | | **9.06** |

*Note:* The data is carried forward from beginning inventory; all columns are calculated by the spreadsheet.

**Table 10**. Example 2: Substitution value

| | |
|---|---|
| **Beginning tons lost** | **0** |
| **Tons lost first growing season** | **18** |
| **Tons lost second growing season** | **9** |
| **Total tons lost** | **27** |
| Cost to feed hay (per ton) | $13.40 |
| Cost of replacement forage delivered (per ton) | $150.00 |
| **Total cost of replacement forage** | **$4,441.21** |

*Note:* Enter the cost of replacement forage delivered. The columns in bold are calculated by the spreadsheet.

**Table 11**. Example 3: Beginning inventory

| Beginning Inventory | | Forage production (lb/acre) | RDM (lb/acre) | Grazing efficiency | No. Acres | Usable forage lost (lb) |
|---|---|---|---|---|---|---|
| Site | | | | | | |
| 5 | Annual Grassland/Hardwood Range 0–10% slope, 0–25% woody cover | 2,000 | **500** | **0.5** | 42 | **31,500** |
| 11 | Annual Grassland/Hardwood Range 10–20% slope, 50–75% woody cover | 2,000 | **300** | **0.4** | 45 | **30,600** |
| 18 | Annual Grassland/Hardwood Range >40% slope, 25–50% woody cover | 2,000 | **700** | **0.1** | 31 | **4,030** |
| 19 | Annual Grassland/Hardwood Range >40% slope, 50–75% woody cover | 2,000 | **500** | **0.1** | 32 | **4,800** |
| | | **Total pounds of usable forage lost** | | | | **70,930** |
| | | **Total tons of usable forage lost** | | | | **35.47** |

*Note:* In the spreadsheet, enter the forage production and the number of acres. The columns in bold are calculated by the spreadsheet.

**Table 12**. Example 3: First growing season

| First Growing Season | | Forage production (lb/acre) | Potential forage production | RDM (lb/acre) | Grazing efficiency | No. Acres | Usable forage available (lb) | Usable forage lost (lb) |
|---|---|---|---|---|---|---|---|---|
| Site | | | | | | | | |
| 5 | Annual Grassland/Hardwood Range 0–10% slope, 0–25% woody cover | **2,000** | **0.6** | **500** | **0.5** | **42** | **14,700** | **16,800** |
| 11 | Annual Grassland/Hardwood Range 10–20% slope, 50–75% woody cover | **2,000** | **0.6** | **300** | **0.4** | **45** | **16,200** | **14,400** |
| 18 | Annual Grassland/Hardwood Range >40% slope, 25–50% woody cover | **2,000** | **0.6** | **700** | **0.1** | **31** | **1,550** | **2,480** |
| 19 | Annual Grassland/Hardwood Range >40% slope, 50–75% woody cover | **2,000** | **0.6** | **500** | **0.1** | **32** | **2,170** | **2,560** |
| | | **Total pounds of usable forage lost** | | | | | | **36,240** |
| | | **Total tons of usable forage lost** | | | | | | **18.12** |

*Note:* The data is carried forward from beginning inventory; all columns are calculated by the spreadsheet.

**Table 13**. Example 3: Second growing season

| Second Growing Season | | Forage production (lb/acre) | Potential forage production | RDM (lb/acre) | Grazing efficiency | No. Acres | Usable forage available (lb) | Usable forage lost (lb) |
|---|---|---|---|---|---|---|---|---|
| Site | | | | | | | | |
| 5 | Annual Grassland/Hardwood Range 0–10% slope, 0–25% woody cover | **2,000** | **0.8** | **500** | **0.5** | **42** | **23100** | **8,400** |
| 11 | Annual Grassland/Hardwood Range 10–20% slope, 50–75% woody cover | **2,000** | **0.8** | **300** | **0.4** | **45** | **23400** | **7,200** |
| 18 | Annual Grassland/Hardwood Range >40% slope, 25–50% woody cover | **2,000** | **0.8** | **700** | **0.1** | **31** | **2790** | **1,240** |
| 19 | Annual Grassland/Hardwood Range >40% slope, 50–75% woody cover | **2,000** | **0.8** | **500** | **0.1** | **32** | **3410** | **1,280** |
| | | **Total pounds of usable forage lost** | | | | | | **18,120** |
| | | **Total tons of usable forage lost** | | | | | | **9.06** |

*Note:* The data is carried forward from beginning inventory; all columns are calculated by the spreadsheet.

**Table 14**. Example 3: Substitution value

| | |
|---|---|
| **Beginning tons lost** | **35** |
| **Tons lost first growing season** | **18** |
| **Tons lost second growing season** | **9** |
| **Total tons lost** | **63** |
| Cost to feed hay (per ton) | $13.40 |
| Cost of replacement forage delivered (per ton) | $95.00 |
| | |
| **Total cost of replacement forage** | **$6,790.72** |

*Note:* Enter the cost of replacement forage delivered. The columns in bold are calculated by the spreadsheet.

**Table 15**. Definitions of terms used in the Prior Grazing Forage Replacement spreadsheet

| Term | Definition |
|---|---|
| Site | Sites are broken into three basic range types: Dry Annual (< 12 inches rainfall); Annual Grassland/Hardwood (12 to 40 inches of rainfall); and Coastal Prairie (> 35 inches rainfall). Slope and woody cover (bushes and trees) also affect forage productions and therefore are broken into categories. Determine the type of range, then the appropriate slope and woody cover. |
| Forage production | The total amount of feed (grass and broadleaf) produced in a year, in pounds per acre. |
| RDM | Residual dry matter; the amount of forage that must be left at end of summer to protect the soil. |
| Grazing efficiency | How well livestock can use the forage on the site; steeper slopes tend to reduce grazing efficiency. |
| No. Acres | The number of acres affected by the forage loss for each site. |
| Usable forage | The amount of forage available for grazing, calculated by the spreadsheet in pounds. |
| 0–10% Slope | Flat to gentle rolling hills. |
| 10–20% Slope | Gentle rolling hills. |
| 20–40% Slope | Steep hills. |
| >40% Slope | Extremely steep hills. |
| 0–25% Woody Cover | Very patchy trees or brush. |
| 25–50% Woody Cover | Patchy trees. |
| 50–75% Woody Cover | Woody cover becoming more dense; some solid stands of trees. |
| 75–100% Woody Cover | Dense to solid woody cover. |
| Cost to feed hay | Based on a 2009 report of the cost of feeding hay as calculated by the use of a truck. Labor is not included. |
| Cost of replacement forage delivered | Enter cost of purchased hay delivered (as opposed to the current cost of hay on the market). |

# For Further Information

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