TECHNICAL NOTE

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Harvest Efficiency in Prescribed Grazing

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This technical note transmits information on the concepts and terminology surrounding harvest efficiency, and how they can be applied in conservation planning.

Background

Most range conservationists learned the concept of utilization during their education in range management. The old "take half, leave half" rule of thumb (figure 1) still applies with the new concept of harvest efficiency. The term 'harvest efficiency' is relatively new in range management. This term first appeared in the Journal of Range Management in 1980 (Beaty and Engel, 1980), and was first introduced in NRCS through the 1997 edition of the National Range and Pasture Handbook (NRPH). The Society for Range Management Glossary of Terms Used in Range Management (1989 edition) did not contain the term "harvest efficiency", but the concept could be found in the definition of Utilization (Use): *The proportion of current year's forage production that is consumed or destroyed by grazing animals.* Recognizing that some forage is consumed and some is destroyed is a key concept to understanding harvest efficiency.

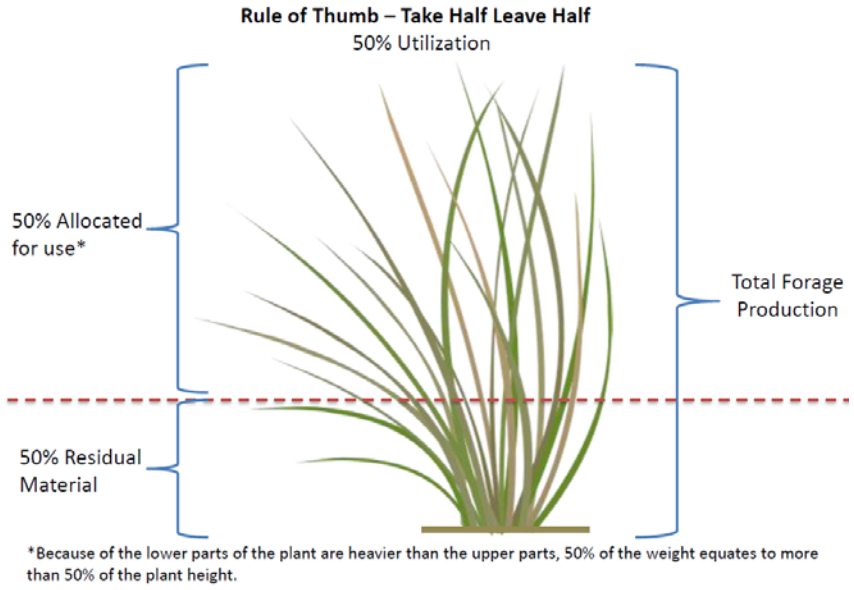


Figure 1 – Illustration of the utilization concept

Definition

The NRPH defines harvest efficiency as "*The total percent of vegetation harvested by a machine or ingested by a grazing animal compared to the total amount of vegetation grown in the area in a given year…. Harvest efficiency is the percentage of forage actually ingested by the animals from the total amount of forage produced.*" Figure 2 illustrates this concept.

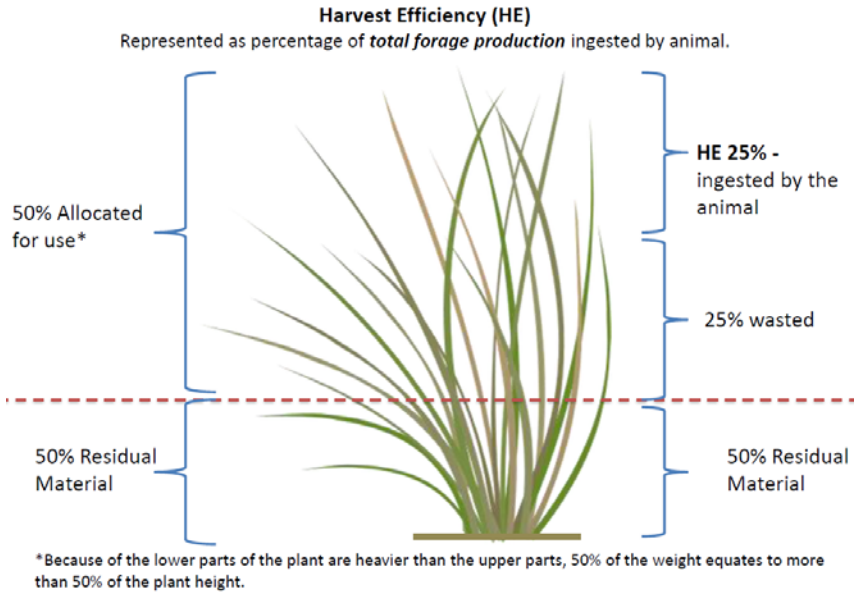


Figure 2 – Illustration of the harvest efficiency concept

Total forage production (TFP) includes only the forage species in the plant community, and represents all of their above ground annual production, not just that portion above a stubble height. The 'Leave Half' portion (50%) represents post-grazing residual forage (R). This is the most important part of the old take half, leave half rule of thumb for grazing. The 'Take Half' portion (50%) allocated for use represents utilization (U), and includes both consumed and destroyed portions. The 'ingested' portion (25%) represents harvest efficiency (HE), or that portion that actually ingested by the grazing animal. The 'wasted' portion (25%) represents forage that was utilized but went to waste through trampling, desiccation, manure and urine, bedding, etc.

Finding the Correct Value

The NRPH recommends the following: *"For continuous grazing, harvest efficiency usually averages:*
Rangeland 25 percent
Pastureland 30 percent
Grazed cropland 35 percent"

These values can fluctuate depending on the stocking density. As further explanation, the NRPH says "*Harvest efficiency increases as the number of animals increases in an area and they consume plant material before it senesces, transfers to litter, or otherwise leaves the area.*" Recent research has verified these values to be correct. If total forage production (TFP) is estimated and animal intake (I) is assumed to be a generally accepted value, the actual harvest efficiency can be calculated. The equation is:

Units and Equations

Animal Unit Day (AUD)

Daily Herbage Intake (DHI) = lbs/AUD

Stocking Rate (SR) = AUD/area

*Intake (I) = DHI * SR*

Total Forage Production (TFP) = lbs/area

*Harvest Efficiency (HE) = I/TFP*100*

Residual (R) = lbs/area

*Utilization (U) = 1-(R/TFP)*100*

*Grazing Efficiency (GE) = I/(TFP-R)*100*

I/TFP*100 = HE

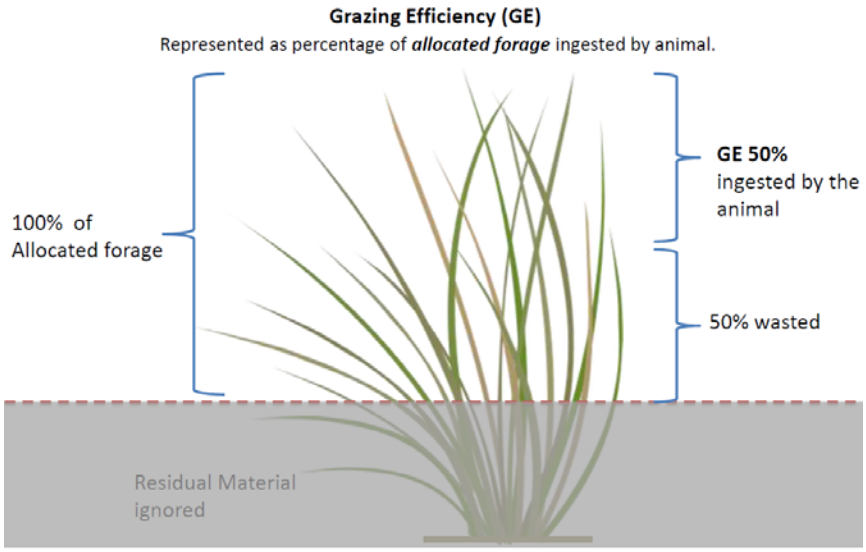
For example:

[1]

If the residual (R) left over following grazing is estimated, utilization (U) can be calculated as well. The equation is:

1-(R/TFP)*100 = U

For example:



*Because of the lower parts of the plant are heavier than the upper parts, 50% of the weight equates to more than 50% of the plant height.

Figure 3 – Illustration of the grazing efficiency concept

The relationship between utilization and harvest efficiency has been documented. Grazing studies on rangelands in Wyoming, South Dakota, Kansas, Colorado, North Dakota, and Oklahoma have shown that at 50% utilization rates, harvest efficiency is 25%. If utilization is increased to 65%, harvest efficiency increases to about 37%. If utilization is decreased to 40%, harvest efficiency decreases to about 15% (Smart et al, 2010). However, utilization rates should not be increased for the sole purpose of improving harvest efficiency.

Another related expression of efficiency is grazing efficiency (GE) (figure 3). Of all forage utilized (this includes what is wasted), that portion actually ingested by the animal is grazing efficiency. The equation for grazing efficiency is:

[1] Daily intake rate for an animal unit NRCS uses, National Range and Pasture Handbook 600.0603(a)

I/(TFP-R)*100 = GE

For example:

[2]

Stock density (# of head/area) can be used as a tool to improve both harvest efficiency and grazing efficiency (Briske, 2011 and Gerrish, 2004). As stock density increases, grazing distribution improves, selectivity decreases, and the proportion of utilized forage that is actually ingested (grazing efficiency) increases. So, increased harvest efficiency and grazing efficiency can happen by increasing stock density while utilization remains at targeted levels.

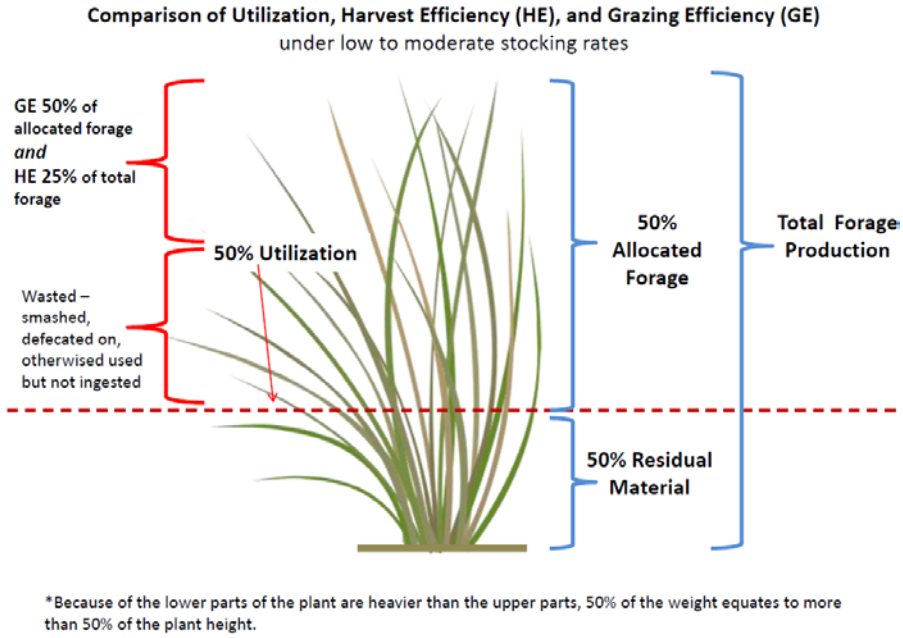


Figure 4 – Comparison of the utilization, harvest efficiency and grazing efficiency concepts

Table 1 and figure 4 contrasts the concepts of utilization, harvest efficiency, and grazing efficiency. Under a basic grazing scenario, typical values for rangeland are portrayed. Under the high stock density scenario, utilization remains at 50% but harvest efficiency improves. Understanding these concepts and relationships is key to providing sound technical advice to cooperators using the prescribed grazing practice during the conservation planning process.

[2] Daily intake rate for an animal unit NRCS uses, National Range and Pasture Handbook 600.0603(a)

Table 1		
Utilization	**Harvest Efficiency**	**Grazing Efficiency**
Proportion of annual forage production that is removed or destroyed	Proportion of total forage production ingested by the grazing animal	Proportion of utilization that is ingested by the grazing animal
basic grazing scenario		
50%	25%	50%
high stock density scenario		
50%	35%	70%

Contacts:

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