United States Department of Agriculture
Natural Resources Conservation Service

2016 – 1
2017 – 1 Renewal

Plant Enhancement Activity – PLT16 – Intensive management of rotational grazing

Enhancement Description
This enhancement is for the harvest efficiency of grazing livestock to increase forage harvest, and to improve forage quality and livestock health. The grazing system is managed to produce high quality, nutritious forage and maintain plants with sufficient energy reserves to recover quickly when adequate soil moisture is available for regrowth. Generally, livestock are rotated through pastures in the grazing system based on the physiological growth and nutritional stage of the forage plants and the daily dry matter intake and nutritional requirements of the animal. This enhancement is for: rotational grazing systems with increased numbers of pastures or paddocks, the accompanying required infrastructure, shorter grazing periods, and increased stock density. Selection of this enhancement requires the activity to be planned concurrently on all eligible land use acres.

Land Use Applicability
Pastureland, Rangeland, Forestland

Benefits
The main benefits of Intensive Management of Rotational Grazing are efficient resource use with increased forage utilization, improved manure distribution, and nutrient cycling throughout the grazing acreage, and increased carbon sequestration resulting from greater forage harvest. Optimal environmental conditions are achieved by maintaining healthy, actively growing forage plants that improve the quantity and quality of cover available for wildlife and protect the soil surface from erosion, thereby reducing risks to ground or surface water quality.

Conditions Where Enhancement Applies
This enhancement applies to all grazed acres designed as pasture, range or forest land use acres on the entire operation.

Note: the grazing acres of the operation must have a defined rotation before selecting this enhancement. A single grazed field/pasture does not constitute a rotation. The minimum number of grazed fields/pastures in Utah is 4.

Criteria
A prescribed grazing plan is developed that increases harvest efficiency by utilizing a 75% increase in the number of pastures/paddocks per movement group (herd). See the attached "Supplement" for specifics on harvest efficiency.

Adoption Requirements

This enhancement is considered adopted when a prescribed grazing plan is complete, and implementation of the plan has begun, that incorporates a 75% increase in the number of pastures/paddocks, including the necessary infrastructure (fences/water/etc.)

Documentation Requirements

1. Copy of signed "National Supplement to Plant Enhancement Activity – PLT 16 – Intensive management of rotational grazing" certifying that a grazing plan has been implemented with a 75% increase in the number of paddocks/pastures for the herd (movement group) increasing the harvest efficiency resulting from greater stock density and reduced grazing time per pasture/paddock .

2. A map or aerial photo showing the pastures/paddocks making up the rotational grazing system. The layout of the pastures/paddocks both before implementation and after implementation shall be delineated on the map or photo.

References

Bertelsen, B.S., D.B. Faulkner, D., Buskirk and J.W. Castree. 1993. Beef Cattle Performance and Forage Characteristics of Continuous, 6-paddock, and 11-paddock Grazing Systems. Journal of Animal Science 71:1381-1389.

Jacobo, E.J., A.M. Rodríguez, N. Bartoloni and V.A. Deregibus. 2006. Rotational Grazing Effects on Rangeland Vegetation at a Farm Scale. Rangeland Ecology & Management 59(3): 249-257.

McKown, C.D., J.W. Walker, J.W. Stuth and R.K. Heitschmidt. 1991. Nutrient intake of Cattle on Rotational and Continuous Grazing Treatments. Journal of Range Management 44(6).

Rayburn, E.B. (editor). 2007. Forage Utilization for Pasture Based Livestock Production. NRAES – Book 173. PALS Publishing, Ithaca, New York.

Smart, A.J., J.D. Derner, J.R. Hendrickson, R.L. Gillen, B.H. Dunn, E.M. Mousel, P.S. Johnson, R.N. Gates, K.K. Sedivec, K.R. Harmoney, J.D. Volesky and K.C. Olson. 2010.
Effects of Grazing Pressure on Efficiency of Grazing on North American Great Plains Rangelands. Rangeland Ecology and Management 63(4): 397-406.

Teague, W.R. and S.L. Dowhower. 2003. Patch Dynamics under Rotational and Continuous Grazing Management in Large, Heterogeneous Paddocks. Journal of Arid Ecology 55: 211-229.

USDA-NRCS. 2010. Conservation Practice Standard: Prescribed Grazing-Code 528.

Brazee, Brendan and Shane A. Green. 2012. Harvest Efficiency in Prescribed Grazing. Idaho and Utah Plant Materials Technical Notes no. 73

United States Department of Agriculture
Natural Resources Conservation Service

2016 – 1
2017 – 1 Renewal

National Supplement to Plant Enhancement Activity – PLT 16 – Intensive management of rotational grazing

State: Utah **Participant:** _____

Increase harvest efficiency resulting from greater stock density and reduced grazing time per pasture/paddock

Change the current grazing system to allow for an increased number of pastures or paddocks, including the necessary infrastructure (fences/water/etc.), shorter grazing periods, and increased stock density. The grazing plan should document the planned length of grazing periods in pastures and length of time between grazing periods for an overall reduction in total grazing activity per pasture and an increased harvest efficiency resulting from greater stock density and reduced grazing time per pasture/paddock because of the 75% increase in the number of paddocks/pastures for the herd (movement group).

Criteria: Use the following formula for documentation, and attach a plan map showing the location of the grazing system design. The following example is provided.

EXAMPLE:

A. Current # of Pastures/Paddocks 6
B. Planned # of Pastures/Paddocks 11
C. % Increase= ((B/A)-1)100% ((11/6)-1)100 = ((1.83)-1)100 = (.83)100% = **83%**

Grazing Plan:

A. Current # of Pastures/Paddocks _____
B. Planned # of Pasture/Paddocks _____
C. % Increase= ((B/A)-1)100 _____

Operation and Maintenance:
Operation: Livestock grazing plans should accommodate increased rest of grazing units, particularly during the active growing season of desirable rangeland and pasture species. Planned grazing use should not exceed 60% of annual production. Additional practices and inputs such as cross fences and water facility development may be required to facilitate adequate rest periods and increased harvest efficiency.

Maintenance: Grazing unit rotation of livestock should be accomplished annually, alternating the planned rotation sequence of grazing units each subsequent year, or specifically providing growing-season rest periods based on individual pasture condition.

Certification:
I certify that I have applied the grazing management system as explained in the narrative in the field(s) and listed in the table above.

Name:_____Date:_____

TECHNICAL NOTE

USDA - Natural Resources Conservation Service
Boise, Idaho – Salt Lake City, Utah

TN RANGE NO. 73 **July 2012**

Harvest Efficiency in Prescribed Grazing

Shane Green, State Range Conservationist, NRCS, Salt Lake City, Utah
Brendan Brazee, State Range Conservationist, NRCS, Boise, Idaho

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.

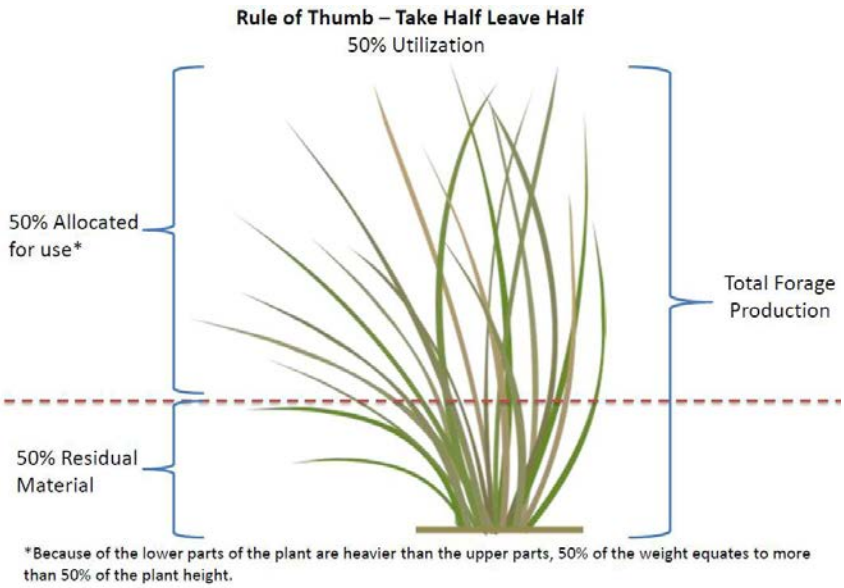

Figure 1 – Illustration of the utilization concept

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.

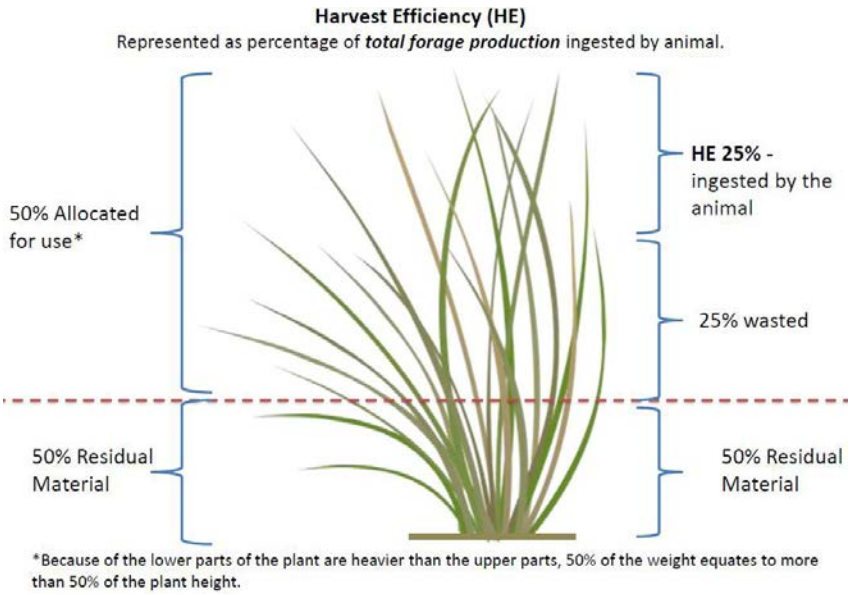

Figure 2 – Illustration of the harvest efficiency concept

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:

$$\frac{30 \text{ lbs forage/day} * 50 \text{ mother cows (1000 lbs each)} * 90 \text{ days in the pasture}}{1500 \text{ acre pasture} * 375 \text{ lbs/ac total forage production}} * 100 = 24\% \text{ Harvest Efficiency}$$

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:

$$1 - \frac{1500 \text{ acre pasture} * (188 \text{ lbs})/\text{ac residual forage following grazing}}{1500 \text{ acre pasture} * 375 \text{ lbs/ac total forage production}} * 100 = 50\% \text{ Utilization}$$

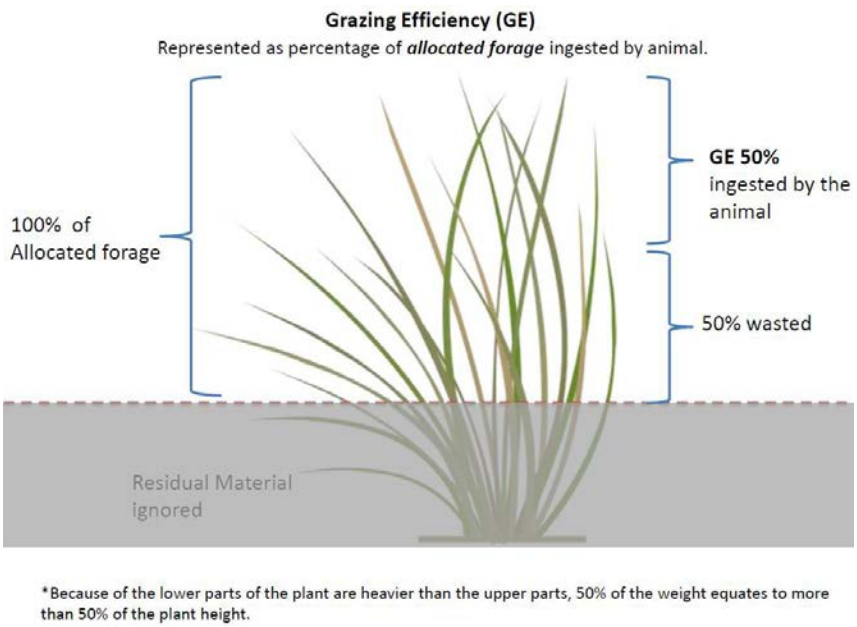

Figure 3 – Illustration of the grazing efficiency concept

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:

I/(TFP-R)*100 = GE

For example:

$$\frac{30 \text{ lbs forage/day} * 50 \text{ mother cows (1000 lbs each)} * 90 \text{ days in the pasture}}{1500 \text{ ac} * 375\text{lbs/ac total forage production} - 1500 \text{ ac} * (188 \text{ lbs})\text{/ac residual}} = 48\% \text{ Grazing Efficiency}$$

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.

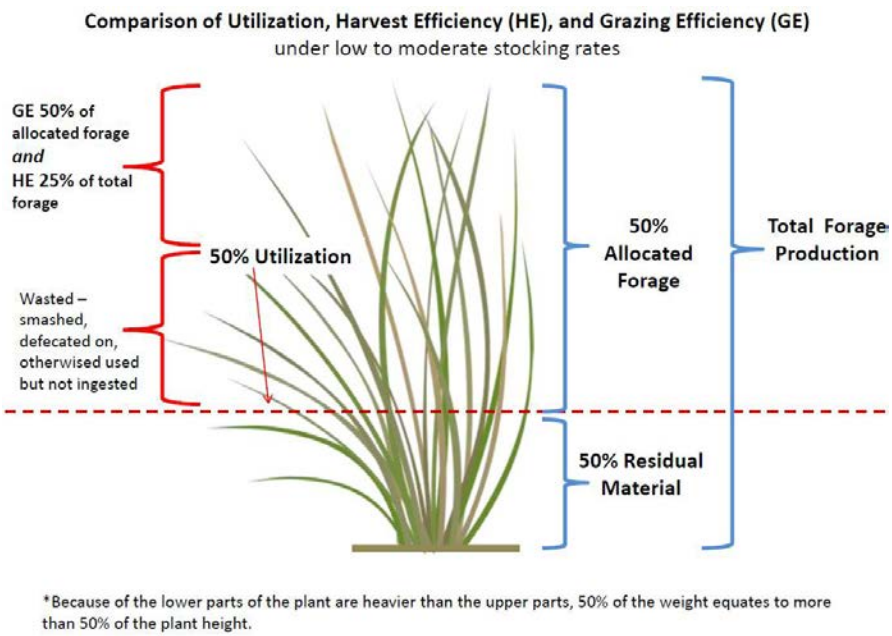

Figure 4 – Comparison of the utilization, harvest efficiency and grazing efficiency concepts

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.

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:

Shane Green, State Rangeland Management Specialist, NRCS Utah
Brendan Brazee, State Rangeland Management Specialist, NRCS Idaho

Literature Cited:

Beaty E. R. and J. L. Engel. 1980. Forage Quality Measurements and Forage Research: A Review, Critique and Interpretation, Journal of Range Management, Vol. 33, No. 1, pp. 49-54

Briske, D.D., editor. 2011. Conservation Benefits of Rangeland Practices: Assessment, Recommendations, and Knowledge Gaps. United States Department of Agriculture, Natural Resources Conservation Service.

Gerrish, Jim. 2004. Management intensive Grazing – The Grassroots of Grass Farming

Smart A. J., J. D. Derner, J. R. Hendrickson, R. L. Gillen, B. H. Dunn, E. M. Mousel, P. S. Johnson, R. N. Gates, K. K. Sedivec, K. R. Harmoney, J. D. Volesky, and K. C. Olson. 2010. Effects of Grazing Pressure on Efficiency of Grazing on North American Great Plains Rangelands. Rangeland Ecology & Management: Vol. 63, No. 4, pp. 397-406

Society for Range Management. 1989. A Glossary of Terms Used in Range Management. Glossary revision special committee. Publications committee. Denver, Colorado

USDA Natural Resources Conservation Service. 1997. National Range and Pasture Handbook. Fort Worth, TX: US Department of Agriculture, Natural Resource Conservation Service, Grazing Lands Technology Institute.

Operations & Maintenance, Conservation Measures, and Client Acknowledgement

Operation and Maintenance
Operation: Maintenance:
Conservation Measures
Actions that must be implemented by the landowner/manager during enhancement implementation:
Client's Acknowledgement Statement
The Client acknowledges that: a. They have received a copy of the enhancement and understand the contents and requirements. b. It shall be the responsibility of the client to obtain all necessary permits and/or rights, and to comply with all ordinances and laws pertaining to the application of this enhancement. **Planner:** _____ **Date:** **Client:** _____ **Date:**