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Managing Steep Terrain for Livestock Forage Production

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Introduction

Kentucky has a diversified landscape that ranges from level river bottoms to steep mountainous side slopes with narrow ridge tops. Soils that form or develop on each of these landscape positions offer various land use opportunities and limitations for agricultural production.

Many of the grass and legume species adapted to Kentucky's climate and soils can be used for livestock production on steep terrain. However, the unique characteristics of steep terrain often result in soil productivity limitations that should be considered when managing these same grass and legume species for pasture and/or hay production. Decades of surface mining in the eastern region of the state have created extensive acreages of steep reclaimed land. These lands currently support an abundance of underutilized forage that could be managed for horses, beef cattle, and goat production.

This publication addresses the agronomic, economic, and human safety aspects of managing steep terrain for livestock forage production.

Table 1. Land capability classes for land use decisions in Kentucky.[1]

Slope Range	Class	% of Total Land Area	Description
0-2%	I	0.7	Few limitations that restrict land use
2-6%	II	20.1	Require moderate conservation practices
6-12%	III	13.8	Require special conservation practices
12-20%	IV	10.2	Require careful management and special conservation practices
	V	0.3	Not likely to erode but have other limitations impractical to remove (i.e., flooding, stoniness)
20-30%	VI	14.4	Severe limitation, unsuitable for cultivation, limited to pasture and hay production
30-50%	VII	26.4	Very severe limitation that restrict use to forest
Other		14.1	Water bodies, pits, quarries, and rock outcrops

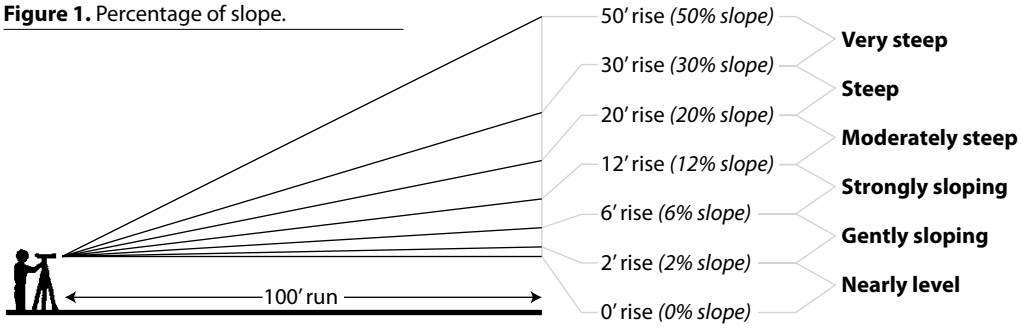
[1] Source: 1977 Natural Resource Inventory, NRCS.

What Is Steep Terrain?

The slope of a field refers to the number of feet of rise or fall in 100 feet of level distance (Figure 1). This is a very important landscape characteristic because it affects the productivity of the soil in many ways. In general, as the percent slope of a field increases, productivity decreases because the soil's erosion hazard increases and the ability of the soil to supply moisture to plants decreases. Steep terrain soils are often low in natural fertility due to the loss of topsoil from past erosion.

Soil scientists use slope and other soil characteristics to group soils into capability classes to indicate limitations in use and risks of damage by agricultural practices (Table 1). In general, soils in capability classes I to IV (0 to 20% slope) are favorable for row crop production when appropriate conservation cropping practices are used. The "steep terrain" designation for livestock forage production in this publication refers to soils in capability class VI (20 to 30% slope). These soils have severe limitations that are generally unsuitable for conservation row crop production and should be limited to pasture and hay production. Class VII soils have very severe limitations that restrict their use primarily to forest. Table 1 indicates the distribution of land in each of the land capability classes for Kentucky.

Figure 1. Percentage of slope.



Soil Acidity and Liming

As with any other cropping system, lime and fertilizer management on steep terrain should begin with a composite soil sample from the area. Soil cores should be collected to a depth of 4 inches following the procedures outlined in University of Kentucky Extension publication AGR-16, *Taking Soil Test Samples*. Soil test results and fertilizer recommendations will let you know how much and which fertilizers to apply.

The most common soil fertility problem on steep terrain is low soil pH. Low pH indicates that the soil is acidic, and plant growth will probably be reduced. A secondary effect of low pH is that less desirable species of plants begin to dominate the landscape. For example, soils with pH in the optimal range (6.0 to 7.0) will generally have a good mixture of grasses and legumes. As the pH drops below the optimal range, the legumes will disappear, and grasses will dominate. If the pH is allowed to drop into very low range (<5.4), then weed species with very little nutrient value like broom sedge will dominate. Soil test results from the mountain area of eastern Kentucky show that 19% of the soil samples submitted between 1999 and 2001 had pH below 5.4, and 47% were below pH 6.0.

Agricultural limestone is used to increase soil pH because it neutralizes soil acidity, but knowing how much acidity is in the soil is only half of the answer. It is also important to understand that limestone quality varies widely across the state and especially within the eastern region. The purity of the stone and the fineness of grind are the two factors that determine the effectiveness or "relative neutralizing value" of liming materials (refer to AGR-19 and AGR-106). Twice a year, the Kentucky Department of Agriculture analyzes the quality of agricultural limestone from all quarries in the state. The results are made available to the county Extension agents so that they can adjust the lime rate recommended by the soil test to account for the local lime quality.

Lime can be applied at any time, and with adequate soil incorporation and moisture, a measurable pH change can occur within four weeks. However, on steep terrain where incorporation of lime is not feasible or recommended due to a high erosion hazard, it may take six to 12 months for a significant amount of the surface-applied lime to dissolve and make the desired change in soil pH. For this reason, lime should be applied at least six months before seeding forage crops. Fall is a good time to apply lime so it can be dissolving during the winter. Also, fall weather is usually better for getting on sloping land with spreading equipment.

Once corrected, soil pH will remain in the optimal range for five or more years, so you should look at limestone as a long-term investment. It is very important to recheck soil pH prior to pasture renovation with clover or other legumes. Livestock producers are often disappointed by poor renovation results that can frequently be traced back to low soil pH at the time of seeding.

Pasture Fertilization

In addition to lime requirements, soil testing also indicates how much fertilizer is required to maintain a high level of forage production (refer to AGR-1). Almost without exception, nitrogen (N) is the most limiting plant nutrient because steep terrain has shallow soils with low organic matter. There are several ways that farmers can increase plant available N.

The most obvious is to use commercial fertilizers, but N fertilizers only increase productivity for the year in which they are applied, and they are more expensive in the long run. Annual applications of nitrogen fertilizers on steep ground are also a safety hazard because of the volume (100 to 150 pounds) required per acre, and multiple applications per year are required to obtain maximum productivity.

A better alternative to annual N applications is to renovate using legumes like red or white clover. Once established, bacteria living on the clover roots will fix enough atmospheric N to meet the N requirements of the pasture. As long as there is at least 25% clover in the pasture, there is no need to apply N fertilizer. In fact, research results show that grass-legume mixtures without N fertilization produce higher yields than pure grass stands with maximum N fertilization. Forage quality is also higher for grass-legume mixtures.

A third way to increase plant available N is to apply manure or tobacco stalks (Table 2). While these options might not be feasible for steep terrain, manure and plant residues are a good source of N and other essential plant nutrients and can be utilized in forage production.

Phosphorus (P) and potassium (K) are the other two plant nutrients that are likely to be low in pasture systems. Soil test results show that about 37% of eastern Kentucky soil samples were low or very low in P, and about 50% were low in K. In these situations, applications of P and K fertilizer will increase yield only if soil pH is optimum and the forage has a good supply of N. Yield increases as a result of P and K applications are not as substantial as for N applications. Manure and tobacco stalks are a good source of P and K (Table 2).

Research data over a number of years indicate that dry matter can be increased from about a ton per acre per year with no soil pH or nutrient management up to four or more tons per year with improved management. Proper fertilization can help increase total dry matter yield and protein content and can minimize seasonal shifts in production. However, unless the increased yields are utilized by grazing or hay harvest, there will be no return on the investment.

Species Selection

The grass and legume species available for pasture and hay use on steep terrain represent a wide range in adaptation characteristics (Tables 3 and 4). Even significant varietal differences may exist within grass and legume species. For example, the adaptation of tall fescue (*Festuca arundinacea* Schreb.) varies depending on the presence or absence of an endophytic fungus. Tolerance to

Table 2. Typical nitrogen, phosphate, and potash content of some animal manures and tobacco stalks.[1]

Manure Type	N	P_2O_5	K_2O_5	Moisture %
	lb/ton			
Beef	11	7	10	52
Horse	12	10	12	50
Goat	22	12	24	52
Sheep	21	9.4	19	52
Dairy	11	9	12	60
Poultry layers	30	40	30	40
Tobacco stalks		30	10	70

[1] All values on an "as-is" moisture basis.
Source: Rasnake et al. ENRI-136.

heat and drought is an important characteristic to consider when selecting forage species for mine land pastures and hayland. Cool-season grass species range from excellent for endophyte-infected tall fescue to poor for perennial ryegrass (*Lolium perenne* L.). Orchardgrass (*Dactylis glomerta* L.) is considered to have good tolerance to drought, while timothy (*Phleum pratense* L.) and endophyte-free tall fescue have only fair tolerance to heat and drought. Therefore, forage species selected for use on steep terrain should have some heat and drought tolerance and persist under relatively low soil fertility levels.

Tall fescue is the most important cool-season grass grown in the United States and provides the primary ground cover on most of our steep terrain pastures in Kentucky. Tall fescue is relatively easy to establish, persistent, and relatively free of disease and insect pests. It produces high dry matter yields when properly fertilized and compares favorably to many other cool-season grasses in its chemical analysis.

Despite the many positive attributes of this grass, several features of KY 31 have been less than ideal. In 1976, Dr. Joe Robbins, USDA, Athens, Georgia, and Dr. C. W. Bacon discovered that an endophytic fungus (*Acremonium coenophialum*) and the ergot alkaloids produced were the causative agent of summer syndrome that occurred in beef cattle grazing KY 31 tall fescue. Animals consuming fescue containing the endophyte have shown some or all of the following responses: (1) lower feed intake, (2) lower weight gains, (3) lower milk production, (4) higher respiration rate, (5) higher rectal temperature, (6) increased water consumption, (7) rough hair coat, (8) more time spent in shade, (9) excessive salivation, (10) greater urine volume,

Table 3. Adaptation of some perennial and annual legumes for livestock production on steep terrain.

Legume Species	Tolerance				Bloat Risk	pH Range	Factors That Reduce Quality for Ruminants
	Heat/ Drought	Wet Soil Conditions	Frequent Cutting	Frequent Grazing			
Perennials							
Alfalfa	E[1]	P	E	F	Yes	6.5-7.5	
Bird's-foot trefoil	G	G	G	F	No	5.0-7.5	
Crown vetch	G	P	P	F	No	5.5-7.5	Tannin
Sweet clover	E	P	P	F	Yes	6.0-7.0	Coumarin
Red clover	F	F	E	G	Yes	5.5-7.0	
White clover	P	F	P	E	Yes	6.0-7.0	
Alsike clover	F	G	P	F	Yes	5.0-7.5	
Sericea lespedeza	E	P	F	G	No	5.0-7.0	Tannin
Annuals							
Korean lespedeza	E	P	F	E	No	5.0-7.0	
Kobe lespedeza	E	P	F	E	No	4.5-7.5	
Hairy vetch	F	P	P	F	Yes	5.5-7.5	

[1] Species rankings: E = excellent, G = good, F = fair, P = poor.

Table 4. Adaptation of some perennial grasses for livestock production on steep terrain.

Grass Species	Tolerance[1]					pH Range	Factors That Reduce Quality for Ruminants
	Heat/ Drought	Wet Soil Conditions	Frequent Cutting	Frequent Grazing	Sod-Forming		
Cool-Season							
Tall fescue—infected	E	G	E	E	G	5.0-8.0	Alkaloids, tall fescue toxicosis
Tall fescue—noninfected	F	G	G	F	G	5.0-8.0	
Orchardgrass	G	P	G	F	F	4.5-7.5	
Timothy	F	P	P	P	P	4.5-8.0	
Matua prairie grass	F	P	P	P	F	6.0-7.5	
Smooth brome	F	F	P	P	G	5.0-8.0	
Reed canarygrass[2]	G	E	G	G	E	4.9-8.2	Alkaloids
Perennial ryegrass	P	P	E	E	P	5.0-7.5	Alkaloids, ryegrass staggers
Warm-Season							
Switchgrass	E	E	P	F	F	4.1-7.6	Photosensitization in sheep
Indiangrass	E	P	F	F	F	5.6-7.1	HCN, prussic acid poisoning
Big bluestem	E	P	F	F	P	6.0-7.5	
Little bluestem	E	P	F	F	P	6.0-7.5	
Caucasian bluestem	E	P	E	E	F	6.0-7.5	
Bermudagrass[3]	E	P	E	E	E	5.1-7.5	
Weeping lovegrass	E	P	P	P	P	4.0-8.0	Nutritional quality low

[1] Species rankings: E = excellent, G = good, F = fair, P = poor.
[2] Use only low alkaloid varieties of reed canarygrass.
[3] Must be established by sprigs or winterhardy seeded varieties.

(11) reduced prolactin level, (12) reduced reproductive performance, and (13) nervousness. These responses have been shown with animals consuming pasture, hay, silage, green-chop, and seed. There is little doubt that the endophyte is associated with the majority of quality problems long observed in tall fescue.

Research suggests at least three areas that should be considered to offset or eliminate the endophyte effect in animal production (refer to AGR-119):

1. **Manage fescue and animals to minimize the endophyte effect**. Mature fescue is poor feed. Grazing and/or mowing, to keep plants young and vegetative will result in better animal performance than grazing or feeding more mature plants.
2. **Dilute the endophyte effect**. Negative effects on animal performance can be diluted substantially by the presence of other feeds in the diet. The most practical and economical way of diluting the effect is by growing legumes with infected fescue.
3. **Replace infected stands with low endophyte varieties**. Determine the level of infection before deciding to replace an old stand. Your county agricultural Extension agent can give you copies of PPA-30, *Sampling for the Tall Fescue Endophyte in Pasture or Hay Stands*, and can advise you how and when to take samples and where to send them.

Warm-season grasses can also be used to supplement cool-season grass production during drought and heat stress common on slopes with a southern exposure. In general, most native warm-season grass are very different in establishment requirements from the cool-season grasses with which most Kentucky farmers are familiar (refer to AGR-145). Because these grasses are slow in becoming established (one full growing season is often required) and only a few options exist for post-emergent chemical weed control, it is important to start with a weed-free seedbed. On steep terrain, a tilled seedbed is rarely an option; however, warm-season grasses can be no-till seeded if the soil surface is not too rough and weed pressure not too heavy. It is also important that herbicides be used in accordance with label directions.

Research has shown that species such as switchgrass (*Panicum virgatum* L.), big bluestem (*Andropogon gerardii*), indiangrass (*sorghastrum nutans*), and little bluestem (*Schizachyrium scoparium* [Michx.] Nash) are well adapted to droughty, steep, and shallow soils commonly found on sideslopes and ridgetops (Table 7). Either adding legumes through pasture renovation or maintaining existing legumes in warm-season grass stands increases forage yield and quality during periods of drought and heat stress when cool-season grass production is low. Deep taprooted legume species such as sweet clover (*Melilotus officinalis* Lam.), alfalfa (*Medicago sativa* L.), and sericea lespedeza (*Lespedeza cuneata* [Dum.- Cours.] G. Don) are also able to avoid short-term drought compared to the very shallow root system of white clover (*Trifolium repens* L.).

In general, grass-legume mixtures produce higher yields than stands with the same species growing alone. However, complex grass and legume seed mixtures compete for light, moisture, and nutrients. Therefore, it is important to carefully evaluate the compatibility of these species prior to seeding or renovation. Renovating with desirable grasses and legumes for livestock grazing can be challenging due to steep slopes, rocky mine soils, and the constant threat of soil erosion.

Weed Control

Pastures and hayfields often contain unwanted plants along with the desirable grasses and other forages utilized for livestock grazing. These unwanted plants or weeds can limit the potential productivity of the forages available to the animals. Because of the topography and landscape positions of steeper slopes it can sometimes be more challenging to combat problem weeds that occur on these sites.

Overall, pasture management practices can have a major impact on the presence of unwanted plants. For example, low soil fertility and overgrazing promote growth of weedy plants. The ideal approach is to incorporate and utilize management practices that are more adaptable to the growth of desirable forage species and less favorable for unwanted plants. These practices may include: (1) maintaining proper soil pH and fertility levels based on soil test levels, (2) using controlled grazing practices, (3) mowing or clipping pastures (if feasible) at the proper timing and stage of maturity, and (4) allowing new forage seedings to become well established before they are accessible to livestock.

When seeding new forage species, the time of year seeding occurs can impact the type of weed species that will be most troublesome during the establishment phase. Spring seedings are vulnerable to competition from warm-season annual weeds such as yellow foxtail and common ragweed, whereas forages seeded in the fall are more at risk to competition with winter annual weeds such as common chickweed and henbit.

A pasture management program that integrates several different weed control methods is generally more successful than relying on only one method. Controlled grazing can be an effective weed management tool for some weed problems. The greatest benefit from grazing is obtained when weeds are small and in their early vegetative stages of growth. In fact, many weedy plants have some nutritional value when utilized before they become too mature (Table 5). Goats are even capable of browsing woody type vegetation. On the other hand, animals often selectively graze some plants because of differences in palatability or physical barriers created by the weed. For example, weeds such as tall ironweed and multiflora rose become more prominent over time in grazed pastures.

One consideration before allowing livestock to graze fields heavily infested with weeds is the potential for exposure to poisonous plants. The potential for livestock poisonings depends on the availability and quantity of the poisonous plant available, the stage of plant growth, the time of year, and the kind of animal. Most potentially poisonous plants (but not all plants) must be consumed in large quantities to cause animal death. Many plants have an undesirable taste, and animals do not consume them at levels that are toxic unless other forages are limited during periods of drought or long winter seasons. Several of the potentially toxic plants that can be found in Kentucky are listed in Table 6.

More information about poisonous plants can be found in the University of Kentucky Extension publication ID-2, *Some Plants of Kentucky Poisonous to Livestock,* or the following Web sites:

- http://www.aces.edu/pubs/docs/A/ANR-0975
- http://vet.purdue.edu/depts/addl/toxic/cover1.htm
- http://www.uaex.edu/Other_Areas/publications/PDF/FSA3025.pdf

Timely mowing or clipping of pastures can be especially helpful to reduce the effects of many erect broadleaf weeds. However, steep slopes are not always conducive for use of heavy mowing equipment. Therefore, some areas may not be accessible, and hand removal practices may be necessary. The key to successful mechanical control efforts such as mowing or clipping weeds is the use of these practices before unwanted plants are capable of producing new seed. Therefore, mowing should begin when weeds are in the stem elongation stage but before flowers and new seed are produced. Frequent mowing, repeated over a three- to five-year time span, can also help deplete root reserves of some perennial weeds.

Clipping fields in late spring or early summer is beneficial in fields containing problem weeds that flower in the spring such as musk thistle, whereas late summer is the best time of year to mow summer annual and perennial weeds that flower later in the year. It is also important to clip pastures that have been selectively grazed by animals. This helps prevent or reduce seed production of weedy plants left by the animals.

It is sometimes necessary to consider the use of a herbicide for control of problem weeds. Most herbicides available for use on grazed pastures control broadleaf type weeds growing in established cool-season grass forages such as tall fescue and orchardgrass. Clovers or other legumes interseeded with the grasses will be killed or severely injured by a herbicide application. Some herbicides are also effective for control of woody brush, such as multiflora rose. Woody plants or brush can be treated with herbicides by making foliar applications, treating dormant stems during the winter months, or as a cut stump treatment.

Table 5. Digestibility (IVDMD[1]) of cool- and warm-season weeds and seeded forage species at three stages of maturity (adapted from Auburn University and University of Minnesota[2]).

	Stage of Growth					
	Vegetative		*Flower/Boot*		*Heading*	
	Digestibility (%)					
Species	*IVDMD*	*Crude Protein*	*IVDMD*	*Crude Protein*	*IVDMD*	*Crude Protein*
Cool-Season						
Henbit	-	-	78	20	75	16
Virginia pepperweed	86	32	72	26	63	17
Curly dock	73	30	54	19	51	16
Chicory	-	15	-	-	-	-
Warm-Season						
Redroot pigweed*	73	24	71	17	64	11
Ivyleaf morningglory	80	19	-	-	78	11
Jimsonweed*	72	25	66	21	59	17
Common lambsquarters	-	-	68	25	-	-
Common ragweed	-	-	73	25	-	-
Fall panicum	72	19	63	9	54	7
Yellow foxtail	73	18	66	12	57	14
Crabgrass	79	14	72	8	63	6
Goosegrass	75	17	-	-	53	8
Pennsylvania smartweed	47	9	-	-	45	4
Goldenrod	54	11	-	-	53	8
Common cocklebur*	76	11	-	-	59	7
Common pokeweed*	75	17	-	-	57	12
Horsenettle*	60	25	-	-	55	13
Kudzu	-	14	-	-	-	-
Multiflora rose	-	18	-	-	-	-
Seeded Forages						
Alfalfa	-	-	72	26	-	-
Tall fescue	78	22	73	17	67	13
Ladino clover	81	27	85	22	83	23
Winter rye	79	27	81	24	70	13
Bermudagrass	58	16	51	7	43	7

[1] IVDMD = *in vitro* dry matter digestibility. A measurement of the amount of dry matter lost upon filtration following the incubation of forage in test tubes with rumen microflora.
[2] C. S. Hoveland, et al. 1986. Bulletin 577 Alabama Agricultural Experiment Station. Auburn University, Alabama; S. C. Bosworth et al. 1980. Agron. J. 72:1050-1054; S. C. Bosworth et al. 1985. Weed Science 34:150-154; G. C. Marten and R. N. Anderson. 1975. Crop Science 15:821-827.
* Potentially poisonous plant to livestock.

One of the primary factors when choosing a herbicide is the type of weed to be controlled. Other factors to consider are: (1) applying the herbicide at the appropriate time to be the most effective, (2) the ease of the application, (3) the waiting period after application before the treated area can be grazed or harvested for hay, and (4) the cost of treatment. Young, actively growing plants are easier to kill with herbicides than older plants. In addition, waiting to treat unwanted plants with a herbicide after they are mature or have already produced new seed is very unproductive for suppressing weed problems the next season.

Herbicides can be applied by a variety of methods. On level or somewhat rolling topography, boom type sprayers can be used to apply a broadcast treatment over large areas. However, because of obstacles such as trees, a boomless type of sprayer can be more advantageous for many pasture situations for broadcast applications. Conventional type sprayers are not as conducive on steeper slopes, whereas sprayers mounted on an ATV may be able to reach more remote areas. ATV-mounted sprayers are very useful for spot spraying problem fencerows. Handheld backpack sprayers are good for spot spraying individual plants or for applying dormant stem or cut-stump treatments. Wick bar applicators are sometimes considered for pasture use. However, a height differential must exist between the weed to be controlled and the desirable forage plants. In addition, wick bar applicators are not very effective on plants such as tall ironweed that have leaf surfaces that do not readily absorb the herbicide applied.

Specific details on herbicides labeled for use on grazed pastures and hayfields can be obtained in the University of Kentucky Extension publication, AGR-172, *Weed Management in Grass Pastures, Hayfields, and Fencerows.*

Table 6. Plants potentially poisonous to livestock in Kentucky.

Common Name	Scientific Name	Toxic Part of Plant	Animals Affected
High Risk			
Buckeye, Ohio	*Aesculus* spp.	Young shoots and leaves; mature seed	All animals
Horsechestnut			
Mountain Laurel	*Kalmia latifolia*	All parts of plant, particularly the leaves	Cattle, goats, sheep
Rhododendron	*Rhododendron maxium*		
Red Maple	*Quercus rubra*	Leaves, especially when fallen, damaged, or wilted	Horses primarily
Wild Black Cherry	*Prunus serotina*	Wilted leaves	Ruminants—cattle, goats, sheep are most often affected, although horses can also be affected
Yew, Japanese	*Taxus* spp.	Leaves, bark, wood, and seed	Cattle, horse, goats, sheep
Moderate Risk			
Castor Bean	*Ricinus communis*	All parts of the plant	Horses most susceptible, but all animals can be affected
Larkspur	*Delphinium tricorne*	Entire plant; young leaves most toxic	Cattle most susceptible; other animals include horses and sheep
Hemp Dogbane	*Apocynum cannabium*	All parts of the plant, either green or dried in hay	Cattle, horses
Horsetail	*Equisetum arvense*	Aboveground foliage of plant	Horses are more susceptible than cattle or sheep
Scouring Rush	*Equisetum hyemale*		
Indian Tobacco	*Lobelia inflata*	Leaves, stem, and fruit	All animals
Great Lobella	*Lobelia siphilitica*		
Johnsongrass	*Sorghum halepense*	All plant parts potentially toxic if plants are drought stressed, wilted, or after frost	Cattle, horses, goats, sheep
Oaks	*Quercus* spp.	Young shoots and leaves, sprouts; new buds in the fall; acorns	Other animals may be affected, but primary risk to cattle
Perilla Mint	*Perilla frutescens*	Leaves, stems, seeds	Most often in cattle and horses
Poison Hemlock	*Conium maculatum*	Entire plant—particularly roots and seed	All livestock
Occasional Risk			
Black Locust	*Robina pseudoacacia*	Inner bark, young shoots, leaves, flowers, pods, and seed	Horses most susceptible; cattle, sheep
Bracken Fern	*Pteridium latiusculum*	All stages of plant growth (green or dry)	Sheep are less susceptible than cattle and horses
Buttercup	*Ranunculus* spp.	Stem and leaves; the flowering plant contains more toxin than younger plants	All animals
Kentucky Coffee Tree	*Gymnocladius dioica*	Leaves, seeds, and pulp	Cattle, horses, goats, sheep
Milkweed	*Asclepias* spp.	All parts of the plant, either consumed green or dried in hay	Cattle, horses, goats, sheep
Jimsonweed	*Datura stramonium*	The entire plant, both green and dried; seed are the most toxic part	Cattle, horses, swine, sheep
Pokeweed	*Phytolacca americana*	All parts of the plant, especially the roots and seed	Cattle, horses, swine
Pigweed	*Amaranthus* spp.	Leaves and stem	Cattle, sheep, other ruminants are most susceptible
Common Sneezeweed	*Helenium autumnale*	All parts of the plant are poisonous either fresh or cured in hay, particularly when in bloom	Cattle, horses, sheep
Bitter Sneezeweed	*Helenium tenuifolium*		
White Snakeroot	*Eupatorium rugosum*	Leaves, stems, and green flower heads	Cattle, horses, sheep; other domestic animals
Star-of-Bethlehem		All parts of the plants, especially bulb	Cattle, horses, sheep
St. Johnswort	*Hypericum perforatum*	All parts of the plant, either fresh or dried hay	Cattle, horses, sheep; goats to a lesser degree

How to Renovate Steep Terrain Pasture and Hay Fields

In Kentucky, renovation usually means adding lime and fertilizer according to soil test results, controlling undesirable weeds, and increasing the legume component of the forage base (see AGR-26 for more information on pasture renovation).

Step 1. Soil test and apply needed lime and fertilizer. Legumes need a higher soil pH and fertility level than grasses. However, nitrogen fertilization should be avoided at seeding if legumes and grasses are planted at the same time. Added nitrogen stimulates grasses, which increases competition with the legume.

Step 2. Reduce competition from existing vegetation. This can be accomplished by heavy grazing, mowing, light tillage, or herbicide usage.

Step 3. Select the grass and legumes species/varieties that are best suited for the site (i.e., fertility level, drought tolerance, grazing versus hay).

Step 4. Use certified seed and inoculate legumes (refer to AGR-90) with the appropriate strain of rhizobium bacteria to ensure nodulation.

Step 5. Plant seed at recommended rates and dates so that it makes good contact with the soil (Table 7). On non-erodible sites, this can be accomplished by light surface disturbance using a disc or chain drag. Broadcast seed followed by a second trip with a chain drag to improve soil:seed contact. Clovers can also be successfully seeded on steep terrain in late winter/early spring using an ATV with a small broadcast seed spreader. As the soil freezes and thaws, the seed becomes covered. This method does not work well for alfalfa and most grasses. Another method is to use a no-till pasture renovation seeder. These do a good job of placing seed in good contact with the soil, dispensing seed at the desired rate When operating a no-till pasture seeder on the contour of the slope, keep seed hopper full so all seed cups remain covered for uniform planting, or install baffles to prevent seed from shifting to one end of the hopper.

Table 7. Grass and legume seeding rates and dates for renovating hay and pasture fields.

	Seeding Rate lb/ac	Seeding Date	
		Spring	Fall
Legume(s)			
Ladino white clover	1-3	Feb 1-Apr 15	Aug 1-Sept 10
Red clover	6-12	Feb 1-Apr 15	Aug 1-Sept 10
Alfalfa	12-20	Mar 1-Apr 15	Aug 1-Sept 15
Sericea lespedeza	30-35 (unhulled) 60 (hulled)	Mar 15-Apr 15	
Annual lespedeza	15-25	Feb 15-Apr 1	
Bird's-foot trefoil	6-12 (scarified)	Mar 1-Apr 15	Aug 1-Sept 10
Alsike clover	4-6	Feb 1-Apr 15	Aug 1 Sept 10
Sweet clover	10-15	Feb 1-Apr 1	
Crown vetch	20	Apr 1-May 15	
Cool-Season Grasses			
Tall fescue	10-15	Feb 1- Apr 15	Aug 20-Oct 10
Orchardgrass	10-15	Feb 1-Apr 15	Aug 20-Sept 15
Reed canarygrass	8-12	Feb 1-Apr 15	Sept 1-Oct 1
Perennial ryegrass	15-25	Feb 1-Apr 1	Aug 15-Oct 1
Timothy	3-6	Feb 1-Apr 1	Aug 20-Oct 1
Warm-Season Grasses[1]			
Switchgrass	8-10	May 20-June 10	
Big bluestem	10	May 20-June 10	
Indiangrass	10	May 20-June 10	
Little bluestem	7	May 20-June 10	
Eastern gamagrass	8	May 20-June 10	

[1] Warm-season grass seeding rates are expressed in pounds of pure live seed (PLS) per acre.

Grazing Management on Steep Terrain

Grazing Beef Cattle on Steep Terrain Pastures

Grazing systems on steep terrain tend to be extensive in nature, and large capital investments may not be justified. Therefore, careful planning of pasture size and layout is critical for the economic success of the grazing enterprises. When possible, producers should work with mining companies during reclamation to establish water sources for livestock. Topography should also be considered when establishing water sources.

Cattle do not uniformly graze steep pastures. Within a group of mixed cattle, a range of slopes will be utilized. Research has shown that most cattle will graze moderately sloping land, which is classified as having a 20 to 40% slope. Some cattle will graze steeper slopes (>40%), while others prefer to graze gentle slopes (<20%). This difference in slope grazing preference often leads to overgrazing on the moderate slopes and undergrazing on steep and gentle sloping land.

Reasons for this difference in slope utilization within a herd include forage preference and breed composition of the cattle. Forage composition and quality can vary by elevation, thus influencing grazing location based on individual cattle preference. Research has also shown that breeds of cattle developed in the European Alps regions will utilize steeper slopes and travel further vertical distance to water than English breeds of cattle.

Management of cattle can overcome some slope preference and improve forage utilization on steep terrain. For cow-calf producers, animal selection should be considered. Research over a period of years has shown that cattle classified as steep slope users utilize the same percent slope year after year and that their calves tend to use the same slopes. Observation and culling of cows using only the more gentle slopes will lead to more uniform grazing. Cross breeding to incorporate breeds developed in the European Alps will also improve grazing uniformity.

Fencing across the slope (along the contour) and movement of cattle to different grazing areas are also effective. In a continuous grazing system, placement of water and mineral sources should encourage cattle to move into and graze the less desirable steep slope areas of the pastures. Research has shown there is no difference in the horizontal distance cattle will travel to water on steep slopes.

Fencing pastures to encourage livestock to graze less desirable areas could greatly increase overall pasture utilization (refer to ID-74). Cattle tend to avoid grazing the steep areas of a pasture until reduced forage availability forces them onto these slopes. The plant composition of a pasture also influences grazing activity. Sericea lespedeza, which dominates many mine land pastures, contains

significant amounts of tannins, which reduce its palatability. Fortunately, new low tannin varieties of sericea lespedeza are now available. Although sericea's fresh growth is palatable and nutritious to livestock in the spring, its suitability as a forage declines as the growing season progresses. If allowed to grow above 8 to 10 inches in height, sericea becomes stemmy and low in forage quality. Therefore, pastures with large amounts of sericea lespedeza should be heavily grazed in the spring to maintain it in a vegetative state. Research has demonstrated that sericea-dominated pastures can be converted to more favorable forages by careful and strategic management over a two-year period (Dove and others, 1991; VCE 460-119).

Careful planning of permanent fencing along with the use of temporary fencing can encourage livestock to graze areas of the pasture they would normally avoid. Managing grazing for the stockpiling of fescue-lespedeza pastures could significantly reduce the need for stored winter feed. In the Kentucky study, cattle continuously grazed at the 9-acre per head (light) stocking rate had forage available well into December. In contrast, continuously grazed pastures at the 3-acre per head (heavy) stocking rate during the peak growing period had less ground cover and significantly greater grazing activity over the entire pasture area (Figures 2 and 3).

Producers with limited land resources should consider a rotational grazing system over a continuous grazing system if enough good quality water is available. Pasture size should be adequate to provide one to two weeks of grazing. Paddock numbers in the rotation should be sufficient to allow for a four- to six-week recovery period, especially during the dry summer months. Forage regrowth on steep terrain does not occur as quickly as on more gently sloping soils that have more favorable soil properties. Also, forage on steep terrain is more likely to be overgrazed, which increases recovery time or may even reduce ground cover.

If fencing is not practical because of tract size or other reasons, herding and strategic placement of supplements will also improve pasture utilization. Research has shown that early morning (7 a.m.) location of cattle is a good indicator of where cattle grazed the previous evening and will graze during the morning hours prior to movement to water. Movement of cattle during late afternoon hours to a different grazing location can allow cattle to graze longer in a given location.

Placement of minerals or low-moisture molasses blocks far from water and herding of cattle to these sites has also been shown to increase forage use. This combination is more effective than herding alone. It is also more effective in spring when the forage is much lusher.

Grazing Horses on Steep Terrain Pastures

The amount of grazing that horses will do on steep pastures will be greatly affected by the percent slope of that pasture. Horses prefer to graze along the contour of a slope and may be reluctant to graze up and down the slope. This grazing preference can result in poor utilization of available forage, lower forage intake, and failure to meet the nutrient requirements of the animal.

For the horse owner, the actual number of acres used by the horse needs to be taken into account. A reduction in usable acres may lead to overgrazing of those areas. While the level ground can be overgrazed, hopefully the areas on the slope that are not grazed as heavily will maintain a good stand of forage and help to reduce erosion in the pasture.

Hoof damage by horses is a concern regardless of the topography of a pasture. Routine movement of the horses across the pasture during normal grazing behavior will result in well-worn areas as is the case with other classes of livestock. On steep pastures, this often results in soil erosion. In addition to those well-worn paths, horses can damage areas where they congregate such as shade, feeders, water sources, or around the gate. Horse owners need to consider using material that will provide good drainage in these areas to keep them from becoming muddy.

Keeping horses on steep pastures will require added management. Horse owners need to consider not only the nutritional needs

Figure 2. Percent cover as affected by beef cattle stocking rate on reclaimed mine land in southeast Kentucky**.** Bars followed by the same letter are not significantly different according to LSD (P<0.10).

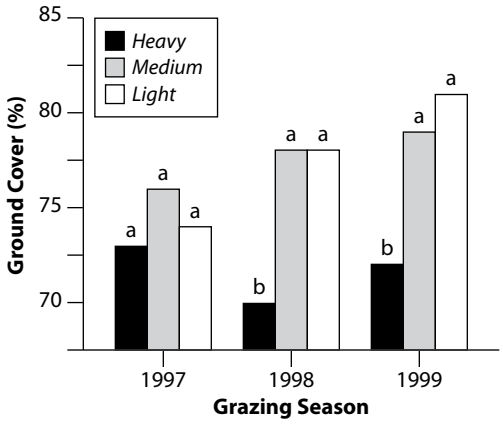
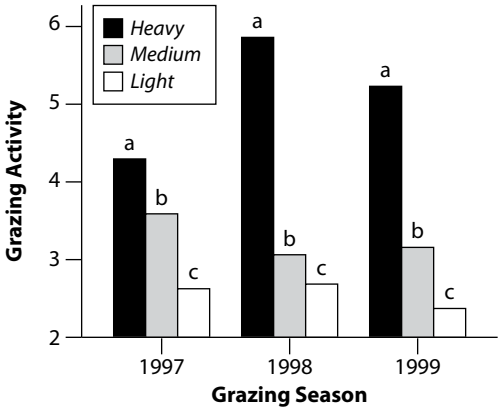


Figure 3. Effect of stocking rate on grazing activity on reclaimed mine land in southeast Kentucky. Scale: 1 = none, 2 = light (<20% tillers defoliated), 3 = light+ (21-40% tillers defoliated), 4 = moderate (41-60% tillers defoliated), 5 = moderate+ (61-80% tillers defoliated), and 6 = heavy (>80% tillers defoliated). Bars followed by the same letter are not significantly different according to LSD (P<0.10).



of their horses but also the effects of animals on the pasture (refer to ASC-120 and ID-147). Overgrazing can be prevented by a rotational grazing program to rest the pasture and allow for regrowth. It is also important to select forage species and varieties that offer the most grazing tolerance (refer to PR-515) and are compatible with the physical and chemical soil characteristic of each field (Tables 3 and 4).In addition, it is important to have an area such as a dry lot to move horses off the pasture during drought or extremely wet conditions where excessive damage can be done to the pastures. Table 8 lists the forage species that are most desirable and those that are not recommended for horse pastures in Kentucky.

Table 8. Forage species that are desirable and those not recommended for horse pastures in Kentucky.[1]

Desirable Species	**Cautions**
Alfalfa	
Bermudagrass	
Big bluestem	
Bird's foot trefoil	
Eastern gamagrass	
Kentucky bluegrass	
Orchardgrass	
Perennial ryegrass	May contain an endophyte that can cause neurological problems in all classes of horses. To prevent this, request forage type perennial ryegrass endophyte free seed.
Red clover	Horses grazing red clover may experience slobbers. If horses are slobbering excessively while on red clover pasture, they should be removed from the pasture.
Tall fescue	Tall fescue that is infected with the endophyte fungus *(Acremonium coenophalium)* should not be used with broodmares in the last one third of gestation. Tall fescue seed that is endophyte free can be used, or seed bearing the novel endophyte can be used to prevent the problems associated with the endophyte infected tall fescue (refer to ID-144).
Timothy	
White clover	
Undesirable Species	**Cautions**
Alsike clover	May cause photosensitization and liver problems
Johnsongrass	Can cause cystitis due to cyanide toxicosis
Sorghum sudan	Can cause cystitis due to cyanide toxicosis

[1] Assumes that growing conditions are favorable for the species listed.

Grazing Goats on Steep Terrain Pastures

Goats have a very diverse diet, much more diverse than sheep, and have been described by grazing ecologists as browsers. However, goats can also be opportunistic generalists because they consume the most palatable forage first and move on to the next level within the palatability and nutritional plane.

Goats prefer to graze uphill in a zigzag motion and, conversely, graze very little coming downhill. They often graze steep slopes and around rock outcrops first, showing a preference for areas inaccessible to cattle and sheep. Furthermore, goats generally approach the feeding area from the outermost boundary of the feeding perimeter and eat toward the center and forward to the initial starting point. Goats often return to the starting point of the grazing area and congregate for resting and rumination. This grazing habit creates a concaved grazing pattern that provides maximum visibility of the surroundings for the herd.

Goats grazing steep terrain will often have a higher nutritive requirement than goats grazing more level pastures because they must expend more energy to gather feed. Therefore, if the primary objective is grazing for brush control, less productive or maintenance goats should be used to consume lower-quality forage.

Goats are resistant to many plant toxins and anti-nutritive factors commonly found in non-agricultural areas. Therefore, goats are capable of defoliating most plant species, many of which cattle will not utilize. The primary anti-nutritive factors are naturally occurring plant tannins. The taste of tannins is bitter and generally unpalatable for cattle, and for most ruminants, tannins bind rumen proteins and reduce their uptake. Goats, however, favor the bitter taste and can utilize the bound proteins as bypass protein. Bypass protein is nondegraded protein that passes directly to the abomasum or true stomach for more efficient utilization. Therefore, goats can sustain themselves on low protein vegetation for some time by utilizing protein more efficiently than can cattle.

Given the opportunity, goats consume a predominance of browse (73%) and lesser amounts of grasses (23%) and forbs (4%), although the proportion will vary with availability of standing forage. Time of year and weather conditions also may dictate what goats eat. Goats tend to eat viney plants like honeysuckle early in the browse season. As the weather gets warmer and the succulent plants are either consumed or no longer favored, goats turn to a more diverse plant population including hardwood seedlings and broadleaf foliage from low hanging branches. Eastern red cedar remains untouched by goats until it becomes more desirable for browsing in mid- to late winter.

The diverse grazing habit of goats helps the restoration of the plant-soil nutrient balance to degraded and eroded soils. Woody plant species store large quantities of plant nutrients. These nutrients (N, P, and K) remain bound in the woody tissue for very long periods of time. Woody plants must die and decompose before the nutrients are released to the soil. As goats consume a variety of woody species and assorted plant parts, plant nutrients are more rapidly released to the soil by way of goat waste degradation by soil microflora. This process has been observed by monitoring soil nutrient changes occurring following three years of goats grazing shinnery oak (*Quercus havardii*). Soil N, P, and K levels increased from 1 to 21 lb/ac and 5 to 23 lb/ac and 119 to 312 lb/ac, respectively.

Similarly, goats are a beneficial addition to a mixed species grazing pasture environment. Goats preferentially consume seedling stems of weedy plants, thus reducing the spread and perpetuation of weeds by seed. Range management scientists have observed that goats reduce the seed bank of thistles when used to control thistles and sericea lespedeza in the tall grass prairie of the western United States.

Goats can be used similarly in Kentucky's cool-season pastures to control weedy species that they prefer as browse such as blackberry, green briar, sumac, winged elm, poison ivy, ironweed, and kudzu.

Goats have a moderate preference for multiflora rose, ragweed, hickory, hawthorne, and eastern red cedar. They have a low preference for Osage orange, hackberry, buckbush, and giant ragweed but will consume these species when other forage and browse are not available.

Finally, goats can graze in combination with cattle, horses, or sheep. The main benefit of multi-grazing is that goats utilize and thereby suppress plant species that are not utilized by cattle. Scientists have observed that pasture utilization and carrying capacity was improved 10 to 24% by grazing goats in combination with cattle and sheep. The browsing and top grazing habit of goats increased desirable grass and legume populations within pasture settings by reducing competition from undesirable plant species.

Tractor Safety on Steep Sloping Terrain

Farming steep sloping terrain presents some unique hazards for tractor operators and requires both knowledge and experience to perform safely. However, even knowledge gained from years of experience does not guarantee that a tractor overturn or other serious injury will not occur. The largest single source of agricultural deaths in Kentucky is tractor overturns, and activities on steep and rugged terrain will only increase the potential risk for a serious incident. Thus, the first rule for operating tractors and equipment on sloping or steep terrain is always to use tractors equipped with a rollover protective structure (ROPS) or "roll bar," as it is commonly called. It is essential for safe operation on steep or sloping terrain.

General Safety Considerations

- No extra riders on equipment is always a good policy and should be strictly enforced on steep slopes. Extra riders may distract the operator and are at greater risk of being thrown from the tractor in an overturn or if rough terrain is encountered. Even extra riders in a cab are at risk unless the cab has an approved training seat with a seatbelt.
- Avoid the use of any substance that would impair the operator's function. Operation of equipment on sloping terrain requires full attention.
- Only those who are well rested, mentally alert, and in good physical condition should operate equipment on steep sloping terrain. Avoid operating equipment when tired.
- Only operators who are experienced and knowledgeable of the hazards associated with operating on steep sloping terrain should be permitted to drive.
- Scout steep slopes in advance and flag or mark all known hazards or obstacles.
- Always be on the alert for washouts or other obstacles or obstructions that could cause a hazardous condition.
- Plan the work procedure in advance, and start out on the more gentle areas of the slope and work toward the steeper areas. Constantly be alert for any signs of reduced stability or traction with the equipment.
- Do not exceed the capability of the equipment beyond the limits of safe operation.
- All equipment should be in good repair and properly maintained, including good brakes.

Preventing Side Overturns

- Because of the increased risk of overturns when operating on slopes, only tractors equipped with approved rollover protective structures (ROPS) should be used on steep sloping terrain, and the seatbelt should always be worn. The use of a seatbelt when operating on slopes increases comfort and decreases fatigue.
- Low profile or utility-type tractors are more stable and preferred for use on steep slopes because they have a lower center of gravity.
- Tricycle-type tractors and small offset-type tractors should not be used on steep sloping or uneven terrain as they are more prone to side overturns.
- Adding wheel weights or fluid to the rear tires helps stabilize the tractor by lowering the center of gravity.
- Widening the wheel spacing greatly increases the tractor's lateral stability and is critical for safe operation on slopes.
- Always reduce speed when operating on steep slopes to reduce the tipping momentum from hitting unseen holes, bumps, or other obstacles.
- Always slow down and make gradual turns on steep slopes. Avoid sudden steering changes or any quick or sharp turns especially when traversing across or going down sloping terrain.
- If a tractor starts to feel unstable on a slope, turn downhill if possible.
- If pulling a heavy load such as a fertilizer spreader, turn uphill if possible. Turning downhill can lead to loss of traction and possible jackknifing.

Preventing Rear Overturns

- Add weights to the front of the tractor anytime fluid or rear wheel weights are added to the rear tires to maintain the tractor's weight distribution of 30% of the weight on the front tires and 70% on the rear.
- If equipment is mounted on the three-point hitch, add weights to the front of the tractor to maintain sufficient weight on the front tires for steering stability.
- Always hitch loads to the tractor drawbar. Hitching to any point above the recommended drawbar height increases the risk of a rear overturn.

Case example:

An experienced farmer, who had farmed hill farms all of his life, was mowing a pasture with a batwing rotary field mower on a summer evening. It was nearly dark as he made the last pass up a sloped area with the mower. Suddenly, the right rear tractor tire dropped in a washed-out cow path causing the batwing mower to dig into the dirt. Before he could react, the tractor flipped over backward onto the mower. Fortunately, he was using a tractor retrofitted with a ROPS and was able to walk away without any serious injuries. He had never flipped a tractor before and did not think it would happen to him.

- Always back up a steep sloped area. The wheel torque from driving up a steep slope may cause the tractor to overturn backward.
- Avoid pulling heavy loads up a steep slope due to the increased risk of a rear overturn.
- Using two-wheeled implements that place excessive weight on the tractor drawbar transfers weight from the front axle to the rear axle and increases the risk of a rear overturn.
- Sudden braking while coasting backward down a slope or any quick engagement of the clutch while driving up a slope greatly increases the risk of a rear overturn and should be avoided. Downshift to the appropriate gear before proceeding up a slope.

Loss of Traction and Jackknifing

- Two-wheel drive tractors are at special risk of losing traction when pulling loads down slopes. On steep slopes with poor traction conditions, this can even occur without a load. Loss of traction can occur when driving downhill because weight is transferred from the rear tires to the front, resulting in less traction with the rear tires. This can lead to jackknifing and the possibility of a side overturn.
- If available, use tractors with front wheel assist which, if the front wheels are engaged, will provide four-wheel traction to control the force of the load.
- Use a larger, heavier tractor, or reduce the size of loads when operating on slopes.
- Use additional wheel weights to ensure better traction for driving up and down slopes.
- Avoid pulling loads up or down slopes when traction conditions are poor such as from heavy dew, rain, dry hard soil conditions, lush green plant material, frozen or thawing ground conditions, etc.
- Gear down and throttle back before heading down a slope using the same gear as required to pull the load up the slope.
- Only use tractors with good tires that are properly inflated when pulling on slopes.
- If loss of traction does occur when driving down a slope, the only course of action is to attempt to steer in the direction of the rear wheel skid and keep the tractor in alignment in front of the implement until traction and control are regained.

All-Terrain Vehicle and Utility Vehicle Safety on Steep Sloping Terrain

All-terrain vehicles (ATVs) and more recently utility vehicles (UTs) have long been known for their general utility in agricultural operations. Both of these vehicles offer many advantages for operation on steep sloping terrain, but both have the potential for causing injuries. For example, the number of deaths associated with ATVs has climbed dramatically in recent years to a high of 40 deaths in 2002 and 2004. Over the last five years, the state has averaged 36 ATV deaths per year. Although most of these ATV deaths are a result of recreational activities and not work related, contrast that number with an average of 22 total agricultural work-related deaths per year in the state over the same five-year period.

While the number of deaths associated with the use of utility vehicles such as the Mule, Gator, RTV, Ranger, Bobcat, etc. is unknown, they are designed as a work vehicle with the following characteristics: (1) a wider wheel tread width and longer wheel base for more stability, (2) larger load carrying and towing capacity, (3) typically maximum speeds of less than 25 miles per hour, (4) seating for an extra passenger, and (5) a rollover protective structure (ROPS) and seatbelts, which are available on some models to provide operator protection in an overturn. These design factors make the utility vehicle a viable alternative for use in agricultural work, and the ROPS helps ensure operator and passenger safety on steep slopes where there is high risk of an overturn. However, do not be deceived: *Both the ATV and the utility vehicle can pose a serious threat to operator safety and require specific precautions when being used on rough terrain and steep slopes.*

Safety Tips for Operating on Steep Slopes

- Only experienced operators who are familiar with using ATVs or utility vehicles and have used them with mounted or towed equipment in agricultural activities should operate this equipment on steep sloping terrain. Remember:
  - ATVs are "rider active" machines that require operator skill in shifting weight while riding to maintain balance of the machine. This operator skill will be critical for safe operation on steep slopes.
  - Utility vehicles are designed for work purposes and provide more stability; however, for maximum operator protection on rough terrain and steep slopes, only those vehicles equipped with a rollover protective structure (ROPS) and seatbelts that meet current rollover protection standards are recommended. Brush guard type frames that have not been tested should not be trusted to provide rollover protection. Check with your dealer regarding availability of ROPS on new or existing utility vehicles.
- If using an ATV or a utility vehicle, heavy-duty, four-wheel drive models are preferred for use in agricultural activities, especially on steep slopes. Check with your local ATV dealer regarding the models, suspension systems, and other features most appropriate for your work requirements.
- Regardless of the type of ATV or utility vehicle used, always check the operator's manual for towing and load carrying limitations or restrictions. Never exceed the manufacturer's recommendations. Also check for other recommendations regarding the use of towed or mounted equipment. Any mounted or towed equipment will affect the stability and/or the handling characteristics on steep sloping terrain.
- Good maintenance of the brakes and braking system is critical for safe operation on steep slopes.
- Tires with good tread and proper air pressure are important for good traction on steep slopes. Replace worn tires and maintain tire air pressures as recommended by the manufacturer. Improper or uneven tire pressures can lead to loss of control.
- Always follow the manufacturer's recommendations and specifications when mounting equipment on the ATV or utility vehicle. Do not alter the height of the mounting points or increase the towing capacity beyond those indicated by the manufacturer.
- Always observe the ATV manufacturer's specifications regard-

ing load ratings for front and rear carrier racks. Attachments or loads carried on the front or rear racks can raise the center of gravity and decrease the stability. Likewise, heavy or high loads on utility vehicles can decrease the stability. Secure all loads and mounted equipment to prevent shifting when operating on rough or sloping terrain.

- With utility vehicles, avoid driving across steep slopes or making sharp turns on slopes. Drive up and down steep slopes, and make turns on more level areas at the top or bottom of the slope if possible.
- Always hitch loads to the drawbar according to the instructions in the owner's manual. Hitching loads above the drawbar height greatly increases the risk of a rear overturn. The shorter wheelbase and lighter weight of the ATV make it more prone to rear overturns than the utility vehicle.
- Towing loads uphill or heavy attachments on the rear of the ATV increases the risk of a rear overturn. Sudden acceleration of the ATV throttle when going up inclines or sudden braking when backing down a slope will also increase the risk of a rear overturn.
- Descending steep slopes with towed loads increases stopping distances and can result in loss of traction and possible jackknifing. Reduce the size of towed loads on steep slopes, and avoid conditions such as heavy dew, hard dry or loose soil, lush green plant material, etc., that reduce traction. To maintain control, use the assistance of four-wheel drive, shift to the low range, and use the brakes as necessary. If the vehicle's tires start to skid, release some of the braking pressure so the vehicle can be steered in the direction of the skid to help prevent jackknifing.
- Some slopes may be too steep for safe operation for either ATVs or utility vehicles. Consider the conditions of the terrain and the type of towed or mounted equipment being used, and then use good judgment and common sense in determining if the activity can be carried out safely.
- ATVs are designed for off-road use, and operation on hard surfaces at high speeds can adversely affect handling characteristics. Although use on public roads is not recommended, Kentucky law does permit the use of an ATV on a two-lane public highway "if the operator is engaged in farm or agricultural-related activities." If used on a public road, the law requires that the operator must have a valid driver's license, the vehicle must have at least one headlight and two tail lights that are illuminated, and they can only be operated on public roads during daylight hours. Check the Kentucky law for restrictions on the crossing of public roads for non-work related uses.
- The use of a helmet is recommended anytime an ATV is in operation since severe head injuries are a common result in serious ATV injuries and deaths. While the Kentucky law does not require the use of a helmet when the ATV is being used for agricultural purposes, the use of a helmet is highly recommended. Other recommended protective clothing includes over-the-ankle boots with heels, long-sleeved shirt or jacket, long pants, gloves, and goggles or face shields if used at higher speeds.
- Use of a helmet when operating a utility vehicle is not as critical because the speeds are generally much slower, but a helmet is recommended for operation on rough terrain and steep slopes because of the increased risks of overturns or other incidents and when used at higher speeds.

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