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Pork Industry Handbook: Forages for Swine

Michigan State University

Cooperative Extension Service

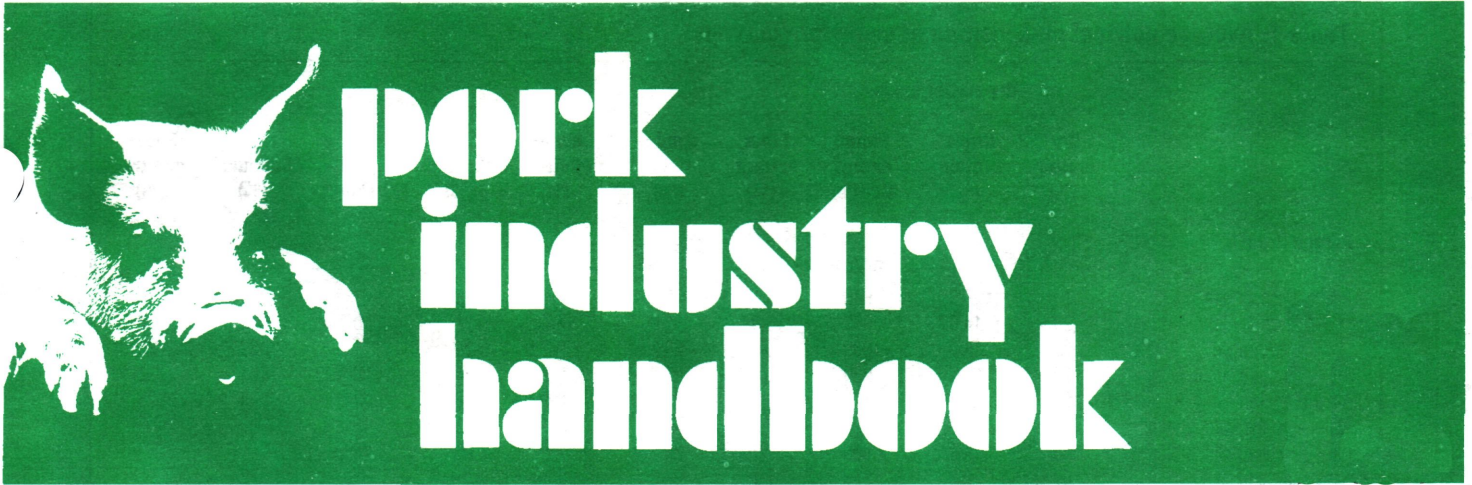
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Michigan State University Extension

## Forages For Swine

(Key Words: Forages, Fiber, High-Forage Diets, Swine)

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### Use of Forage

Pork producers have long recognized the value of forages in the swine enterprise. Prior to 1950, pasture was considered a vital component in swine feeding programs. But after synthetic vitamins became universally available during the early '50's, the need for forage crops in swine production was diminished. But even today, pastures and forages may contribute a practical and economical part of feeding hogs.

**Can hogs utilize forage?** Research demonstrates that pigs can make good uses of forage crops. Most of the fiber digestion occurs in the large intestine which enables pigs to recover a significant amount of energy from hay and forage crops. However, the importance of using forage when it is at an early stage of maturity is more critical with swine than with ruminants. Studies with sows show that the digestibility of fiber improves after an adaptation period of at least two months. Many pork producers consider using forage in their feeding programs because they can utilize marginal lands. Others have abundant supplies of forage or hay that can be used to save on grain or protein costs.

Before making forage a major part of the diet, first consider the potential savings that may be realized. Since most forages contain more protein than the grains contain, both grains and protein supplements may be reduced when using forages. But it is also important to remember that the digestibility of protein in forages is lower than that of soybean meal or other protein supplements. If the diet contains more than 25% forages, the protein content in the complete feed should be slightly higher than that of a typical grain-soybean meal diet.

Forage can simplify feeding and management of the breeding herd. For example, sows on good quality pasture can be fed less often and with a smaller amount of concentrate. With the proper amounts of forage in a complete feed, sows can be self-fed during gestation without adversely affecting weight gain or reproductive performance (although some feed wastage may occur). Sows may be more content when the diet contains a significant amount of forage, compared to limit-fed sows that receive only 4 lb to 5 lb of concentrate each day.

Forage may also be used to provide a source of fiber. Nutritionists and producers have both recognized that fiber improves gut motility during late gestation and early lactation. Diets for newly arrived feeder pigs and starter diets containing increased fiber levels have been shown to reduce diarrhea problems. While it is not a direct benefit of the forage, pigs and sows on pasture may have fewer health problems because of improved sanitation and air quality.

**Potential drawbacks to forage.** Fresh forages are low in dry matter, which means the pig must consume more material to get the same amount of nutrients found in grain or in complete feed. For this reason, pastures and/or high levels of forage in the diet are less practical for pigs weighing less than 40 lb and for sows in lactation. In addition, pigs often consume less energy per day when feeds contain more than 20% forage, because high-forage diets are less energy dense and less palatable.

Another drawback to using forages, especially pastures, is that they might not be available during the entire year. This means that the feeding program may have to be modified from one season to the next.

**Table 1. Average nutrient composition of some forage crops<sup>1</sup>.**

Forage Crop <sup>2</sup>	Dry matter basis									
	Dry matter (%)	Crude protein (%)	Metab energy Kcal/lb	Ether extract (%)	Crude fiber (%)	Hemi-cellulose (%)	Cellulose (%)	Lignin (%)	Calcium (%)	Phosphorus (%)
Alfalfa, fresh, er blm	23	19.0	986	3.1	25.0	8	23	7	2.33	.31
Alfalfa, fresh, fl blm	25	14.0	905	2.8	31.0	13	27	10	1.53	.27
Alfalfa meal, dehyd	92	18.9	1005	3.0	26.2	-	24	11	1.52	.25
Alfalfa hay, sun cured, er blm	90	18.0	986	3.0	23.0	9	24	8	1.41	.22
Alfalfa hay, sun cured, lt blm	90	14.0	854	1.8	32.0	12	26	12	1.43	.25
Alfalfa haylage, wlted, er blm	35	17.0	986	3.2	28.0	9	23	10	-	-
Alfalfa haylage, wlted, fl blm	45	14.0	905	2.7	33.2	12	25	12	-	-
Barley hay, sun cured	87	8.7	923	2.1	27.5	-	-	-	.23	.26
Bluegrass, Kentucky, fresh, er vegetative	31	17.4	1182	3.6	25.3	-	26	3	.50	.44
Bluegrass, Kentucky, hay, sun cured	89	13.0	923	3.5	31.0	-	-	-	.33	.25
Brome, Smooth, hay, sun cured, midblm	90	14.6	923	2.6	31.8	22	31	4	.29	.28
Clover, Alsike, hay, sun cured	88	14.9	955	3.0	30.1	13	-	-	1.29	.26
Clover, Crimson, hay, sun cured	87	18.4	936	2.4	30.1	-	-	-	1.40	.22
Clover, Ladino, hay, sun cured	90	22.0	986	2.7	21.2	-	-	7	1.35	.31
Clover, Red, fresh, er blm	20	19.4	1136	5.0	23.2	-	-	-	2.26	.38
Clover, Red, hay, sun cured	89	16.0	905	2.8	28.8	9	26	10	1.53	.25
Corn, Dent Yellow, silage, well eared	33	8.1	1150	3.1	23.7	-	-	-	.23	.22
Lespedeza, Common-Lespedeza, Korean, hay, sun cured, er blm	93	15.5	905	-	28.0	-	-	-	1.23	.25
Orchardgrass, fresh, midblm	31	11.0	932	3.5	33.5	27	33	6	.23	.23
Rape, fresh, er blm	11	23.5	1232	3.8	15.8	-	-	-	-	-
Rye, fresh	24	15.9	1136	3.7	28.5	-	-	-	.39	.33
Ryegrass, Perennial, hay, sun cured	86	8.6	986	2.2	30.3	-	-	2	.65	.32
Sorghum, Sudangrass, fresh, midblm	23	8.8	1036	1.8	30.0	25	34	5	.43	.36
Sweetclover, Yellow, hay, sun cured	87	15.7	886	2.0	33.4	-	-	-	1.27	.25
Timothy hay, sun cured, er blm	90	15.0	968	2.9	28.0	29	31	4	.53	.25
Timothy, hay, sun cured, fl blm	89	8.1	922	3.1	32.0	30	34	6	.43	.20
Trefoil, Birdsfoot, hay, sun cured	92	16.3	968	2.5	30.7	-	24	9	1.70	.27
Wheat, fresh, er vegetative	22	28.6	1200	4.4	17.4	18	24	4	.42	.40

<sup>1</sup>Adapted from Nutrient Requirements of Beef, National Academy Press. Metabolizable energy values shown are for beef, since comparable values are unavailable for swine. Similarly, amino acid levels are unknown for most forages.

<sup>2</sup>er=early; blm=bloom; fl=full; dehyd=dehydrated; lt=late; wlted=wilted; midblm=midbloom.

Hogs should be rotated off pastures periodically to prevent heavy bacterial and parasite contamination.

Feed value from pastures is often over-estimated by producers since forages may be heavily damaged by hogs. Both the pasture and the forage crop must be well-managed to provide optimum feed savings. Producers may find this difficult especially during the spring and fall months when damage from hogs rooting the soil reaches a peak.

Finally, hogs housed in a pasture setting have a higher energy requirement since hogs outside get more exercise than those housed in pens or enclosed facilities. Sows will require more feed during gestation, and market hogs may gain slower and less efficiently.

**Forage analysis.** Table 1 lists the average nutrient composition for various forages. The table can be used as a guide to formulation, but forage analysis should form

the base for diet formulation whenever practical. Crude protein, calcium, and phosphorus can be assayed at most analytical laboratories at a relatively low cost. In addition, most laboratories offer Neutral Detergent Fiber (NDF) analysis. NDF provides an estimate of the percentage of cell walls contained in the forage. The cell walls contain all of the fiber, which is the least digestible component of the forage. The fibrous components of the cell wall primarily include cellulose, hemicellulose, and lignin. None of the lignin is digestible, and only 30% to 40% of the hemicellulose and cellulose is digestible. The percent of cellulose in the forage is estimated by subtracting Acid Detergent Fiber (ADF), another fiber analysis, from NDF. Percent lignin is estimated with an Acid Detergent Lignin (ADL) analysis. Percent hemicellulose is calculated by subtracting ADL from ADF. If levels of hemicellulose and lignin are significantly higher than the

average values shown in Table 1, metabolizable energy and crude protein concentrations in the forage will likely be lower.

## Methods of Feeding Forage

**Pasture.** Pastures containing a high percentage of legumes are normally the most practical for pork producers. On a dry matter basis, legumes are similar in energy content and higher in crude protein than are the grasses. Some grass species in the mixture may help prevent soil erosion.

Optimum stocking rates depend on soil types, plant species, and weather conditions. Normally, 4 to 6 gestating sows per acre (8 to 12 if irrigated) or 10 to 12 growing hogs (15 to 25 if irrigated) will make good use of the pasture crop without excessive damage. Damage to the pasture from hogs rooting the soil is most prevalent in the spring and fall months.

Sows should be fed approximately 2 lb to 3 lb of complete feed while on pasture. Grower-finisher pigs should have free access to complete feed at the same time they are grazing a pasture crop. Suggested feed formulas for sows and growing pigs are shown in Tables 2, 3, and 4.

Pastures should be plowed, disked, and reseeded at least every other year. This serves to level the pasture, re-establish plant growth, and reduce bacterial and parasite contamination.

When grazing hogs on legume pastures in northern latitudes, allow enough time in the fall to permit at least 6

in. of growth before the arrival of a killing frost. This helps reduce winter-kill by enabling the plant to build root reserves.

**Silage and haylage.** Feeding programs for gestating sows or replacement gilts weighing more than 250 lb in gestation can include silage and haylage. These forages should be finely chopped to prevent sorting by sows. To avoid reproductive problems, be sure that any ensiled forage is fresh and free of mold.

Offer corn silage as a free-choice item. Intake is variable, but under most conditions sows will consume 10 lb to 12 lb per head per day. Sows also should be fed approximately 2.5 lb of a complete feed in addition to the silage. For best results, the corn silage should be made when the ears are formed, and at the same time the plant is still green and not frosted. Silage made from corn nearing maturity is less palatable and digestible.

When feeding legume haylage, offer all the haylage sows will clean up (usually 6 lb to 8 lb per head per day), plus 2.5 lb of complete feed.

Suggested feed formulations for use with haylage and silage are listed in Table 5.

**Complete feed.** Dried forages can be included in a complete feed. For many producers this is the most practical feeding method. Producers who choose to grind their own forage should use hammermills equipped with screens containing 3/16- to 1/4-in. openings to provide the correct particle size. Pelleting the diets that contain high amounts of forage will reduce separation, and improve palatability and fiber digestion. Recommended diets containing dried forages for sows and growing-finishing pigs are listed in Tables 6, 7, 8, and 9.

**Table 2: Suggested diets<sup>1</sup> to supplement pasture for gestating sows.**

	Type of pasture				
	Legume	Grass	Legume-grass mix	Rape	
<b>Ingredients, lb.</b>					
Corn	1951	1769	1757	1944	1898
Soybean meal, 48%	-	152	-	-	-
Soybean meal, 44%	-	-	164	-	-
Ground limestone	-	13	13	-	17
Dicalcium phosphate	-	42	42	-	61
Monosodium phosphate	25	-	-	32	-
Salt	12	12	12	12	12
Vitamin premix <sup>2</sup>	6	6	6	6	6
Trace mineral premix <sup>3</sup>	6	6	6	6	6
Totals	2000	2000	2000	2000	2000
<b>Calculated composition</b>					
Metab energy, kcal	1516	1492	1484	1511	1475
Crude protein, %	8.1	11.0	10.9	8.1	7.9
Lysine (estimated), %	.25	.46	.46	.25	.25
Calcium, %	.04	.81	.81	.04	1.09
Phosphorus, %	.55	.69	.69	.62	.83
<sup>1</sup> Assumptions: Sows will consume 3.5 lb pasture dry matter and will be fed 2.5 lb of the diet per day. Pasture and feed together will provide a minimum of .65 lb protein, 11 g lysine, 14 g calcium, and 11 g phosphorus per day, respectively. <sup>2</sup> Should provide the following amounts per ton of complete feed: 6,000,000 IU vitamin A; 300,000 IU vitamin D; 64,000 IU vitamin E; 1.0 g vitamin K (menadione); 300 mg biotin; 2,000 g choline; 2 g folacin; 15 g niacin; 18 g pantothenic acid; 6 g riboflavin; 2 g thiamin; 2 g vitamin B <sub>6</sub> ; 22 g vitamin B <sub>12</sub> . <sup>3</sup> Should provide the following amounts per ton of complete feed: 8 g copper; 200 mg iodine; 120 g iron; 30 g manganese; .44 g selenium; 75 g zinc. (Concentrations higher than normal to compensate for reduced dry feed intake.)					

**Table 3: Suggested diets<sup>1</sup> to supplement pasture for growing hogs (40 - 125 lb.).**

	Type of pasture							
	Legume		Grass		Legume-grass mix		Rape	
<b>Ingredients, lb.</b>								
Corn	1482	1447	1419	1379	1446	1409	1493	1460
Soybean meal, 48%	475	-	527	-	505	-	448	-
Soybean meal, 44%	-	510	-	566	-	542	-	481
Ground limestone	6	6	16	16	11	11	17	16
Dicalcium phosphate	17	17	18	19	18	18	22	23
Salt	10	10	10	10	10	10	10	10
Vitamin premix <sup>2</sup>	5	5	5	5	5	5	5	5
Trace mineral premix <sup>3</sup>	5	5	5	5	5	5	5	5
Totals	2000	2000	2000	2000	2000	2000	2000	2000
<b>Calculated composition</b>								
Metab energy, kcal	1517	1493	1504	1478	1512	1487	1505	1483
Crude protein, %	17.4	17.2	18.4	18.1	18.0	17.7	16.8	16.6
Lysine (estimated), %	.91	.91	.98	.98	.95	.95	.87	.87
Calcium, %	.42	.42	.64	.64	.53	.53	.68	.68
Phosphorus, %	.53	.53	.55	.55	.54	.54	.57	.57
<sup>1</sup> Assumptions: Hogs will consume .75 lb pasture dry matter plus 3.75 lb of the diet per day. Pasture and feed together will provide a minimum of .75 lb protein, 18 g lysine, 12 g calcium, and 10 g phosphorus per day, respectively. <sup>2</sup> Should provide the following amounts per ton of complete feed: 1,500,000 IU vitamin A; 165,000 IU vitamin D; 12,000 IU vitamin E; 1.0 g vitamin K (menadione); 50 mg biotin; 350 g choline; 350 mg folacin; 11 g niacin; 9 g pantothenic acid; 3 g riboflavin; 2 g thiamin; 2 g vitamin B <sub>6</sub> ; 11 g vitamin B <sub>12</sub> . <sup>3</sup> Should provide the following amounts per ton of complete feed: 5 g copper; 150 mg iodine; 70 g iron; 3 g manganese; .33 g selenium; 70 g zinc. (Concentrations higher than normal to compensate for reduced dry feed intake.)								

**Table 4: Suggested diets<sup>1</sup> to supplement pasture for finishing hogs (125 - 240 lb.).**

	Type of pasture							
	Legume		Grass		Legume-grass mix		Rape	
<b>Ingredients, lb.</b>								
Corn	1647	1623	1610	1585	1576	1548	1658	1636
Soybean meal, 48%	315	-	345	-	374	-	288	-
Soybean meal, 44%	-	339	-	370	-	402	-	309
Ground limestone	4	4	10	10	15	15	15	15
Dicalcium phosphate	14	14	15	15	15	15	19	20
Salt	10	10	10	10	10	10	10	10
Vitamin premix <sup>2</sup>	5	5	5	5	5	5	5	5
Trace mineral premix <sup>3</sup>	5	5	5	5	5	5	5	5
Totals	2000	2000	2000	2000	2000	2000	2000	2000
<b>Calculated composition</b>								
Metab energy, kcal	1522	1506	1517	1500	1512	1494	1510	1495
Crude protein, %	14.3	14.1	14.9	14.7	15.4	15.2	13.7	13.6
Lysine (estimated), %	.69	.69	.73	.73	.77	.77	.65	.65
Calcium, %	.33	.33	.45	.45	.56	.56	.60	.60
Phosphorus, %	.47	.47	.48	.48	.49	.49	.51	.51
<sup>1</sup> Assumptions: Hogs will consume 1.0 lb pasture dry matter plus 5 lb of the diet per day. Pasture and feed together will provide a minimum of .90 lb protein, 19 g lysine, 12 g calcium, and 10 g phosphorus per day, respectively. <sup>2</sup> Should provide the following amounts per ton of complete feed: 1,500,000 IU vitamin A; 165,000 IU vitamin D; 12,000 IU vitamin E; 1.0 g vitamin K (menadione); 50 mg biotin; 350 g choline; 350 mg folacin; 8 g niacin; 8 g pantothenic acid; 3 g riboflavin; 2 g thiamin; 2 g vitamin B <sub>6</sub> ; 6 g vitamin B <sub>12</sub> . <sup>3</sup> Should provide the following amounts per ton of complete feed: 4 g copper; 150 mg iodine; 60 g iron; 3 g manganese; .33 g selenium; 55 g zinc. (Concentrations higher than normal to compensate for reduced dry feed intake.)								

# Value of Forage Crops

## Legumes

**Alfalfa.** Most of the research on the use of forage in swine diets has been with alfalfa. It appears to be the most practical forage crop for the pig because it can be used for both pasture and silage. Because of their maturity, sows make better use of alfalfa (and other forages) than do growing-finishing hogs. Potential benefits to feeding alfalfa during gestation include improved survival of the baby pigs during the nursing period and a reduced culling rate in the sow herd. Some research has shown that as much as 97% can be included in gestation diets without impairing reproductive performance. For commercial operations, however, no more than 65% alfalfa should be used in gestation diets. Gestation diets containing approximately 60% alfalfa can be self-fed.

Growing pigs show satisfactory performance on diets containing alfalfa, provided the level does not exceed 20% of the diet. Even at this level, one can expect a 5% to 15% depression in feed efficiency compared to a grain-soybean meal diet. Receiving diets containing 10% alfalfa may improve gain and feed intake in newly arrived feeder pigs. When grinding alfalfa hay through a hammer mill, use a screen with approximately 1/4-in. openings to provide the correct particle size. Also, digestibility may be improved if the diet is pelleted.

**Alsike clover.** This clover provides a leafy crop with fine stems and it grows well in soils that are too acidic or

too wet for red clover. It is less desirable where hot, dry summer conditions are common. It is often used in pasture mixtures.

**Birdsfoot trefoil.** Birdsfoot trefoil is palatable and similar in nutrient content to alfalfa. Unlike alfalfa, it grows well on poorly drained soils. While it is not as productive as alfalfa on good soils, birdsfoot trefoil yields have exceeded yields of alfalfa on the wetter soils. Most varieties perform better in cooler climates. It will normally outlive red clover by several years.

**Crimson clover.** Crimson clover provides a good spring forage and sometimes winter forage in warm climates.

**Ladino clover.** Under optimum conditions, ladino clover will not produce as much forage per acre as alfalfa. But the protein content of ladino clover is superior to that of alfalfa. Ladino clover works best as an all-summer pasture crop in the northeastern and northcentral states.

**Lespedeza.** Also called Japanese clover, this species is less palatable to pigs than all clovers except sweet clover. It cannot be grazed until mid-summer but it does grow reasonably well without lime and fertilizer and will adapt to soils that can't be used for red clover.

**Red clover.** Red clover is a short-lived, relatively easy-to-establish perennial legume that will grow on soils too acidic or too wet for alfalfa. Red clover does not yield as much forage early in the spring as alfalfa and it is not as drought resistant as alfalfa. It is useful for pasture or silage. It will provide good forage through most of the grazing season if it is not overgrazed or allowed to

**Table 5: Suggested diets<sup>1</sup> to supplement silage and haylage for gestating sows.**

	Type of silage	
	Legume haylage (45% dry matter)	Corn silage (33% dry matter)
<b>Ingredients, lb.</b>		
Corn	1951	1728
Soybean meal, 48%	-	189
Soybean meal, 44%	-	-
Ground limestone	-	21
Dicalcium phosphate	-	38
Monosodium phosphate	25	-
Salt	12	12
Vitamin premix <sup>2</sup>	6	6
Trace mineral premix <sup>3</sup>	6	6
Totals	2000	2000
<b>Calculated composition</b>		
Metab energy, kcal	1576	1489
Crude protein, %	8.1	11.7
Lysine (estimated), %	.25	.51
Calcium, %	.04	.91
Phosphorus, %	.55	.66

<sup>1</sup>Assumptions: Sows will consume 3.5 lb haylage or silage dry matter and will be fed 2.5 lb of the diet per day. The ensiled forage and feed together will provide a minimum of .65 lb protein, 11 g lysine, 14 g calcium, and 11 g phosphorus per day, respectively.

<sup>2</sup>Should provide the following amounts per ton of complete feed: 6,000,000 IU vitamin A; 300,000 IU vitamin D; 64,000 IU vitamin E; 1.0 g vitamin K (menadiolone); 300 mg biotin; 2,000 g choline; 2 g folacin; 15 g niacin; 18 g pantothenic acid; 6 g riboflavin; 2 g thiamin; 2 g vitamin B<sub>6</sub>; 22 g vitamin B<sub>12</sub>.

<sup>3</sup>Should provide the following amounts per ton of complete feed: 8 g copper; 200 mg iodine; 120 g iron; 30 g manganese; .44 g selenium; 75 g zinc. (Concentrations higher than normal to compensate for reduced dry feed intake.)

become too mature. Several studies have shown that pigs on red clover forage gain as rapidly as those on alfalfa.

**Soybean forage.** Soybeans as a green forage are less valuable than alfalfa, red and ladino clovers, and rape. The soybeans should be grown in rows to reduce damage from trampling. Unlike most forages, soybeans cannot regenerate new growth from the crowns. Soybeans are less sensitive to nutrient levels in the soil than are alfalfa and clovers. In hot climates, soybeans may out-yield other legumes during the same period of time.

Pigs grazing mature soybeans also should have access to grain fortified with vitamins and minerals. However, inhibitors in the raw soybeans will prevent the pig from utilizing the dietary protein efficiently. In addition, the oil contained in the beans tends to make the carcass soft.

**Sweet clover.** Since pigs find sweet clover unpalatable, it may be more suitable for soil improvement. Sweet clover may be planted on soils not adapted for alfalfa or other clovers. If biennial sweet clover is sown in the spring, the first season's growth is more succulent and palatable than that harvested during the second summer.

**White clover.** White clover is a practical perennial legume to use with permanent pasture, especially those containing bluegrass. White clover makes a high-quality pasture and it does well in years of frequent rain. Note that ladino clover is a large-type white clover. Dutch or common white clover is a small-type.

## Brassicas

**Rape (canola).** Rape is a high-yielding, fast-growing annual forage that belongs to the brassica family. Related species include kale and swede. Rape provides an excellent pasture for swine. When overgrazing is avoided,

it provides abundant, palatable forage for a long growing season. Rape can lead to photosensitization (sunburning), when grazed wet. Pigs with white skin are most sensitive.

## Grasses

**Bluegrass.** Bluegrass may serve as a permanent pasture for swine. The pasture can be grazed early, but it contains less protein than do legumes and is usually dormant during the warmest part of the summer.

**Smooth bromegrass.** Bromegrass is a palatable crop that withstands heavy grazing. Its early spring growth enables it to be pastured for longer periods than many legumes. Studies show that pigs on bromegrass pastures require more grain and supplement than pigs grazing alfalfa. Bromegrass can be successfully mixed with legumes.

**Orchardgrass.** Orchardgrass, a perennial, is a hardy species that can tolerate trampling. It quickly loses its palatability if not grazed down to prevent the grass from becoming tall and mature.

**Sudangrass.** Sudangrass, an annual, is palatable to pigs, and when seeded thickly, it provides ample forage during the hottest part of the summer when other species are dormant. The early growth of sudangrass contains a cyanogen, which may be converted to prussic acid (extremely toxic to pigs) under certain conditions such as wilting, trampling, chewing, frost, and drought. Because of the near-neutral pH in the rumen, ruminants are more sensitive to cyanogens than are nonruminants. Poisoning can be avoided if the grass is grazed only after it reaches a height of at least 18 in. to 24 in. Because sudangrass is low in protein, it is better adapted for sows and older market hogs.

**Table 6: Suggested diets containing alfalfa hay for gestating sows.**

	Diet							
	1	2	3	4	5	6	7	8
<b>Ingredients, lb.</b>								
Corn	1271	1257	1074	1065	875	869	667	665
Soybean meal, 48%	165	-	121	-	77	-	34	-
Soybean meal, 44%	-	178	-	130	-	83	-	36
Alfalfa	500	500	750	750	1000	1000	1250	1250
Limestone	18	18	8	8	0	0	0	0
Monosodium phosphate	28	29	29	29	30	30	31	31
Salt	8	8	8	8	8	8	8	8
Vitamin premix <sup>1</sup>	5	5	5	5	5	5	5	5
Trace mineral premix <sup>2</sup>	5	5	5	5	5	5	5	5
Totals	2000	2000	2000	2000	2000	2000	2000	2000
<b>Calculated composition</b>								
Metab energy, kcal/lb	1302	1294	1209	1203	1114	1110	1013	1011
Protein, %	13.5	13.4	13.7	13.6	14.0	13.9	14.2	14.2
Lysine (estimated), %	.60	.60	.60	.60	.60	.60	.60	.60
Calcium, %	.77	.77	.77	.77	.80	.80	.98	.98
Phosphorus, %	.61	.61	.61	.61	.61	.61	.61	.61

<sup>1</sup>Should provide the following amounts per ton of complete feed: 4,000,000 IU vitamin A; 200,000 IU vitamin D; 40,000 IU vitamin E; 1.0 g vitamin K (menadione); 180 mg biotin; 1,200 g choline; 2 g folacin; 10 g niacin; 11 g pantothenic acid; 4 g riboflavin; 1 g thiamin; 1 g vitamin B<sub>6</sub>; 14 g vitamin B<sub>12</sub>.

<sup>2</sup>Should provide the following amounts per ton of complete feed: 5 g copper; 130 mg iodine; 75 g iron; 20 g manganese; .27 g selenium; 50 g zinc.

**Table 7: Suggested high-forage diets for gestating sows.**

	Diet									
	1	2	3	4	5	6	7	8	9	10
<b>Ingredients, lb.</b>										
Corn	1256	1243	1277	1265	1231	1216	1215	1199	1205	1187
Soybean meal, 48%	182	-	158	-	205	-	220	-	237	-
Soybean meal, 44%	-	195	-	170	-	220	-	236	-	255
Birdsfoot Trefoil	500	500	-	-	-	-	-	-	-	-
Red Clover	-	-	500	500	-	-	-	-	-	-
Kentucky Bluegrass	-	-	-	-	500	500	-	-	-	-
Orchardgrass	-	-	-	-	-	-	500	500	-	-
Ryegrass	-	-	-	-	-	-	-	-	500	500
Ground limestone	16	16	18	18	13	13	14	14	10	10
Dicalcium phosphate	-	-	-	-	33	33	33	33	30	30
Monosodium phosphate	28	28	29	29	-	-	-	-	-	-
Salt	8	8	8	8	8	8	8	8	8	8
Vitamin premix1	5	5	5	5	5	5	5	5	5	5
Trace mineral premix2	5	5	5	5	5	5	5	5	5	5
Totals	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
<b>Calculated composition</b>										
Metab energy, kcal	1359	1350	1341	1333	1346	1335	1347	1336	1365	1354
Crude protein, %	13.6	13.5	13.1	13.0	.60	13.1	13.0	12.9	12.8	12.7
Lysine (estimated), %	.60	.60	.65	.65	.65	.65	.65	.65	.65	.65
Calcium, %	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77
Phosphorus, %	.61	.61	.77	.77	.77	.77	.77	.77	.77	.77
<p><sup>1</sup>Should provide the following amounts per ton of complete feed: 4,000,000 IU vitamin A; 200,000 IU vitamin D; 40,000 IU vitamin E; 1.0 g vitamin K (menadione); 180 mg biotin; 1,200 g choline; 2 g folacin; 10 g niacin; 11 g pantothenic acid; 4 g riboflavin; 1 g thiamin; 1 g vitamin B<sub>6</sub>; 14 g vitamin B<sub>12</sub>.</p> <p><sup>2</sup>Should provide the following amounts per ton of complete feed: 5 g copper; 130 mg iodine; 75 g iron; 20 g manganese; .27 g selenium; 50 g zinc.</p>										

**Timothy.** Timothy withstands heavy use, but it should only be included as a minor part of a pasture mixture since it is less desirable than most other pasture crops.

**Winter rye.** Winter rye seeded during late summer will provide a useful forage crop for winter or early spring grazing. Optimal planting time should provide just enough growth so that seed stems are starting to shoot when the plant enters winter dormancy. When pigs are allowed to graze rye during the winter and spring months, stock the pasture with no more than 8 growing pigs, or 3 to 5 sows per acre.

**Winter wheat and barley.** These two cereal grains are at least as palatable and nutritious as rye, but they do not provide as much fall production as rye and they cannot be grazed as heavily. Note that fresh wheat forage contains significantly more crude protein than is contained in barley forage.

## Economics of Forage Use

**Pasture.** Costs for establishing and maintaining pasture crops should be estimated before making this forage system a part of your feeding program. For example, the annual cost for maintaining alfalfa pasture in the north-east is about \$290/acre (including land costs of \$50/acre) according to the 1997-1998 *Penn State Agronomy Guide*. If the pasture were available for 180 days, the cost per

day would be \$1.61. For a stocking rate of 5 sows per acre, the daily feeding cost associated with the pasture would be \$0.32 per sow per day. Using the pasture should reduce feed requirements by about 3.5 lb per sow per day. If the cost for 3.5 lb of complete feed is more than \$0.32, then the pasture system will be economical.

If the same pasture were used for growing-finishing hogs at the rate of 10 pigs per acre, the daily feeding cost associated with the pasture would be \$0.16 per pig per day. Using the pasture should reduce feed requirements by 0.75 lb to 1.0 lb per pig per day. To make the pasture profitable in this situation, the cost of purchasing 0.75 lb to 1.0 lb of feed should be more than \$0.16.

In summary, making pasture a viable feeding system for sows or growing pigs will require low land costs, land that is unsuitable for crop production, or expensive feed.

**Silage and haylage.** Using corn silage or haylage will reduce sow feed requirements by about 3.5 lb per head per day (see Table 5). But higher than normal lysine and mineral concentrations are required in the feed used to supplement corn silage. That means the reduction in feed requirement is partly offset by a higher feed cost (usually about \$20) per ton.

For example, if corn silage is worth \$35/ton, a feeding rate of 10 lb. per sow per day would cost \$0.18 per sow per day, (10 lb. X [\$35/2000 lb.]). If gestation feed



normally costs \$170 per ton, then the feed used to supplement corn silage would cost about \$190 per ton because of the increased nutrient concentrations. Since sows would require about 2.5 lb. per day of this supplementary feed, the cost would be \$0.24 per day. Adding this to the silage costs of \$0.18 per day brings the total feed costs to \$0.42 per day per sow on a corn silage program. This compares favorably to \$0.43 per day associated with feeding 5 lb of conventional gestation feed (assuming \$170/ton).

Feed used to supplement legume haylage is similar in cost to conventional gestation feed since the only change in formulation is a reduction in the level of calcium (an inexpensive nutrient). If alfalfa hay costs \$120 per ton, alfalfa haylage (45% dry matter) would be worth about \$60 per ton [(45%/90%) X \$120/ton = \$60/ton]. At a feeding rate of 7.75 lb per day, the haylage would cost \$0.23 per sow per day. Sows would require 2.5 lb of feed to supplement the silage. Assuming the supplementary feed costs \$170 per ton, the daily expense for this feed would be \$0.21. Adding this to the haylage costs of \$0.23 per day would bring the total feed cost to \$0.44 per day for a sow on an alfalfa haylage program. This is similar to the \$0.43 per day associated with feeding 5 lb of conventional gestation feed (assuming \$170/ton).

**Complete feed.** When any forage is incorporated into a complete feed, the energy density of the feed is decreased because of the low concentrations of metaboliz-

able energy in forages. Tables 6 and 7 provide suggested gestation diets containing alfalfa and other forage. To determine whether these diets are more economical than conventional diets, the producer must do two things. First, the costs per lb of the conventional diet and the high forage diets must be calculated using current market prices. In addition, the feed cost per day of feeding a sow on each of the diets must be calculated—keeping in mind that sows will require about 0.5 lb of additional feed per day for every 500 lb of forage included in a 1-ton formulation.

For example, a conventional diet may cost \$170/ton. At a 5 lb feeding rate, the feed cost per sow per day would be \$0.43 (5 lb X [\$170/2000 lb]). A high forage diet (containing 500 lb of alfalfa) may cost only \$160 per ton. But since the sow will need 5.5 lb each day to meet her energy requirements, the daily feed cost would be \$0.44 (5.5 lb X [\$160/2000 lb]).

Table 8 provides suggested high-forage diets for grower pigs. Since the amounts of forage in these formulations are at a moderate level of 250 lb per ton, little or no change in weight gain or feed conversion is expected. This means that as long as the feed cost per ton of the high-forage diets is similar or lower than a conventional diet, feed cost per lb of gain should also be similar to that of a conventional diet.

However, in Table 9, 400 lb of forage per ton of feed are suggested in each of the diets for finisher pigs.

**Table 8: Suggested high-forage diets for growing hogs (40 -125 lb.).**

	Diet											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>Ingredients, lb.</b>												
Corn	1248	1214	1246	1211	1256	1222	1224	1188	1216	1180	1210	1175
Soybean meal, 48%	461	-	468	-	456	-	481	-	488	-	497	-
Soybean meal, 44%	-	495	-	503	-	490	-	516	-	524	-	534
Alfalfa	250	250	-	-	-	-	-	-	-	-	-	-
Birdsfoot Trefoil	-	-	250	250	-	-	-	-	-	-	-	-
Red Clover	-	-	-	-	250	250	-	-	-	-	-	-
Kentucky Bluegrass	-	-	-	-	-	-	250	250	-	-	-	-
Orchardgrass	-	-	-	-	-	-	-	-	250	250	-	-
Ryegrass	-	-	-	-	-	-	-	-	-	-	250	250
Ground limestone	10	10	6	6	7	7	15	15	16	15	14	14
Dicalcium phosphate	15	15	14	14	15	15	14	15	14	15	13	13
Salt	8	8	8	8	8	8	8	8	8	8	8	8
Vitamin premix1	4	4	4	4	4	4	4	4	4	4	4	4
Trace mineral premix2	4	4	4	4	4	4	4	4	4	4	4	4
Totals	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
<b>Calculated composition</b>												
Metab energy, kcal	1453	1430	1449	1426	1440	1417	1436	1412	1437	1412	1446	1421
Crude protein, %	17.9	17.6	18.3	18.1	18.1	17.8	18.1	17.9	18.0	17.7	17.9	17.6
Lysine (estimated), %	.95	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
Calcium, %	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60
Phosphorus, %	.50	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55

<sup>1</sup>Should provide the following amounts per ton of complete feed: 1,200,000 IU vitamin A; 140,000 IU vitamin D; 10,000 IU vitamin E; 1.0 g vitamin K (menadione); 50 mg biotin; 300 g choline; 300 mg folacin; 10 g niacin; 8 g pantothenic acid; 3 g riboflavin; 1 g thiamin; 1 g vitamin B<sub>6</sub>; 10 g vitamin B<sub>12</sub>.

<sup>2</sup>Should provide the following amounts per ton of complete feed: 4 g copper; 130 mg iodine; 55 g iron; 2 g manganese; .27 g selenium; 55 g zinc.

Research shows that although finisher pigs can utilize higher levels of forage than that of grower pigs, growth rate in finishing pigs consuming the diets in Table 9 would be reduced by 5% to 10%, and feed/gain ratios would be increased by 10% to 15%. Therefore, the feed cost of the high forage diet should be at least 10% less than a conventional finisher diet to be economical. For example, if a conventional finisher diet costs \$150 per ton, a high forage diet should cost no more than \$135 per ton (150 - [10% X \$150] = \$135).

## Summary

Forages in the form of pasture, or as part of a complete feed, can be successfully used in pork production. However, because of their high fiber content and low energy density, they should be used only to a limited extent for young pigs and lactating sows. Even in growing-finishing, and gestation diets, forage is best utilized at an early stage of maturity. Forages may be used to reduce both grain and protein costs, but producers should consider all factors discussed before making forage a major part of the diet.

**Table 9: Suggested high-forage diets for finishing hogs (125 - 240 lb.).**

	Diet											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>Ingredients, lb.</b>												
Corn	1323	1306	1319	1301	1336	1319	1292	1271	1278	1257	1270	1247
Soybean meal, 48%	240	-	251	-	232	-	270	-	282	-	296	-
Soybean meal, 44%	-	257	-	269	-	249	-	290	-	303	-	318
Alfalfa	400	400	-	-	-	-	-	-	-	-	-	-
Birdsfoot Trefoil	-	-	400	400	-	-	-	-	-	-	-	-
Red Clover	-	-	-	-	400	400	-	-	-	-	-	-
Kentucky Bluegrass	-	-	-	-	-	-	400	400	-	-	-	-
Orchardgrass	-	-	-	-	-	-	-	-	400	400	-	-
Ryegrass	-	-	-	-	-	-	-	-	-	-	400	400
Ground limestone	10	10	4	4	6	6	11	11	12	12	9	9
Dicalcium phosphate	-	-	-	-	-	-	11	12	12	12	9	10
Monosodium phosphate	11	11	10	10	10	10	-	-	-	-	-	-
Salt	8	8	8	8	8	8	8	8	8	8	8	8
Vitamin premix <sup>1</sup>	4	4	4	4	4	4	4	4	4	4	4	4
Trace mineral premix <sup>2</sup>	4	4	4	4	4	4	4	4	4	4	4	4
Totals	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
<b>Calculated composition</b>												
Metab energy, kcal	1419	1407	1412	1400	1398	1386	1396	1383	1397	1383	1412	1397
Crude protein, %	14.0	13.9	14.7	14.6	14.3	14.1	14.4	14.2	14.2	14.1	14.0	13.9
Lysine (estimated), %	.68	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65
Calcium, %	.48	.48	.48	.48	.48	.48	.48	.48	.48	.48	.48	.48
Phosphorus, %	.43	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55
<sup>1</sup> Should provide the following amounts per ton of complete feed: 1,200,000 IU vitamin A; 140,000 IU vitamin D; 10,000 IU vitamin E; 1.0 g vitamin K (menadione); 50 mg biotin; 300 g choline; 300 mg folacin; 7 g niacin; 7 g pantothenic acid; 2 g riboflavin; 1 g thiamin; 1 g vitamin B <sub>6</sub> ; 5 g vitamin B <sub>12</sub> . <sup>2</sup> Should provide the following amounts per ton of complete feed: 4 g copper; 130 mg iodine; 50 g iron; 2 g manganese; .27 g selenium; 50 g zinc.												







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