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Nutrient and Vegetation Management in Outdoor Hog Production Systems

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Outdoor swine enterprises represent an opportunity for small producers, who could benefit from the growing consumer interest in pork produced locally, in a more natural way. Outdoor hog production systems allow producers to meet these consumer needs and to do so in smaller scale enterprises that can be economically feasible.

Despite these opportunities, outdoor hog operations can create environmental damage related to the phosphorous (P) and nitrogen (N) contained in hog manure and urine. Also, the natural behavior of hogs outdoors can damage vegetation and cause soil compaction. Unless managed correctly, high concentrations of nutrients can accumulate in the soil and cause nutrient losses to ground water, surface waters and into the atmosphere. However, if properly managed, outdoor operations provide an opportunity for producers to earn a profit, improve their quality of life, sustain natural resources and support local communities.

Knowing the amount of nutrients passing through hogs during the various production phases can be useful to managers who want to capture that valuable "fertilizer" for crop production while minimizing the potential for contaminating surface and ground waters. Nutrient loading is strongly dependent on the stocking density and the length of time animals occupy specific land areas.

Integrating hogs to crop rotation allows soil nutrient removal

Table 1 provides some estimates for the annual nutrient loading when one sow and her 14 finished pigs are kept on one acre of land for one to five years. Note that the increase in the NCDA Soil Test P-Index goes from 15 to 74 if there is no removal of P from the site during those years.

Similarly, Table 2 shows estimates of the effect of stocking density of finishing hogs over a five-year period on soil nutrient loads of P. These estimates show that P buildup can be managed with animal density, but would be strongly related to the soil type and landscape and crop removal. Effective buffers alongside streams would be needed to help control runoff and the movement of soil particles and nutrients from the land area used by hogs.

Table 1. Nutrient loading for farrow to finish operation with 1 sow and 14 pigs per acre stocking rate when site is used for 1 to 5 years continuously

Years of continuous use	Plant Available Nutrients excreted onto the site lbs/acre			Change in Soil Test P-Index with no crop removal fom site.
YR	N	$P_2 0_5$	$K_2 0$	P-I
1	72	72	94	15
2	143	144	188	29
3	215	217	282	44
4	287	289	377	59
5	358	361	471	74

Crop response to P application does not change when P-I from NCDA Soil Test is above 80 (which is equal to about 390 lbs of available P_2O_5/acre (based on Mehlich-3 extractant procedure}). Plant available N is for 1st year and is 0.4 of total output; Plant available P_2O_5 and K_2O are 0.9 of total output.

Table 2. Nutrient loading from Feeder to Finish operation at various stocking rates (14 to 56 head/ac/ yr) when same site is used continuously for 1 or 5 years.

Feeder-Finishers, Hd/acre (based on 220 Mkt wt.)	Years on same site	Plant Available Nutrients excreted onto the site, lbs/acre			Change in Soil Test P-Index with no crop removal from site
		N PAN	$P_2 0_5$ PAP	$K_2 0$ PAK	P-I
14	1	56	49	67	10
28	1	112	98	133	20
56	1	224	196	266	40
14	5	280	245	333	50
28	5	560	490	665	100
56	5	1120	981	1330	200

Crop response to P application does not change when P-I from NCDA Soil Test is above 80 (which is equal to about 390 lbs of available P_2O_5/acre based on Mehlich-3 extractant procedure). Plant available N is for 1st year and is 0.4 of total output; Plant available P_2O_5 and K_2O are 0.9 of total output.

To minimize the potential environmental impacts outdoor hog enterprises need to consider how to prevent a build-up of nutrients in the soil and how to prevent soil, water and nutrients from being transported to nearby streams. To prevent a nutrient build up there must be a balance between the nutrients deposited on the soil by the hogs' manure and urine and those removed as meat and crops. The amount of vegetative cover on the hog lots and the use of buffer strips between the hog enterprise and streams affects the loss of soil and nutrients from the hog lots. Different strategies can be used to reduce these environmental impacts including: maintaining moderate animal stocking rates, reducing the length of stay of the animals in a pen or paddock and removing harvested crops or forage from the sites. Moving shelters, shades, waterers and feeders periodically will prevent high concentrations of nutrients from building up in small areas of the hog lots.

There are two basic outdoor hog production systems. **Dry-lot systems** have a high density of animals on a relatively small area of land with a lower priority for maintaining vegetative cover on that land. **Pasture-based systems** are designed to maintain soil cover by rotating animals through a series of paddocks using a low stocking rate and other management practices. Within these two basic approaches there are many alternative layout designs for managing the animals.

The distribution of the nutrients on the land area used by the hogs will depend on how the system is designed and how the hogs are managed. We will provide two examples, each showing the annual nutrient loading over the land area based on output from the various hog production phases. One example is for hogs managed on a dry lot system and one is for a pasture-based operation.

To prevent nutrients build up there must a balance between imported and exported nutrients

Common assumptions to both examples:

Both production systems are designed to have the same number of sows producing the same number of hogs. Each system produces an equal number of market hogs each month to meet consumer demand. The land area required for production differs between the two systems.

Each system has 24 sows producing 2 litters per sow per year with 7 pigs weaned per litter. There are 2 boars.

Sows farrow in groups of four every month of the year and weaned pigs are placed in growing and finishing groups for 4-5 months.

I. <u>Hogs on Dry-lot or Pens followed by Crop Rotation for Nutrient Management</u>

Assumptions and considerations for the dry-lot example:

1. The basic goal in designing this example is that nutrient loading on the land should remain constant over a long period of time. In other words, nutrients harvested through cropping should equal the nutrient coming from hog manure and urine. There are many alternatives to this example that could meet the soil nutrient loading goal, depending on the soil type, water table, slope, crop selection, and crop management.

2. The production system requires a total of 48 acres, with one third (16 acres) used each year for hogs and the remaining two-thirds being cropped to remove nutrients. Each year the hogs move to 16 acres that were cropped the previous two years, creating a rotation of one year of hogs and two years of crops. A buffer acreage is provided to prevent nutrients from migrating from the farmed area into a stream and this is in addition to the 48 acres needed for the hog-crop rotation.

3. The size of the dry-lot relative to the number of animals is based on animal welfare or behavioral needs, the numbers of animals in a specified production phase and the length of time animals spends in a specific production phase.

4. Each year the acreage used by hogs is subdivided so that about 31% is used for sows and boars and about 69% is used for the growing and finishing animals. The color coded parts of Table 3 show the acreage of each area allocated to each type of animal and production phase with the estimated amounts of nutrients (N, P and K) produced during the year.

a. Boars use about 0.2 acres

b. Breeding area is about 0.45 acres

c. Gestation period uses about 2.10 acres and this area may be divided into early and late gestation to facilitate sow group management.

d. Lactation period uses about 2.26 acres which may be divided into early and late lactation areas to better facilitate sow groups and pig management.

e. Finishing pens are about 1.83 acres each and are used for two feed-out periods of about 4-5 months each; this means there will be a two- to four-month

Excessive algae growth results as excess nutrients entering surface water from runoff or nutrients

period between finishing groups when vegetation can recover or when annual crops could be grown to provide vegetative cover.

5. This system stocks animals on 1/3 of the farmed acreage for one year followed by the growing of crops for two years, to be harvested to remove nutrients deposited by the hogs. Each year the hog enterprise is moved to land previously cropped for two-years.

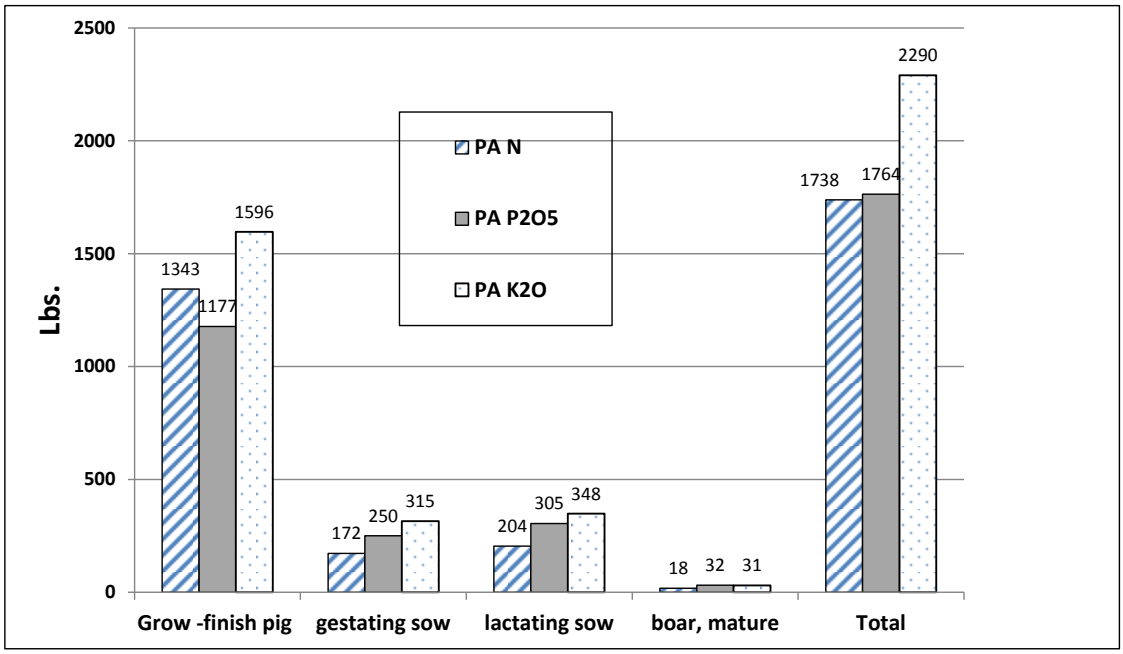
6. The annual nutrient loads are of plant available nutrients based on the coefficients shown in the Figure 1.

7. Fences are electrified 3-wire that can be moved relatively easily.

8. Each separate lot (paddock) has a watering point, feeders and shelter/shade.

The suggested farm layout (Table 3) provides some guidelines on the nutrient loading of specific paddocks based on the hog production phase using the paddock. Each year, the 24-sow farrow-to-finish operation produces about 1738, 1764 and 2290 lbs of plant available N, P2O5, and K2O respectively (Figure 1). Well over 70% of the nutrients are from the finishing phase of the operation. The total fertilizer value of the output is more than $2,000 at 2013 estimated prices for commercial fertilizer.

Figure 1. Annual nutrient loading from a farrow-to-finishing operation with the following animal numbers: 24 sows weaning 14 pigs (7 pigs/farrowing) and 2 boars. Availability coefficients: N=.4; P & K = .9



Value of nutrients based on the data presented in the figure above

Commercial Fertilizer Prices Nov 2013			
Fertilizer type	$/ton	P $ - N$	$/lb
Urea 45-0-0	$ 484		$ 0.54
18-46-0	$ 470	$ 276	$ 0.30
0-0-60	$ 475		$ 0.40

Nutrients produced and value based on figure above		
Nutrient	lbs	$ value
PA N	1738	$ 935
PA P2O5	1764	$ 530
PA K2O	2290	$ 907
Total		$ 2,371

Table 3. Estimated acreage and annual nutrient loading for an Outdoor DRYLOT hog operation stocked at 24 sows+finished pigs per 16 acres in combination with 32 acres of cropland. Hogs and crops will be on a 3 year rotation (1 yr hogs followed by 2 years of crops (48 total acres).

Acreage for each production phase when 5 aces are used for 24 sows & 2 boars producing two litters of 7 pigs each. Sows farrow in groups of 4 every month. Nutrient loading is annual total for all production phases.			Acreage, stocking rate and nutrient loading for each finishing group of feeder to finishing pigs from 24 sows. Six feeding lots are used twice per year with a two month rest period between finishing groups.		
SOW # = 24	**Acres for Sows, prewean pigs and boar= 5.0**		**Acres for Feeder to Finishing hogs = 11.0**		
lbs PAN/ac = 79	**lbs P2O5/ac = 117**	**lbs K2O/ac = 139**	**122 lbs PAN/acre/yr**	**107 lbs P2O5/acre**	**145 lbs K20/acre**
Acres for each phase of sow/boar and preweaning production			**Acres / pen= 1.83**	**hd/pen = 28**	**hd/acre= 15**
Breeding-post wean	**Early Lactation**	**Early Gestation**	Pen 1 finish 2 groups	Pen 2 finish 2 groups	Pen 3 finish 2 groups
0.45 acres	**1.13** acres	**1.05** acres	**Jan-Apr** **Jly-Oct**	**Feb-May** **Aug-Nov**	**Mar-Jun** **Sep-Dec**
Boar	**Late Lactation**	**Late Gestation**	Pen 4 finish 2 groups	Pen 5 finish 2 groups	Pen 6 finish 2 groups
0.20 acres	**1.13** acres	**1.05** acres	**Apr-Jly** **Oct-Jan**	**May-Aug** **Nov-Feb**	**Jun-Sep** **Dec-Mar**

The block above shows the subdivisions of the 16-acre block during the year that hogs are on the site.

Assuming a 6 year production time-line this 16-acre block would have hogs during years 2 & 5 and harvested crops in years 1, 3, 4 & 6.

Assuming a 6 year production time-line this 16-acre block would have hogs during years 3, & 6 and harvested crops in years 1, 2, 4, & 5.

Runoff Buffer

The size of the buffer depends on many things such as, slope, proxmity to water course, soil, nutrient loading, width, vegetation type and management of the vegetation.

Potential Crops for pens or dry-lots

The example presented here provides a reasonable chance for maintaining some ground cover under normal growing conditions. The suggested example design for the finishing hogs provides for 2 to 4 months of "rest" between finishing groups, and there are annual forage crops that could be used to produce cover for the soil during that period. The annual forage crops listed in Table 4 provide quick germination and seedling development during the very short period between feed-out groups. One would not expect high forage production during most seasons, but high seeding rates can improve the plant density and reduce runoff during this period. Many of these forage crops also could be used as cover crops following the harvest of row-crops used in the rotation. In addition, the early spring growth could be harvested for hay thereby removing additional nutrients from the site. Perhaps other grazing animals, such as cattle, could be used to control some of the cover crop, but not many nutrients are removed from the land.

Table 4. Potential vegetative cover crops to provide temporary soil cover during the "rest period" between groups of finishing animals

Dry Lot Pen #	# pigs per group	# pigs per acre	1st Use Period	Rest Period	Potential crops planted at high seeding rates to provide temporary cover during the dry lot rest period.	2nd Use Period	Rest Period	Potential crops planted at high seeding rates to provide temporary cover during the dry lot rest period.
1	28	15	Jan-Apr	May-Jun	Crabgrass, Millet, Sudan, Teff, Lovegrass, Buckwheat	Jly-Oct	Nov-Dec	Cereal Rye &/or Brassicas
2	28	15	Feb-May	Jun-Jly	Crabgrass, Millet, Sudan, Teff, Lovegrass, Buckwheat	Aug-Nov	Dec-Jan	Cereal Rye &/or Brassicas
3	28	15	Mar-Jun	Jly-Aug	Crabgrass, Millet, Sudan, Teff, Lovegrass, Buckwheat	Sep-Dec	Jan-Feb	Cereal Rye &/or Brassicas
4	28	15	Apr-Jly	Aug-Sep	Crabgrass, Millet, Sudan, Teff, Lovegrass, Buckwheat	Oct-Jan	Feb-Mar	Cereal Rye &/or Brassicas or Ryegrass
5	28	15	May-Aug	Sep-Oct	Cereal Rye, Oats, Brassicas	Nov-Feb	Mar-Apr	Cereal Rye, Oats&/or Brassicas or Ryegrass
6	28	15	Jun-Sep	Oct-Nov	Cereal Rye, Oats, Brassicas	Dec-Mar	Apr-May	Crabgrass,Sudan, Buckwheat

Cereal rye and ryegrass mixture that could be harvested for nutrient removal or provide cover during the subsequent feed out period.

Other Considerations

As noted above, this is one example of a dry-lot production system and the specific characteristics of a site will affect the system design. Soil types, landscape and crop choices affect both the hog operation and the cropping rotation. The cropping systems to be used in the rotation with the hogs could include any crop that is marketable in the region. It may be possible to keep hogs on the same site for two years and meet the nutrient balance goal by following the hogs with 3 or 4 years of crops. Maintaining animals on the same site for two years would reduce the number of times the fences would have to be move but the nutrient loading would be greater after 2 years than 1.

Planting a quick growing "cover crop" between harvested crops can be helpful in controlling erosion and nutrient loss.

Many factors affect the vegetative cover that can be maintained and the desirable level of cover. Cover may be less of a priority if sufficient buffers are in place to manage nutrient run-off. However, it may be necessary or desirable to plant a cover crop or use crop residue to provide some cover from the time the hogs are moved to or from the site at the beginning or end of each rotation cycle.

When the crop to be rotated with the hogs is a perennial grass it should be possible to maintain cover in the finishing paddocks because the stocking rate is less than 20 head/acre.

The hog area will need to be planted to forage crops when the crop rotation is based on row-crops. There is a possibility of maintaining some cover in

Stocking density and length of stay in the paddock are factors that impact soil nutrient loading

the finishing paddocks, especially early in the finishing phase of each group. If over-seeding or re-planting is required after a group leaves a paddock, the crop should planted immediately following the removal of the previous finished hog group. Table 4 contains some of the annual crops that might be grown. Consider increasing seeding rates by 50% to 100% as compared to normal forage planting guidelines for establishing new pastures. Seedling density will be critical to effective soil cover when the growth period is limited between finishing groups. For cover crop planting following row-crop harvest the normal seeding rates should suffice.

Lack of vegetative ground cover can lead to nutrient and soil movement with runoff and erosion.

Cereal rye and ryegrass mixture paddock at the end of the finishing production cycle (30 pigs/ac), almost no vegetative ground cover is left. Notice the crop buffer surrounding the pen

The Cropping Rotation

The goal of the cropping rotation is to use most, If not all, of the nutrients recycled through the hogs as a way to minimize soil buildup. The actual choice of crops in the rotation will be governed by soil type, landscape and climate as well as the nutrient needs. Estimates of the nutrient uptake by various crops at specific yield levels are found in Table 5. This information can be useful in determining the cropping systems to use for nutrient harvesting from the hog production sites.

Table 6 shows the nutrient production from the example dry-lot hog operation and the nutrient uptake from corn and Bermuda grass. The assumed corn yield is 123 bushels/acre and the Bermuda grass yield is 4 tons/acre during the two cropping years of the three-year rotation with hogs. Corn at this yield level potentially removes more P than Bermuda grass hay at 4 tons/acre. Note that about 90% to 115% of the P deposited by the finishing hogs is taken up in the hay and corn grain crop respectively, but the uptake levels in the boar and sow areas ranged from 61% to 373% of that deposited. The post weaning sites have the least amount of nutrients deposited.

Table 5. Nutrient (N and P_2O_5) uptake estimates for selected crops at specific yield levels.

crop	Yield	N	P_2O_5
		lbs/acre	
Corn grain, bu	123	136	54
Soybeans full season, bu	49	191	39
Wheat Grain, bu	59	118	29
Sweet potatoes, bu (+vines)	300	70	22
Bermudagrass Hay, tons	4.9	218	60
Fescue hay, tons	4.9	218	77
Mixed cool grass hay, tons	3.4	152	49
Sorghum Sudan hay, tons	4.7	232	65
Bell Peppers, tons	9	137	52
Cabbage, tons	20	130	35
White potatoes, tons (+vines)	15	151	68

Table 6. Crop removal of P_2O_5 from corn or Bermuda hay during 2 years of harvests in a 3 -yr rotation with 24 sows farrow to finishing operation on 48 acres. Hogs occupy 1/3 of the acreage every year and crops occupy two-thirds.

Animal Production Phase	Nutrients Deposited, lbs/acre/yr	Yield, Corn Grain, 123 bu/acre/yr		Yield, Bermuda Hay, 4 Tons/acre/yr	
		% Removal	Soil Test P-Index Change	% Removal	Soil Test P-Index Change
Post wean/breeding	33	373%	-18	291%	-13
Gestation, Early	106	117%	-4	91%	2
Gestation, Late	105	118%	-4	92%	2
Farrowing/lactation, 1/2 of area	135	91%	3	71%	8
Farrowing/lactation, 1/2 of area	135	91%	3	71%	8
Boar number= 2	158	78%	7	61%	13
Sows & Boar avg based on weighted acres		105%	-1	82%	4
Finishing hogs		115%	-3	90%	2
Averages for sows and finishers, but not a weighted over acres		110%	-2	86%	3
For every 4.931 lbs of P_2O_5 added to the land that is not removed through crop harvest or animal product the NC Soil Test P Index increases by one point.					

Hay cropping is an effective way to remove nutrients

Appropriate site selection and use of grassed buffer areas minimize runoff potential

Implementing periodic movements of waterers, feeders and shelter/shade structures help improving nutrient distribution

Matching crop nutrient needs and the nutrient production by the hogs is a challenge and an exact match is unlikely. The problem of variations in the nutrient distribution across the site could be mitigated by changing the location of the various pen types over successive three-year rotations, by planting parts of the area to different crops or by applying supplemental fertilizer in some areas.

Based on data from the NC Department of Agriculture and Consumer Services soil testing services the overall P Index would remain fairly static (range from -18 to 13) over multiple crop rotation cycles. Considering that many soils in North Carolina currently have P indices below 100, the stocking rate and crop rotation in this example could operate for many years before P levels would be of concern. There are implications that higher stocking rates could be used without overloading phosphorus. We conclude that this example dry-lot operation can achieve the desired nutrient goals.

Corn crop besides N and P_2O_5 can remove other macronutrients as K_2O, MgO, CaO, and S, and micronutrients as Fe, Zn, Mn, B, Cu, Mo and Cl

II. Nutrient Management in Pasture based Farrow to Finish Hog operations

Assumptions and considerations for this example:

1. Total acreage is 24. with 24 sows & 2 boars.

2. Paddock size is based on potential nutrient loading, animal welfare or behavioral needs, and length of time in the production phase.

3. The acreage used by hogs is subdivided so that about 33% is used for sows and boars and about 67% is used for finishing (see Table 7 for example layout).

   a. Boars use about 0.24 acres

   b. Breeding area is about 0.8 acres

   c. Gestation period uses about 3.6 acres and it may be divided into early and late gestation to facilitate sow group management.

   d. Lactation period uses about 3.36 acres which may be divided into early and late lactation to better facilitate sow groups and pig management.

   e. Finishing pastures are about 1.33 acres and will be used for one feed out period of about 4-5 months each year; this means there will be a seven to eight month period between finishing groups where perennial vegetation can recover or perennial and/or annual grass crops could be over sown to provide improved ground cover.

4. On average 20% of the acreage is renovated with permanent vegetation each year.

5. Fences are electrified 3-wire that can be moved if design changes are needed. .

6. Each paddock has a watering point, feeders and shelter/shade. The infrastructure can be managed flexibly to help control nutrient distribution and heavy use areas.

The example farm layout 7) uses estimated nutrient production by the hogs to estimate the nutrient loading of the acreage based on the hog production phase using the specific paddocks.

Rotational grazing management improves nutrient distribution along the paddock and provides a "rest" period to the grass

Table 7. Layout, acreage of permanent pasture and estimate of annual nutrient loading for a hog operation stocked at one sow+ 14 finished pigs per acre/yr. The system is for 24 sows and pigs on 24 acres.

Acreage for each production phase when 24 acres are used for 24 sows producing two litters of 7 pigs each. Sows farrow in groups of 4 every month. Nutrient loading is total for all production phases each year.			Acreage, stocking density and the associated nutrient loading for feeder to finishing for two litters of 7 pigs each /year. Each of the 12 feed lots or paddocks are used for one feed out group per year.					
SOW # = 24	**Acres for sows, prewean and boar= 8.0**		**Acres for Feeder to Finishing hogs = 16.0**					
49 lbs PAN/ac	**73 lbs P2O5/ac**	**87 lbs K2O/ac**	**84 lbs PAN/acre/y**		**74 lbs P2O5/acre**		**100 lbs K20/acre**	
Acres for each phase of sow/boar and preweaning production			**Acres/pen=**	**1.33**	**Head/pen =**	**28**	**Head/acre=**	**21**
Breeding-post wean	**Early Lactation**	**Early Gestation**	**Jan-Apr**	**Feb-May**	**Mar-Jun**	**Apr-Jly**	**May-Aug**	**Jun-Sep**
0.8 acres	**1.68 acres**	**1.8** acres	**Pen 1**	**Pen 2**	**Pen 3**	**Pen 4**	**Pen 5**	**Pen 6**
Boar	**Late Lactation**	**Late Gestation**	**Jly-Oct**	**Aug-Nov**	**Sep-Dec**	**Oct-Jan**	**Nov-Feb**	**Dec-Mar**
0.24 acres	**1.68 acres**	**1.8** acres	**Pen 7**	**Pen 8**	**Pen 9**	**Pen 10**	**Pen 11**	**Pen 12**

BUFFER

The size of the buffer depends on many things such as slope, proxmity to water course, soil type , nutrient loading, width, vegetation type and management and use of the vegetation.

Periodical soil sampling helps monitor soil nutrient levels.

Pasture Crops for Outdoor Hog Production

The system outlined here uses perennial grasses, (mainly tall fescue or bermudagrass) for providing soil cover, but depending on stocking rate and the length of time hogs will occupy the paddock several annual crops may be useful for renovation and temporary cover when perennial vegetation is poor (Table 8). In this example the finishing pastures are used at a relatively low stocking rate and with up to eight months rest between finishing groups it is likely that vegetative cover will be satisfactory and renovation needs may be minimal. However, Under North Carolina conditions 20% of the land used by hogs may need to be renovated in a typical year and it may be useful to consider some of the annual forage crops as companion crops for temporary cover. Depending on the seasons of the year, it may be possible to renovate only portions of the pastures with the base perennial crops (bermuda and tall fescue). With a total of 12 finishing pastures it is possible to use some pastures twice per year while renovating other pastures.

Considerations for Perennial Species

Since it is important to maintain vegetative cover to reduce environmental impacts, there is justification for using endophyte containing tall fescue because of its improved persistence. Non-toxic endophyte types are available, but they generally are not as persistent as the toxic types found in KY 31 fescue. Since animals are being fully fed, the toxic endophyte will not likely cause any adverse effects on animal performance.

Bermudagrass, with its rhizomes and stolons, has the potential to spread and recover even following extensive rooting and trampling in heavy use areas. The hybrid types will be more expensive to establish, but they have the advantage of potentially producing more pasture and they are easier to control if there is a desire to rotate the pastures into some other cropping system. Seeded types of bermuda are cheaper to establish but their reseeding capability will ensure that the soil is full of seed for future generations, and this may become a disadvantage if cropping systems change. If spreading of seed around the farm is of little concern, then this option is a viable one.

Nutrient Removal.

Nutrient removal, especially for P, from pastured sites is nil when a crop is not harvested and removed from the site. Very few nutrients are removed from a pasture-based system because the vegetation is rarely harvested and removed from the site, and the amount of nutrients removed through the sale of animals is relatively low. Table 9 illustrates the change in NCDA soil test P index based on the nutrient loading by 1 sow with 14 pigs farrow-to-finish per acre when no crop is harvested. The length of time hogs can remain on the same site will be directly related to hog density and soil capability for capturing and holding nutrients from manure and urine. Depending on the initial soil test P level, soil type, landscape, duration of use, and the amount and type of any periodic harvesting of

Table 8. Potential pasture crops to provided soil cover for the finishing phase of outdoor hog production. Finishing hogs on pasture continuously for 4 months followed by 8 months of rest on each pasture. After one yearly cycle of finishing, it might be practical to alter the sequence of paddock use, especially if there are significant differences in vegetation survival.

# of paddocks	# pigs/group of 4 sows	Head/acre while on pasture	1st year			2nd year			Potential renovation crops following a finishing cycle
			Months on pasture	Months of no hogs	Base Crops in each pasture (choose grasses with rhizomes, stolons)	Months on pasture	Months of no hogs	Possible renovation needs following 4 months of finishers	Annual crops that would cover the soil quickly following 4 months of hogs, but may not be there 8 months later when hogs return
1	28	21	**Jan-Apr**	May - Dec	Mostly Fescue mixed with some Bermuda	**Jan-Apr**	May - Dec	Renovate with Bermuda in May or Fescue in Aug.	bermuda; crabgrass, sorghum, sudan, millet, teff, lovegrass
2	28	21	**Feb-May**	Jun-Jan	Mostly Fescue mixed with some Bermuda	**Feb-May**	Jun-Jan	Renovate with Bermuda in June or Fescue in Aug	bermuda; crabgrass, sorghum, sudan, millet, teff, lovegrass
3	28	21	**Mar-Jun**	July - Feb.	Mostly Fescue mixed with some Bermuda	**Mar-Jun**	July - Feb.	Renovate with Bermuda in Jly or Fescue in Aug	bermuda; crabgrass, sorghum, sudan, millet, teff, lovegrass
4	28	21	**Apr-Jly**	Aug-Mar	Mostly Bermuda with some Fescue	**Apr-Jly**	Aug-Mar	Renovate with Bermuda and Fescue in Aug	fescue, ryegrass, rape
5	28	21	**May-Aug**	Sep-Apr	Mostly Bermuda with some Fescue	**May-Aug**	Sep-Apr	Renovate with Fescue in Sept and Bermuda in March	fescue, ryegrass, rape
6	28	21	**Jun-Sep**	Oct-May	Mostly Bermuda; Perhaps fall overseeded with Smallgrain	**Jun-Sep**	Oct-May	Renovate with Fescue in Oct and Bermuda in March	fescue, ryegrass, rape
7	28	21	**Jly-Oct**	Nov.- Jun	Mostly Bermuda; Perhaps fall overseeded with Smallgrain	**Jly-Oct**	Nov.- Jun	Renovate with Fescue in Nov and Bermuda in March	fescue, rye, rape
8	28	21	**Aug-Nov**	Dec-Jly	Mostly Bermuda; Perhaps fall overseeded with Smallgrain	**Aug-Nov**	Dec-Jly	Renovate with Cereal Rye & Fescue in Dec and Bermuda in March	fescue, rye
9	28	21	**Sep-Dec**	Jan-Aug	Mostly Bermuda; Perhaps fall overseeded with Smallgrain	**Sep-Dec**	Jan-Aug	Renovate with Cereal Rye & Fescue in Jan and Bermuda in March	rye
10	28	21	**Oct-Jan**	Feb-Sep	Mostly Bermuda with some Fescue	**Oct-Jan**	Feb-Sep	Renovate with Cereal Rye & Fescue in Feb and Bermuda in March	fescue, rye
11	28	21	**Nov-Feb**	Mar-Oct	Mostly Fescue mixed with some Bermuda	**Nov-Feb**	Mar-Oct	Renovate with Fescue and Bermuda in March	bermuda, rape, crabgrass
12	28	21	**Dec-Mar**	Apr-Nov	Mostly Fescue mixed with some Bermuda	**Dec-Mar**	Apr-Nov	Renovate with Fescue and Bermuda in April	bermuda, crabgrass, sorghum, sudan, millet, teff, lovegrass

Table 9. Nutrients deposited in various phases of a farrow to finish pasture system and the change in P-Index when no crops are removed from the pastures. Based on 24 sows having 14 pigs / yr in farrow to finish operation on 24 acres.

Animal Production Phase	Nutrients Deposited, lbs/acre/yr	Yield, Bermuda Hay, 4 Tons/acre/yr	
		% Removal no harvest	Soil Test P-Index Change
Post wean/breeding	19	0%	4
Gestation, Early	62	0%	12
Gestation, Late	61	0%	12
Farrowing/lactation, 1/2 of area	91	0%	18
Farrowing/lactation, 1/2 of area	91	0%	18
Boar number= 2	132	0%	27
Sows & Boar avg based on weighted acres	**73**	0%	15
Finishing hogs	**74**	0%	15
Averages for sows and finishers, but not a weighted over acres	**73**	0%	15
For every 4.931 lbs of P_2O_5 added to the land that is not removed through crop harvest or animal product the NC Soil Test P Index increases by one point.			

crop or crop residue it could take several years to see significant build up.

Extending the length of time hogs can be grown on a particular land area before nutrient loading reaches problem levels requires the periodic removal of nutrients in harvestable crops. At some point the soils in a pasture-based operation cannot remain below the target levels necessary to meet environmental goals and the land must be converted to other uses that will extract some of the nutrients.

Economics

Creating a productive and environmentally sound outdoor hog operation presents many production challenges. Making money from the enterprise represents an additional challenge. Costs of production are likely to be higher for an outdoor hog operation than for hogs produced by large-scale intensive production systems. Therefore, a higher selling price is necessary to recoup these higher costs and make a profit. Fortunately, there are marketing opportunities to earn this higher price. Specialty or niche markets offer higher prices for market hogs. There are direct marketing opportunities but these come with added work and expense. Producers interested in outdoor hog operations are advised to first assess the market for their products of interest, design a productive and environmentally sound system for producing and marketing the animals, and then evaluate the costs and returns for producing and marketing these hogs. Enterprise budget spreadsheets for producing market-weight hogs are available at //ag-econ.ncsu.edu/extension/outdoor-hogs-budgets. These budgets were developed for the example production systems described here but the spreadsheet entries can be customized for other outdoor hog production systems. These budget spreadsheets can and should be used for evaluating alternative production scenarios before any money is invested.

Conclusions

Outdoor hog production provides opportunities and challenges. Environmental damage resulting from nutrients produced by the hogs can be reduced or eliminated when the production system is designed carefully. Phosphorus and nitrogen produced in the hog manure and urine are the nutrients of concern. Maintaining a nutrient balance over the long term is feasible when hogs are raised in a dry-lot system in combination with a crop rotation. Vegetative cover can be maintained at acceptable levels in a dry-lot system. Vegetative cover can be maintained at high levels in a pasture-based system, minimizing the loss of soil and nutrients through run-off. A nutrient balance is unlikely to be achieved or maintained over the long term but the rate of increase in the nutrient load on the land can be slowed by appropriate management strategies. Stocking rate is a key factor in maintaining satisfactory control over the environmental impact of outdoor hog operations. Producers are advised to design their production systems carefully and to evaluate both the environmental and economic outcomes.