1. **Project name and contact information:**

Producing "Pork of the Season" with Mast-Fed Hogs
USDA SARE Farmer/Grower Grant # FNE06-593
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Introduction: *Integrated Sylvan Systems with Swine.* Many people refer to pastured or forest raised pigs as "old timey" farming, straight out of the book, *Fox Fire*[1]. A better term (that farmers understand) might be profitable farming, especially if farmers can produce a unique product that stands out from the majority of corporate produced hogs that are characterized as the "other white meat" (essentially from the same lean genotype, fed the same diet, etc.). The goal of this project is to help small-scale/part time farmers find new markets and higher profit margins by raising swine in ways that may enhance the flavor of pork (diet, genetics and management systems) as well as the environment they are raised in.

Many species of swine evolved in sylvan environments where cooler temperatures provided by a natural canopy aid in thermoregulation during the warm seasons. Woodlands also supply a vast amount of nutrients in the form of nuts/mast from forest canopies, roots and tubers, and carrion. Appalachian farmers and homesteaders typically ear notched their 150-200 hogs to harvest chestnuts and acorns from the "open range" woods[1]. Chestnut fed hogs produced the "sweetest meat" but rendered the fat into dark oil instead of a white lard. Some acorns produced bitter tasting pork and altered fat consistency. The Iberian hog model offers credence to niche-market application whereby swine purposely harvest tree mast (acorns) to provide a unique flavor and fat profile of the meat.

Iberian hams are produced from Iberian hogs in the southwest region of Spain. At twelve months of age, the hogs graze acorns (2 hogs/hectare) and native grasses exclusively for 2-3 months or until they reach approximately 160 kg. The unique aromatic flavors of the Iberian hams are attributed to the variety of volatile compounds and high levels of amino acids, produced from both the feeding regime of the hogs and aging process of the hams[2]. Iberian hogs are given free range of the oak and pasture lands during which time, the considerable quantity of mast and late season grasses available in the fall enable the hogs to put on 40% of their slaughter weight, all of it high in monounsaturated fats (62%) and anti-oxidants[3]. When the Iberian hog is raised in this system, the locals call it the "four legged olive tree", as the pork fat contains high levels of oleic acid which is found in olive oil. The resultant meat, full of intramuscular fat, produces hams that can age for two or more years without desiccation. Like a long aged wine, these hams develop deep flavor. Fetching prices in excess of 77 Euros per kilo ($35 US per lb.) in fall 2004, the Iberico Ham industry alone is a billion dollar business.

Forest-finished Ossabaw hogs fed peanuts, acorns and alfalfa (PAA) produced pork that was considered more flavorful by food critics and renowned chefs than that of hogs raised on dirt-lots fed a standard corn-soy diet. For health conscious consumers, unsaturated to saturated fatty acid ratios improved ($P < 0.01$) from 1.6 to 2.6 as a result of feeding the PAA diet[4]. Consumption of "heart healthy pork" (pork with higher levels of unsaturated fats in the fat profiles) lowered LDL plasma levels in studies with women[5]. Mast from hardwoods offers the possibility of enhancing pork flavor and fat quality for niche-markets while using a renewable forest resource as a food source.

There are few references regarding managed studies of swine in sylvan ecosystems to improve an existing timber stand or help to establish a more marketable one. According to Dr. Accisioli, of the University of Florence, the main problem with maintaining swine in the woods in the Tuscany region of Italy (similar topography to Appalachia) results from erosion, predominately due to soil compaction and loss of ground cover from continued animal use and inadequate rotation. Because our interest is in enhancing the environment (as well as the meat produced) our animals will remain in their designated wood lots only during periods of peak mast accumulation (3 months) and then subsequently harvested. In order to avoid damage to the ecosystem, reliable estimates of stocking density are required. Carrying capacity of Chinta Senese pigs foraging in turkey-oak forests in the Tuscany region of Italy varied from 0.1 to 2.1 pig/ha, pending annual production of mast. (personal conversations with Dr. Anna Accisioli of the University of Florence). The amount of mast produced in oak, hickory and beech woodlands is not completely synchronized. Within oaks species, seed production is offset with different species having different intermast periods; for some oaks it's two years, others three. This probably represents the time it takes the trees to accumulate the resources to produce an acorn crop. Other factors influence the timing of acorn crops; drought and ambient temperature during the spring flowering period are most notably the biggest factors (personal conversation with Todd Starlett, Dept of Forestry, University of South Carolina). These effects modify the inherent period of the mast cycle for a species.

Managing hogs in the woods is a dynamic "put and take" system and requires careful monitoring to realize the owner's forest management plan. Tree growth response or destruction depends on the animal stocking rate and duration of their stay. Preliminary studies with gestating sows in woodlots during the warm season in North Carolina (two six-month seasons, April 1-September 30) suggests potential for improving hardwood timber stands by reducing vegetative competition. Depending on stocking density (12/Ha or 36/Ha) and duration of placement, sows tended to girdle soft woods and leave hard woods (except elms) intact; 70% of the under-story vegetation was removed [6]. Similar to "Old Oak Savannas" grass production offers an additional feed source to tree mast as the canopy opens up and more light reaches the forest floor. By moving sows to new sylvan lots (both seasonally and/or when forest management goals are achieved), farmers may gradually improve their existing, non-marketable timber stands with wood products of higher market value.

Alternative diets and genetics to produce unique flavors in meat: The characteristic flavor and aroma of different meats is attributed to the unique combinations of water-soluble and lipid components found in each species[7]. The concentration of flavor precursors and their deposition into fat reserves are dependent on the particular feed resources and animal species[8]. Fat also serves as a reservoir for the volatile compounds that accumulate during cooking, and are known to enhance the flavor of meat. Intensive selection pressure over the last 20 years for lean meat composition in hogs, however has resulted in pork with noticeable reductions in intramuscular fat deposits (marbling) and taste. When Tamworth x Duroc hogs were fed barley or corn-soy diets, no differences in the sensory characteristics of the loin chops were observed, presumably due to low amounts of marbling (< 2%) reported in the loins[9]. In a subsequent experiment, when hogs with higher levels of intramuscular fat (>3.5%) were fed similar diets, barley fed hogs were preferred to corn based diets by sensory evaluation panels[10]. Additional research is needed to understand the effects of alternative feedstuffs on pork flavor with hogs that have higher levels of intramuscular fat. Farmers who have orchards or woodlots may be able to produce a *"Pork of the Season"* by gleaning fallen cherries in the spring, peaches in the summer, and apples or acorns in the fall. This preliminary study differs from previous studies reported in that it examines the environmental impact of swine stocking densities on woodlands with an inclined topography.

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2. **Goals and objectives:** The goal of this project is to help small-scale/part time farmers find new markets and higher profit margins by raising swine in ways that may enhance the flavor of pork (diet, genetics and management systems) as well as the environment they are raised in.

Objective 1. Determine impact of swine stocking density on sylvan ecology: Sixteen market sized hogs (average age and weight of barrows and gilts at start of trial was 6 months and 224lbs, respectively) were randomly selected from contemporary littermates and placed in a 9.9 acre section (Plot 1; see appendix) in a predominate oak-hickory woodlot in Mason Co. WV. Another group of sixteen hogs (230 lbs average starting wt.) were placed on pastured lots and fed 16% corn-soy (free choice) ration and represented a production and meat sensory control (study below). Hogs were introduced in the woodlots on 9/10/06 (see appendix) and moved to another fenced woodlot (Plot 2: 8.0 acres) on 10/24/06. Animal impact on the forest ecology is based on animals harvesting mast in Plot 1 for the six week period described. Hogs were weighed again on 11/06/06 and harvested two days later at a USDA plant in VA. Woodlot hogs were fed 50 lbs/d (approximately 3 lbs/d per hog) of whole corn and offered a mineral salt block free choice. A 50'x50' hog panel sacrifice area contained a water trough and facilitated loading the hogs at harvest. Woodland parameters studied included: a) prevalence of rooting, scratching, and marking behavior on timber species, b) effect of swine stocking density on survival, composition and condition of under-story vegetation and ground cover, and c) effect of stocking density on soil compaction and erosion.

Objective 2. Examine potential for woodland mast to improve pork flavor, reduce feed costs and increase revenue from forest ecology. Pork from four hogs consuming mast and four from those consuming the corn-soy diet (control) where tested by a sensory panel at WVU to compare sensory characteristics of chops taken from the two treatments. Fatty acid profiles and pork quality characteristics where conducted by the Food Science Laboratory at WVU. Additionally, an informal pork sensory assessment by farmers, consumers and local chefs where conducted at a Field Day in December 2005 or January 2006.

Objective 3. Demonstrate infrastructure required, animal management strategies utilized, and niche-market applications available to promote small-scale sustainable hog farms in Appalachia. Solicit interest from other small-scale farmers in WV to participate in a more comprehensive project through Workshops and Field Days.

3. **Farm and Woodland Test Plot Profile:** I have owned my 267 A tobacco farm in Mason Co. WV since 1978. My farm produced and sold tobacco up until I participated in the USDA tobacco quota buy-out. There are approximately 10

acres of bottom land, 50 acres of pasture and the rest in woodlands. On July 11, 2006, Valerie Hansen and Scott Eggerud used a GPS satellite tracking device to survey an area of woodlands suitable to the stocking rates prescribed (1/A and 2/A). The stocking rate component of the experiment was changed (see below) to one woodlot area for the entire group (16 animals or 1.6 hogs per acre for six weeks then moved for two weeks to plot #2). Plot #1 was approximately 9.9 acres in size and plot #2 was approximately 8.0 acres in size. See attached map for locations. Both areas have similar physical and cultural characteristics therefore the resulting timber stands are almost identical and will be described together.

Both plots, plot #1 to the south and plot #2, adjacent and to the north, have an entirely western aspect with slopes ranging from 15 to 45% with most of the area between 25 to 35% slopes. Gilpin-Upshur silty loams (soil types) dominate the area. Some rock outcrops occur, however most of the area is a long, gentle to moderate slope, with about 220 feet of relief. Elevation ranges from approximately 600 feet in the northwestern corner of Plot #2 to approximately 820 feet along the eastern side of Plot #2.

Most of this area, along with most of the tract, was cleared for agriculture approximately 70 to 80 years ago. This area reverted back to an oak hickory forest type, dominated by white oak, chestnut oak, black oak, scarlet oak, Virginia pine, hickory, red oak and sugar maple (in descending order). In 1992 the sawlog-sized trees for Stand #2 consisted of white oak 24%, Virginia pine 20%, black oak 14%, scarlet oak 8%, chestnut oak 7%, red oak 7% and sugar maple 7%. White ash, yellow poplar, hickory, basswood, red maple and white pine were also tallied as sawlog-sized trees in 1992. Most of the timber 16 inches DBH (diameter breast height) and larger were harvested in 1994.

Once the plot was marked, a two strand electric fence (one strand at 12 inches and another 20 inches) was built using step-in posts and insulators around standing trees. The fence was charged by a solar powered charger and tested (on average) at 4,000 volts. Orange ribbons where tied every 16 ft on the top wire for (animal) visibility.

Impact assessment study areas: In August 2006, prior to hog placement, 15-0.001 ac (milacre, radius = 3.74 ft.) sampling plots were established along three transects (Figure 1.). Transects were 100 ft. apart, and sample plots were 150 ft. apart along each transect. Plots were permanently marked with a plastic stake and the general location was flagged for future identification. Within each plot, all woody seedlings were tallied by species in one of three size classes: 0-12 in. tall (small), 12-48 in. tall (medium), and > 48 in. tall and < 1 in. diameter breast height (large). In addition, percent cover of non-woody vegetation (ferns, forbs, grasses, sedges, and mosses) as well as percent bare ground and exposed rock were estimated and recorded. Percent cover of woody non-tree species such as greenbrier, Japanese honeysuckle, and blueberries were also estimated.

Sample plots were re-inventoried on November 17, 2006, following removal of hogs. During this resample, we also estimated percent of plots where soil was disturbed.

Because non-woody species structure was recorded as percent cover and woody species were tallied by abundance (e.g., 1000s/acre), we examined differences between before and after for each vegetation category separately. For non-woody percent cover, several data deletions were performed due to seasonal differences in plant presence. Thus, since the post-sample occurred during the dormant season, we deleted forbs and grasses from the analysis. For woody species, we entered data as total heights (Fei et al. 2003) of each species by sample plot, using the midpoint of the height class (e.g., small = 0.5 ft., medium = 2 ft., and large = 4 ft.). Finally we contrasted plot-level species richness and diversity using a two sample t-test ($\alpha = 0.05$).

4. **Participants/Technical Advisors:**

- Chuck Talbott, Ph D and farmer; project coordinator
- Nic Heckett, business partner in Black Oak Holler Farm LLC
- Larry Wilcoxen, Black Oak Holler farm manager
- Rodney Walbrown, Mason Co. Extension Service.
- Scott Eggerod, independent forester, Ona WV.
- Dr. Dave McGill, Division of Forestry, WVU
- Dr. Jim Rentch, Division of Forestry, WVU
- Dr. Tom McConnell, marketing specialist, WVU Extension Service
- Dr. Bill Bryan, organic soil specialist, WVU
- Dr. Ed Rayburn, Crop Science, WVU
- Dr. Brett Kenny, Animal Science, Meat Specialist, WVU
- Joe McDougal, FFA Meats Class Instructor, Shady Springs HS
- Valarie Hansen, NRCS Mason Co. WV

5. **Project activities/changes in design:**

On September 9, 2006 we placed 16 gilts or barrows (average wt., 220 lbs; see table 1) in Plot 1 (Figures 3 and 4). Scott Eggerud (Independent Forester) said that 2006 was the best year for mast he had seen in the 20 years (Figure 5.). I camped directly across from the plot so I could observe the hogs' behavior. I have never heard such pig banter during the day (continuous grunting while working the forest soil for flora, fauna and mushrooms), or continuous squeals of alarm at night (suggesting predator challenge).

Based on the latter observation, I requested to change the experimental design of the project so that if challenged by coyotes or other predators, the pigs would have a better chance of protecting themselves I decided to leave the pigs together (for group defense), rather than split the plots (by stocking rate) as designed.

6. **Results:**

Objective 1, Animal impact on forest ecology: Total woody seedling density before grazing was 26,533/acre (Tables 1 and 2). Eighty-six percent were small seedlings ($\leq$ 12 in.), and average seedling height was 0.8 ft. The most abundant species was red maple (7,667/acre), 96% of which were in the small size-class. Eastern hophornbeam, flowering dogwood, and white ash were abundant in all size classes. The site was moderately stocked with oak seedlings (1,067/acre), however 89% of these were also in the small size-class; no large size-class oaks were tallied. Following one month of hog grazing, small declines were noted for eastern hophornbeam, flowering dogwood, and white ash, however most of these declines occurred in small size-class stems. Among the oaks, a similar pattern occurred for black and white oak. Much larger declines occurred for red maple, sugar maple, and Virginia pine, almost exclusively in the smallest seedling size-class. We suspect that the bulk of these losses were germinal-sized seedlings either buried in leaf-litter or killed from fall frost. Consistent with the mortality of smallest seedlings, post-grazing average height/seedling increased to 1.4 ft.

Table 1. Average percent cover of non-woody vegetation, before and after hog grazing.

	% Before	% After
Grass	7.5	1.2
Fern	2.6	1.4
Sedges	0.9	0.7
Forbs	5.7	1.3
Moss	2.5	2.3
Bare/rock	7.5	6.9
Disturbed soil	na	3.3
Greenbrier	0.3	0.6
Japanese honeysuckle	0.7	0.4
Blueberries	0.9	0.7

Statistical comparison of of the non-woody percent cover before and after grazing yielded conflicting results. The MRPP test suggested no difference in composition or structure ($p = 0.23$, see Table 3. in appendix). Conversely, the Mantel test yielded a positive correlation value ($r = 0.203$), however this was not significant. Neither the MRPP or the Mantel indicated any significant differences in vegetative composition of composition and total height of woody tree seedling species when the two time periods were compared (Table 3.and Table 4.) values were negative, indicating a difference, p values were > 0.05. Similarly, r- and t-values of the Mantel test was positive and statistically significant ($p < 0.001$). Changes in species richness (S) and species diversity (H') showed the opposite pattern. Post grazing S and H' by sample plot were approximately one-half pre-grazing values (S = 7.1 and 3.5, H' = 1.5 and 0.9, pre- and post-grazing, respectively, $p < 0.0001$). Eight species that were tallied in the pre-grazing inventory were absent post-grazing. Virtually all of these seedlings were small and the same caveat suggested for the perceived decline of red and sugar maple likely applies here.

Table 2. Abundance of woody seedlings in three size classes, and total height of woody seedlings, before and after hog grazing.

	Before (Ave. seedlings/ac)				**After (Ave. seedlings/ac)**			
	Small	**Med.**	**Large**	**Total ht (ft.)**	**Small**	**Med.**	**Large**	**Total ht (ft.)**
Viburnum spp.	67	0	0	33	0	0	0	0
Am. beech	67	67	0	167	0	67	67	400
Autumn olive	0	0	0	0	0	67	0	133
Black cherry	133	0	0	67	0	0	0	0
Black gum	200		67	367	0	0	0	0
Blue beech	0	0	133	533	0	0	0	0
Buckeye	67	67	67	433	0	67	67	400
Black oak	400	0	67	467	67	133	67	567
Chestnut oak	133	67	0	200	0	0	0	0
White oak	533	0	0	267	333	0	0	167
Crab apple	67	0	0	33	0	0	0	0
E.hophornbeam	3333	667	400	4600	1333	600	800	5067
Elm	1333	0	0	667	0	0	0	0
Fl. Dogwood	2067	200	200	2233	1467	333	200	2200
Hawthorne	333	0	0	167	0	0	0	0
Hickory	933	0	67	733	400	0	67	467
Paw paw	0	67	0	133	0	0	0	0
Red bud	0	0	67	267	0	0	67	267
Red maple	7333	133	200	4733	133	0	333	1400
Serviceberry	533	200	133	1200	333	133	67	700
Sugar maple	1733	0	0	867	0	0	67	267
Virginia pine	867	0	0	433	67	0	0	33
White ash	2667	867	0	3067	2400	200	0	1600
Totals	**22800**	**2333**	**1407**	**1400**	**6533**	**6733**	**1600**	**1867**

Estimates of percent soil disturbed averaged 3.3% (SE = 1.33). Eleven of 15 milacre plots showed no soil disturbance, and the range of disturbance was 2-20%. Soil disturbance patterns varied somewhat according to whether the sample plot was intersected by a trail. In the case where disturbance was greatest, the sample plot was adjacent to a persimmon tree, a fruit favored by swine. An additional concern is the relationship between hog rooting, soil disturbance, and spread of invasive species. Japanese honeysuckle (*Lonicera japonica*) was noted on three pre-grazing sample plots with an average percent cover of 3.7%. Of greater concern is the invasive Japanese stilt grass

(*Microstegium vimineum*). It occurred on three pre-grazing samples; coverage on one sample plot was 45%. This species possesses characteristics typical of

Table 3. Summary statistics for the multiple response permutation procedures (MRPP) for differences in non-woody percent cover, and total height of tree seedlings before and after hog grazing.

	Obs. Sorenson Distance	Exp. Sorenson Distance	T	p
Non-woody % cover	0.751	0.756	-0.635	0.229
Tree seedlings	0.782	0.791	-1.234	0.114

The T statistic is the weighted mean within-group distance; the p value indicates the likelihood of achieving the observed difference (*T*) by chance

Table 4 Summary statistics for the Mantel test for differences in non-woody percent cover, and total height of tree seedlings before and after hog grazing.

	r	*t*	*p*
Non-woody % cover	0.203	1.458	0.154
Tree seedlings	0.451	3.600	0.0003

The *r*-statistic is a measure of association between matrices, and the *p* value indicates whether or not to reject the null hypothesis of no association between matrices.

many invasive species: it grows quickly, fruits within a single season, produces small but abundant seed that is very persistent in soils, has seeds that adhere to animal fur or clothing, is nonpalatable, and easily invades disturbed habitats (Tu, no date). It is cause for considerable concern in forested ecosystems in the region, because it is capable of invading forestlands and swiftly replacing natural communities with nearly monospecific stands. Post-gazing sampling occurred after this grass was senescent, so an evaluation of the potential spread of this species was inconclusive (Rentch and McGill, 12/06 in appendix).

The roads constructed during the last timber harvest, most of which ran along natural benches, provided excellent access to the pig plots. No damage to the timber stand, including saplings, pole-sized trees and sawlog-sized trees due to pig foraging was noted (Eggerud, 12/06).

Objective 2. *Examine potential for woodland mast to reduce feed costs, improve pork flavor, and increase revenue from forest ecology.*

Over the 56 day trial, the hogs consuming corn-soy gained 118 lbs (Table 5) and the pigs on mast gained an average of 8 lbs. Based on a conservative feed conversion rate of 4 lbs of feed to 1 lb of gain, all pigs consumed approximately 1000 lb of feed (costing $100 @ $.1/lb) to reach 225-250 lbs at the start of the trial. During the 8 week trial, the corn-soy pigs each consumed approximately

590 lbs of grain (5 x 118 lbs) vs. approximately 168 lbs (56d x 3) of shelled corn for each of the acorn fed pigs. A 5:1 feed to gain conversion factor is used during the 56 day trial to reflect the higher maintenance requirements (animals > 250 lbs) needed to deposit nearly one inch more subcutaneous back fat and two percent more intramuscular fat in the corn-soy fed hogs. Hogs consuming acorns travelled up and down 25 degree slopes to find their food and as discussed previously, presumably lost 20-30 lbs at the end of the trial.

At $0.10/lb for feed, the average corn soy pig consumed $59 worth of feed during the trial while the mast fed pig consumed $17. Based upon prices paid for by the processor @ $.60/lb live wt. (no live weight penalties) for corn-soy and $1/lb for acorn fed pigs, the income over feed costs (IOFC) for the corn-soy pigs is $49 (348 lbs. x $.6/lb = $208 gross sales less $159 estimated feed costs); the IOFC for acorn fed hogs was $115 for mast fed hogs (232 lbs * $1/lb = $232 less $117 estimated feed costs). As the demand for corn increases for ethanol production, the cost of feeding pigs will rise accordingly. In order to hedge against higher grain prices, farmers should consider utilizing alternative feed resources and raising as much on-farm nutrients as possible.

Table 5. Initial and Harvest Weights of Hogs Fed Predominately Acorns or Ad-libitum Corn-Soy Diets for 56 days.

Diet	# obs.	Days on Trial	Start Trial Wt 9/11/06	Harvest Wt	Wt Gain ± SE
Acorn*	16	56	224	232	8 ± 3.8
Corn-soy	16	56	230	348	118 ± 6.7

*Hogs consuming mast were offered 3 lbs/day shelled corn

Table 6. Mean back-fat depth and ribeye areas (in^2) from Farmer's Hybrid hogs fed two diets.

	Backfat (in.)	Ribeye area (in^2)
Acorn	0.59 (0.06)[a]	4.96 (0.64)[a]
Corn-soy	1.56 (0.46)[b]	7.04 (1.87)[b]
P value	*0.0045*	*0.0505*

[ab] Means with different superscripts are different (P < .05)

Table 7. Mean % moisture, crude fat, ash and crude protein in 10th rib chops from Farmer's Hybrid hogs fed two diets.

	Moisture (%)	Crude fat (%)	Ash (%)	Crude protein (%)
Acorn lean	70.31 (1.35)	4.07 (0.88)[a]	1.07 (0.05)	24.38 (1.22)
Corn-soy lean	70.07 (1.14)	5.92 (1.18)[b]	1.05 (0.06)	23.51 (1.12)
P value	*0.6143*	*0.0001*	*0.2822*	*0.0687*
Acorn fat	15.45 (2.25)[a]	80.00 (3.55)[a]	--	--
Corn-soy fat	8.64 (2.00)[b]	89.98 (2.48)[b]	--	--
P value	*0.0004*	*0.0002*	--	--

[ab] Means with different superscripts are different (P < .05)

Scores from the informal taste tests at the Lowe Hotel (n=16) and the Farmer Workshop (n=25) are in Table 8. Loin pork roasts served at the Lowe Hotel Dinner from barley-acorn fed hogs had more flavor (SE = 3; P<.1) than pork from corn-soy fed diets. Participants observed no differences in tenderness, juiciness or overall evaluation (rank) in the two loins for the two diet treatments. On the contrary, pork from corn-soy fed hogs was considered more flavorful, juicy and tender than acorn fed hogs at the BOHF farmer workshop. Differences in weights and fat deposition (Tables 5 and 6) of the shoulders due to diet may have influenced the taste test at BOHF. The shoulder from the acorn diet was 7 lbs lighter (corn-soy animals were 100lbs heavier at harvest) than the corn-soy shoulder and may have dried out due to excessive cooking. Unsaturated fats have lower melting points and possibly require different cooking strategies to retain moisture and flavor.

Table 8. Informal Evaluation of Pork Flavor at Lowe Hotel on 12/7/06 and Black Oak Holl'r Farm (BOHF) on 12/8/07 and WVU Meat Science Lab on 12/5/07.

Observation: Diet	# obs.	Tender-ness	Juiciness	Flavor	Overall
Lowe Hotel: (Loins)					
Barley-acorn	16	7.8	7.4	8.1[a]	7.6
Corn-soy	16	7.8	7.6	7.6[b]	7.5
BOHF (Shoulders)					
Barley-acorn	25	6.4[b]	7.3[a]	7.0[a]	7.3
Acorn	25	6.5[b]	6.1[b]	6.4[b]	7.2
Corn-soy	25	7.3[a]	7.6[a]	7.5[a]	7.6
Different superscripts indicate differences (P<.1)					

Six untrained faculty volunteers from the School of Agriculture agreed to sample 1 cm^3 samples of pork loin (cooked to internal temperatures of 165° F) from the BOHF corn-soy and barley diets. There were no statistical differences in sensory characteristics reported between diet treatments (see figure below). Participants at WVU lab tended to favor acorn-fed pork flavor over corn-soy pork and characterized the acorn pork flavor as nutty, sweet and earthy. Minolta scores are listed in Table 9. Acorn pork was darker (P<.01) than corn-soy pork and may reflect the higher intramuscular fat stores in the corn-soy pork (Table 7.). With the considerable exertion in finding mast, different muscle fiber types (red vs. white) could explain the darker muscle color in the acorn-fed hogs (not analyzed).

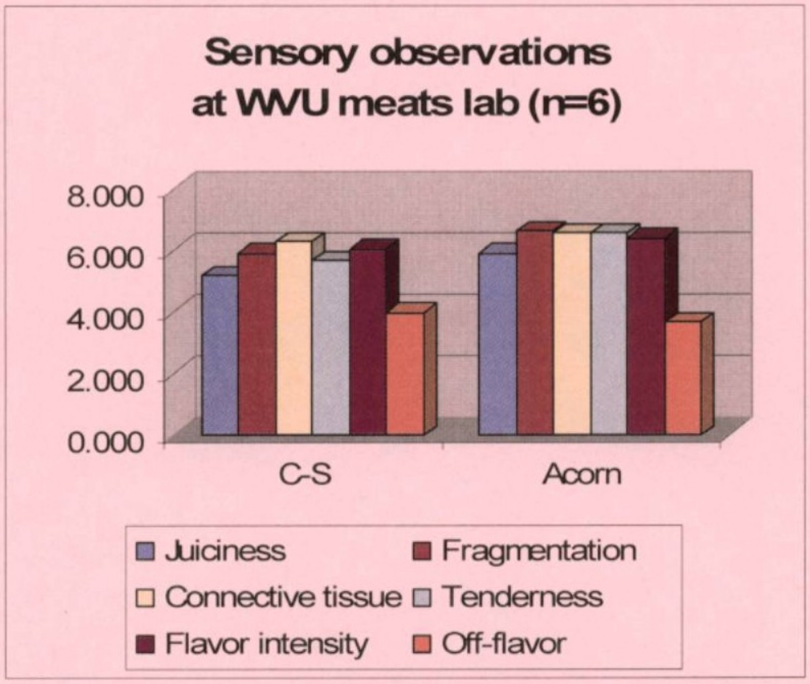

Table 9. Mean Minolta scores (SE) of 10th rib loin chops from Farmer's Hybrid hogs fed two diets.			
	L* value	a* value	b* value
Acorn	55.71 (3.53)[a]	8.60 (2.42)	9.65 (1.58)
Corn-soy	60.60 (3.81)[b]	9.48 (1.20)	9.29 (1.59)
P value	*0.0098*	*0.3129*	*0.6206*
[ab] Means with different superscripts are different (P < .05)			

Table 10. Mean cooking yield and shear force from Farmer's Hybrid hogs fed two diets.		
	Cook yield (%)	Shear force (g)
Acorn	70.08 (1.86)	3504.06 (741.31)
Corn-soy	72.01 (3.56)	3640.36 (742.74)
P value	*0.4276*	*0.4778*
[ab] Means with different superscripts are different (P < .05)		

No differences were observed in cooking yield or shear force (degree of muscle fiber strength and meat tenderness) due to diet (Table 10).

Table 11. Mean fatty-acid profiles from Farmer's Hybrid hogs fed corn-soy vs. acorn diets.						
Fatty acid [2]	Corn-soy	Acorn		Corn-soy	Acorn	
	Subcutaneous fat		*P value*	Lean muscle		*P value*
C14:0	1.43 (0.15)[b1]	1.25 (0.12)[a]	*0.0311*	1.51 (0.14)[b]	1.40 (0.08)[a]	*0.0463*
C16:0	24.89 (1.04)[b]	23.37 (0.62)[a]	*0.0001*	27.35 (0.65)[b]	26.05 (0.56)[a]	*0.0017*
C16:1	2.39 (0.43)	2.46 (0.29)	*0.7284*	4.36 (0.52)	4.07 (0.42	*0.2517*
C18:0	15.22 (1.96)	13.34 (1.02)	*0.0686*	12.16 (1.35)	12.06 (0.89)	*0.8855*
C18:1n9c	44.22 (0.88)	44.36 (1.51)	*0.7076*	44.50 (1.51)	43.78 (0.63)	*0.2431*
C18:2n6c	10.19 (1.03)[a]	12.86 (0.72)[b]	*0.0002*	7.54 (1.49)[a]	9.18 (0.47)[b]	*0.0114*
C20:1	0.75 (0.44)	1.01 (0.04)	*0.1025*	0.55 (0.20)	0.52 (0.20)	*0.7654*
C18:3n3	0.36 (0.20)	0.49 (0.04)	*0.0913*	0.12 (0.11)	0.23 (0.12)	*0.1338*
C20:2	0.37 (0.27)[a]	0.68 (0.13)[b]	*0.0068*	0.22 (0.17)	0.14 (0.20)[3]	*0.3010*
C20:4n6	0.17 (0.03)	0.18 (0.04)	*0.3815*	1.70 (0.42)[a]	2.58 (0.55)[b]	*0.0113*

[1] Mean % relative peak area (standard deviation)
[2] C14:0 = myristic acid; C16:0 = palmitic acid; C16:1 = palmitoleic acid; C18:0 = stearic acid; C18:1n9c = oleic acid; C18:2n6c = linoleic acid; C20:1 = cis-11-eicosenoic acid; C18:3n3 = linolenic acid; C20:2 = cis-11,14-eicosadienoic acid; C20:4n6 = arachidonic acid.
[3] Standard deviation due to non-measurable amounts in several samples.

Objective 3: Demonstrate infrastructure required, animal management strategies utilized, and niche-market applications available to promote small-scale sustainable hog farms in Appalachia. (see section *10. Outreach*)

7. Conditions effecting results: Notes on production and behavioral observations (CT): When we weighed the pigs in September, we questioned what the initial weight should be to result in a hog that finishes around 300 lbs and contains the flavor of the mast in the fat and meat. Based on the Iberian hog model in the dehesu region of Spain, the Iberian hog gains 1/3 of its final weight during the last two months that it consumes acorns and vegetation. I thought that the 260 lb pigs would be too heavy at harvest and not likely to function well over the terrain. Therefore, we selected those around 220 lb to participate. In fact the three that were over 250 lbs (carrying ample condition) were like mountain goats and in retrospect, represented the better weight for starting on mast. Considerable energy is spent climbing the hills looking for sparse acorns.

In early September the pigs foraged the vegetation first while waiting for the mast to fall (Figure 6.). From mid September to mid October, the pigs essentially ignored several of the shelled corn feedings (didn't come when called) and appeared in good condition and gaining weight (Figure 7.). They constantly had their heads in the soil cracking nuts or were resting in make-shift nests; they essentially ignored the herdsman when food was plentiful. I estimate that the pigs had gained on average 40-50 lbs at peak mast availability (approximately 4 weeks into the study and translating to 1 lb to 1.25 lb gained per day) and should have been harvested two-three weeks earlier. By mid October, acorn availability was apparent on one side of the fence and lacking on the side where the pigs were (Figure 8.). We decided to fence in another 8 acres (Plot 2) to utilize the apparent availability of mast. As mast availability decreased, the pigs spent more calories going up and down the slopes, trying to find the next meal. It is possible that when the leaves came off the trees and covered the ground, the pigs ability to easily find acorns (through reduced ability to smell or sight mast) become the limiting nutritional factor. Wilcoxen suggested processing the pigs earlier, but the processor could not accommodate our request. Consequently, the pigs became more attentive to the "role-call" for dinner; crunching was more sporadic. We could not reschedule an earlier kill date with our packer and this became a problem. When the pigs were scheduled for harvest (first week in November), I predict they had lost 30-40 lbs (Figure 9.). The average net gain for the group on mast was 8 lb (see Table 5; SE ± 3.8; range +24lb to -16lb).

8. Assessment: What is the next step?

Recommendations for managing the woodlands ecology.

Results of the post-grazing sampling were somewhat inconclusive because it occurred during the dormant season. The site will be resampled during the growing season at approximately the same time period of the initial sample (i.e., August). This would provide a more accurate assessment of any changes in understory species composition and structure that were associated with rooting and soil disturbance, in general, and permit closer monitoring of spread of Japanese stilt grass, in particular.

Recommendations for managing hogs in the woods:

Based on the availability of acorns (and supplemental feed), I would suggest placing the hogs in the woods at 275 to 300 lbs with a maximum stocking rate of 1per A to 1 per 2A. The main objective is to incorporate the flavor of the mast into the fat and harvest the animal six weeks later (preferably around 300 lbs). Six weeks is considered a minimum period to influence flavor and fat profiles due to changes in diet. Pending acorn availability, supplemental feeding may be necessary to prevent weight loss. Based on price and availability, corn may be more desirable as a supplemental feed if acorn flavor is paramount; peanuts increase the ratio of healthy fats (unsaturated to saturated) but are expensive and not native to Appalachian farms (Talbott et al., 2006; in appendix). Feeding dried bourbon mash (study in progress) may be more appropriate for the WV and KY hollers.

Recommendations for marketing exotic pork:

Farmers must know the type of carcass characteristics that the individual chefs and consumers want, i.e. predominately the amount of backfat, % marbling, color, and % drip loss. Simply put, not all French chefs cook with lard! Will the shoulder be used for sausage, dry cured salumi, slow-cooked BBQ? The farmer must help educate the public about the costs and benefits of producing high quality pork from small farms. All participants, farmers, chefs and consumers, must understand and appreciate that food produced locally and sustainably is important for rural re-vitalization and food security. Consumers must expect to pay a premium (over the sale price at Wall-Mart or the Piggly

Wiggly) for a product of unique flavor and increased health attributes due to the unsaturated fat profiles. The consumer must visit the farms where their food is grown and understand (become a Slow Food Co-Producer) from the farmer how he produces a safe, quality product.

9. Adoption: Plan to continue, why or why not. Any revisions?

I personally think the 2006 acorn pork from our study was the best I have ever tasted. The physical texture and flavor of the fat (particularly the belly for cooking) was most impressive. At room temperature, the fat from the belly felt like lanolin. I finally understand the importance and value of lard for giving flavor to broths and soups. We anticipate grazing 25 in the woods next season. It is important to regularly observe eating behavior (or lack of) of the animals and their (fat) condition. When there are years with minimal mast production, supplemental feeding is required. Portable watering systems may also be required during dry falls; during 2006 there was standing water from rainfall available at several locations. When mast-fed pork becomes profitable, I envision a herdsman moving with the pigs much like Alpine herders.

Producers need to work with a trustworthy and professional processor who can be flexible about the harvest date (± 2 weeks). Our processor promised to pick up a representative sample of my acorn and corn-soy pigs on a certain date and changed his mind at the last minute. Our experimental design was compromised because of him; corn-soy hogs were harvested one week later. The processor promised to distribute our pork surveys for this study (in appendix) to the participating chefs and no information was ever gathered. He still owes us money for the hogs he purchased from us in 2006! The foundation of a local food supply and food security is based on the ability to provide an honorable standard of living for the farmer. The Slow Food mantra is Food that is "Good, Clean and Fair. There are numerous variables which are uncontrollable, so focus on those variables that you have some control. Work with processors who understand and appreciate the value of your product. Make sure they are aware of the uncertainty of mast availability. I emphasize the importance of farm identification (slap tattoo) for all specialty pork with a recognizable farm label tattoo marking on the loin, shoulder and hams. This may be more commonplace when the federal farm/animal ID (NAIS) is initiated.

10. Outreach: Rodney Wallbrown sent invitations to all extension agents and farmers to attend the pork tasting workshops. We had an informal evaluation of the pork flavor at a dinner at the Lowe Hotel (25 attendants; see flier in appendix) on 12/7/06 and a farmer workshop at Black Oak Holl'r Farm (25 farmers and 10 community/academic attendants) on 12/8/07 (Figures 10 and 11). Talbott, Eggerud, Rentch and McGill discussed their observations and distributed their handouts (see appendix). Rodney Wallbrown led the discussions at both sessions. Dr. Tom McConnell asked Talbott to speak about his project at the WV Small-Farms Marketing Conference (>100 farmers) in February 2007. Talbott and Heckett visited Shady Springs High School to discuss their project with Joe McDougal's students in the FFA Meats Class. We brought the students samples of our hams and bellies from the three different diets. The students prepared the samples as they would their own entries for the Annual WV FFA Ham, Bacon and Egg Sale (Figure 12). We will showcase our work at the Collaborative for the 21st Century Appalachia at Fairmount University in August.

11. Report Summary:

The goal of our project was to examine the impact of raising hogs in the woods to harvest mast and find ways to utilize on-farm feed resources that may enhance the flavor of pork. Sixteen market sized hogs (barrows and gilts averaging 6 months of age and weighing 224lbs) were randomly selected from contemporary littermates and placed in a 9.9 acre section in a predominate oak-hickory woodlot in Mason Co. WV. Another group of sixteen hogs (230 lbs average starting wt.) were placed on pastured lots and fed 16% corn-soy (free choice) ration and represented a production and meat sensory control. Hogs were introduced in the woodlots on 9/10/06 and moved to another fenced woodlot (Plot 2: 8.0 acres) on 10/24/06. Animal impact on the forest ecology is based on animals harvesting mast in Plot 1 for the six week period described. Woodlot hogs were offered 50 lbs/day (approximately 3 lbs/d per hog) whole corn and offered a mineral salt block free choice. Informal taste tests from two workshops were conducted and pork from four hogs consuming mast and the corn-soy diet where analyzed for meat quality and tested by a sensory panel at WVU.

Post grazing forest species richness (S) and species diversity (H) were approximately one-half pre-grazing values (S = 7.1 and 3.5, H' = 1.5 and 0.9, pre- and post-grazing). Eight species that were tallied in the pre-grazing inventory were absent post-grazing. Estimates of percent soil disturbed averaged 3.3%; 11 of the 15 milacre plots showed no soil disturbance, and the range of disturbance was 2-20%. Japanese honeysuckle (*Lonicera japonica*) was noted on three pre-grazing sample plots with an average percent cover of 3.7%. This species possesses characteristics typical of many invasive species: it grows quickly, fruits within a single season, produces small but abundant seed that is very persistent in soils, has seeds that adhere to animal fur or clothing, is nonpalatable, and easily invades disturbed habitats. It is cause for concern in forested ecosystems in the region, because it is capable of invading forestlands and swiftly replacing natural communities with nearly monospecific stands. Post-gazing sampling occurred after this grass was senescent, so an evaluation of the potential spread of this species was inconclusive. A reassessment of the 15 milacre plots will be conducted again this August. No damage (girdling, buttressing etc.) to the timber stand, including saplings, pole-sized trees and sawlog-sized trees due to pig foraging was noted. There was no evidence of soil compaction. Over the 56 day trial, the hogs consuming corn-soy gained 118 lbs while the pigs on tree mast gained an average of 8 lbs. The mast fed pigs became very attentive to the "role-call" for dinner while acorn crunching became more sporadic. We could not reschedule an earlier kill date with our packer and this became a problem. When the pigs were scheduled for harvest (first week in November), I predict they had lost 30-40 lbs. For this experiment, hogs should have been harvested at six weeks rather than eight weeks. At $0.10/lb for feed, the average corn soy pig consumed $59 worth of feed during the trial while the mast fed pig consumed $17. Based upon prices paid for by the processor ($.60/lb live wt. for corn-soy and $1/lb for acorn fed pigs), the income over feed costs (IOFC) for the corn-soy pigs is $49 while the IOFC for acorn fed hogs was $115 for mast fed hogs. Preliminary results suggest that hogs should be 275-300 lbs (with a minimum of 1.25-1.5 inches backfat) when placed in the woods. The objective is to incorporate the acorn flavor into the fat.

Scores from the informal taste tests at the Lowe Hotel suggested that the acorn pork roasts had more flavor than pork from corn-soy fed diets. Participants observed no differences in tenderness, juiciness or overall evaluation in the loins for the two diet treatments. On the contrary, pork from corn-soy fed hogs was considered more flavorful, juicy and tender than acorn fed hogs at the farmer workshop. Differences in weights and fat deposition of the shoulders due to diet, exercise and processor problems may have influenced the taste test at the farm. The shoulder from the acorn diet was 11 lbs lighter than the corn-soy shoulder and may have dried out due to excessive cooking. Pork with higher levels of unsaturated fats have lower melting points and may require different cooking strategies to retain moisture and flavor. Professional cooks are recommended when cooking for taste tests.

Untrained sensory panelists at the WVU meats lab tended to favor acorn-fed pork flavor over corn-soy pork and characterized the acorn pork flavor as nutty, sweet and earthy. Acorn pork was darker than corn-soy pork and may reflect the significantly higher intramuscular fat stores in the corn-soy pork over mast fed diets (5.92% vs. 4.07% respectively) or possibly the muscle fiber type (not analyzed). Saturated fats in the subcutaneous fat and muscle tissue from the acorn diets were lower (8.6% and 3.7% respectively) than from the corn-soy diets; unsaturated fats increased 6.1% in the back fat and 2.6% in the muscle when acorns were fed instead of corn-soy diets. More research is needed to assess the heart-health benefits of feeding a diet of acorns to market hogs. In the last two weeks of the experiment, the catabolism of fat of the forest hogs to support energy requirements and maintenance probably influenced the amount and type of fatty-acid accumulation in the muscles.

The predator fears that I had originally cited have been unfounded so far. Coyotes, mountain lions and bears are occasionally heard from at night or sited in the woods. The two strand electric fence proved effective in keeping 16 hogs in a 16 A wood lot. The secret to keeping pigs in electric fence lots is to provide adequate feed and water at all times. The unpredictable nature of mast availability as a reliable feed source adds to the challenge.

Flavor and (possible) health benefits of Appalachian locally and sustainably raised pork must be conveyed to the communities in the context of food security. We must convince our policy makers to invest in "off the grid" farming systems, lest we forget the traditional knowledge of Appalachia, i.e curing and preservation of meat and vegetables in root cellars. The next focus of our work will be to collaborate with existing programs (Slow Food Bluegrass, Collaborative for the

21st Century, WV and KY Extension Service) to document the contribution of the farmer and offer him real value ($) for his work and risks involved.