Outdoor Hog Production

Best Practices for Resource Conservation in the San Francisco Bay Area

Hog Manure Management

by Sheila Barry, Cole Smith and Susan Ellsworth

Hog manure and bedding from outdoor production systems can typically be treated as a solid and may be managed in several ways depending on the structure of the operation. In the Bay Area, outdoor production systems, even when pasture or rangeland -based, typically include a drylot. Periodic removal of hog manure is essential in a drylot to protect water resources, reduce pathogens and avoid nutrient accumulation. Composting can recycle hog manure and bedding in an environmentally friendly and sustainable manner.

Rotational Pasture, Range and Cropland–based Systems

In systems where hogs are moved through pasture, range or cropland, manure is typically distributed and in many cases is viewed as a beneficial nutrient to promote forage or crop growth. However, because hogs are monogastrics and rely on grain or other nutrient dense feeds typically imported from off the farm, their manure contributes additional nutrients to the farm system which can result in nutrient loading. This is different from ruminants that can rely purely on forage, therefore recycling existing nutrients from on-site forage in their manure without adding any to the system.

The degree to which outdoor hog manure is sufficiently distributed to minimize nutrient loading depends on the stocking rate and how frequently the animals are moved. See factsheet on Rangeland and Pasture Management for more information. In many cases, hogs will select a particular area to dung in, resulting in a higher concentration of nutrients in that area. For this reason, it is recommended that outdoor hog farmers monitor nutrients through periodic soil testing.

Animal waste storage system. Photo courtesy of the Alameda County RCD.

Drylot Systems

In drylot systems, by comparison, manure is less likely to be distributed, as the area within which the animals are housed is smaller and stocking rates are higher. As such, the collection and removal of

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manure is more manageable and in many cases, imperative to the well-being of the animals. This factsheet focuses on composting hog manure and bedding from confined or drylot hog systems as a means of reducing the volume of waste, minimizing flies, pathogens and odors and potentially producing a high quality soil amendment.

Composting Hog Waste

Collection of material

Collecting manure is the initial step to develop a successful composting system. Since hogs often dung in one place, collecting material may be simplified by encouraging hogs to dung in the best location for collection and in area that does not receive runoff. The manure may be scraped from the ground in a drylot system or removed with bedding from a concrete or hoop house arrangement. During the rainy season it may be necessary to scrape drylots twice weekly. Rain runoff from drylots may become contaminated and should never flow directly into a waterway. Although scraping removes most of the solids, any runoff from a drylot should pass through a vegetative buffer before reaching a waterway to minimize the possibility of contaminating water with nutrients or pathogens.

It is important to know the moisture content and the initial bulk density of the waste to determine whether a bulking agent is necessary. If the material is excessively moist (>60%) such as a slurry or liquid material without a litter component, a bulking agent may be necessary.

Bulking agents are carbon-based material that add volume to the manure, soak up any excess liquid and balance the C/N ratio necessary to produce high quality compost. Examples of effective bulking agents include: straw, sawdust, peat moss or wood chips. The manure must be mixed evenly throughout the bulking agent to ensure consistency of the final product.

Storage

The location and site where the manure is stored is critical for the stability of the material as well as the reduction of potential environmental contaminants. Once collected, manure must remain covered. Allowing the material to come into contact with rain will increase the amount of nutrient and possibly pathogenic contaminants running off the pile or leaching into surface or groundwater. In addition to posing environmental concerns, the loss of nutrients from a compost pile also results in a decrease of nitrogen retention within the final compost product.

Initially, raw un-composted manure should be kept under a covered area or tarp if possible. The ground on which the manure is stored should be impermeable, such as hard packed earth or cement, with the intention of prohibiting leachate from penetrating the soil profile as well as controlling runoff. A minor grade in the storage surface is favorable in order to collect runoff in a specific location, such as a collection lagoon or biological filtration pool. It is imperative that manure or leachate is not stored near water sources or allowed to flow freely into waterways.

Turned Windrow method. Photo courtesy of NRCS

Compost method

Active v. Passive Aerated Windrows

Aerated composting, either active or passive, is a method designed to provide the composting material with even air pressure throughout the pile, with the volume of airflow often determining the amount of time necessary to complete the process. The more oxygen the material receives during composting the faster the material will break down to become a finished product. Active aeration methods include using powered fans to force air through a series of perforated pipes, evenly distributing oxygen throughout the material. Passive aeration, often a more affordable method than active aeration, consists of placing perforated Schedule 80 PVC pipe evenly throughout the pile. In both active and

passively aerated piles the material should be turned once a month, moving the outer material towards the center of the pile. The pipes may need to be removed prior to turning in an active aerated pile.

Turned Windrow method

Windrow composting is a method in which the manure/bulking agent mixture is piled in long rows, with a minimum size of at least 3ft x 3ft x 3ft and actively turned by hand, tractor bucket or windrow turner for larger piles. To achieve even decomposition throughout the pile the material mixture should be as homogenous as possible, with a moisture content between 65 – 55%. The frequency of turning will determine the speed of decomposition; the more frequently a material is turned the faster the material will compost. Turn approximately every two weeks, based on moisture and temperature to produce compost in a timely manner. Material is considered mature in approximately 49 days using this method.

Finished compost ready for application: photo courtesy of NRCS

Requirements for Safety

Any animal, including hog manure, contains pathogens that can be harmful to human health; precautions must be taken to ensure that the material is safely composted. To kill harmful pathogens it is imperative that the material reaches 55°C (130°F) for at least 3 days. A 3' foot compost thermometer is useful to monitor temperature. In the Bay Area, due to dry climatic conditions, maintaining moisture within the material is imperative to achieving proper sterilizing temperatures. The location of the pile should be out of direct sun to prevent excess moisture loss. These temperatures can be achieved via the methods mentioned above if followed properly. A critical factor in pathogen elimination is that all of the material being composted is exposed to the required high temperatures. This can be achieved by adequately turning the material, making sure to mix the outer material thoroughly into the center.

Use of Product

Once maturity is reached (~7 weeks) the product can be safely used. Visual indicators such as steam no longer rising from the pile can also determine maturity. Properly finished, mature compost can be applied to pastures and fields to increase fertility and soil organic matter. Application rates for compost vary based on the intended outcome, but generally 1-2 inches is sufficient. If compost is being incorporated into the soil profile it should be incorporated at a depth of approximately 5 inches. Due to the risk of pathogen contamination from unfinished processing, compost should not be applied to ground-harvested crops (ie. strawberries, root-crops, squash).

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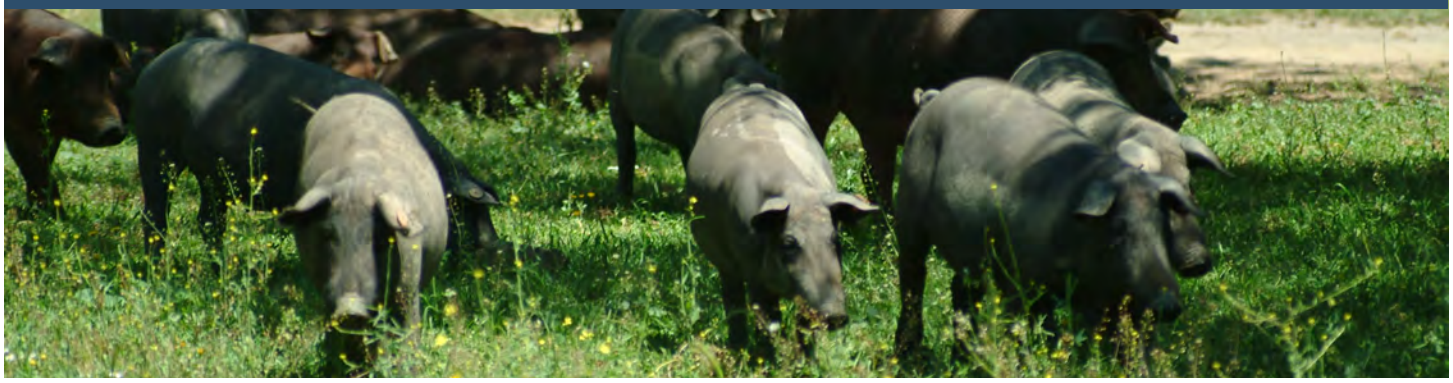

Pastured Pig Production in California Oak Woodlands: Lessons from the Spanish *Dehesa*

By Luke T. Macaulay

Spaniards have been raising pigs on pasture for hundreds of years, and because Spain and California share a Mediterranean climate as well as extensive oak woodlands, Spain's production system is a natural starting point to inform such efforts in California. Pastured pig production in Spain often occurs on oak woodlands referred to as the *dehesa*, which is found in the Southwestern parts of the Iberian Peninsula (Fig. 1). The *dehesa* is managed for a grass or crop understory as part of a multifunctional agricultural unit that often includes grazing by Iberian pigs. Other enterprises might include cattle, cork, charcoal, firewood, grain crops, hunting, mushroom harvesting, and beekeeping.

Although the practices occurring on these lands are ancient, in the last several decades, Spaniards have successfully marketed pig products from the *dehesa* as high-priced gourmet food items. Due to the long evolution of the management and economics of the oak woodlands in Spain, Californians interested in raising pigs on a mixture of pasture and acorns can learn much from the Spanish experience.

Spanish *dehesa*. Photo courtesy of Luke Macaulay

Ecology of Spain and California

Although several species of oaks occur in the *dehesa*, the two primary species are evergreen oaks: the holm oak (*Quercus ilex*) and the cork oak (*Quercus suber).* In California the five most common oak woodland species are the coast live oak (*Quercus agrifolia*), the interior live oak (*Quercus wislizeni*), the blue oak (*Quercus douglasii*), the black oak (*Quercus kelloggii*), and the valley oak (*Quercus lobata*). Tanoaks (*Notholithocarpus*

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Pig foraging in the Spanish *dehesa*. Photo courtesy of Luke Macaulay

densiflorus), a relative of the oak, are commonly found in the northern Coastal Range of California and produce nuts that are similar to acorns which can be utilized by pigs.

Acorn production in both locations is highly variable, and driven by climate and predation by insects (i.e. weevil and moth larvae) and animals (i.e. squirrels, birds, deer) (Koenig et al. 1994, 2013). In California, different oak species react differently to weather conditions (Garrison et al. 2008; Koenig et al. 2013) and have different timings for acorn production. As such, producers may seek to fatten pigs on a property with multiple species of oaks, which reduces the chances of acorn crop failure from 23.5% with one species, to 11.8% with two species, and 8% with 3 species (Koenig & Haydock 1999).

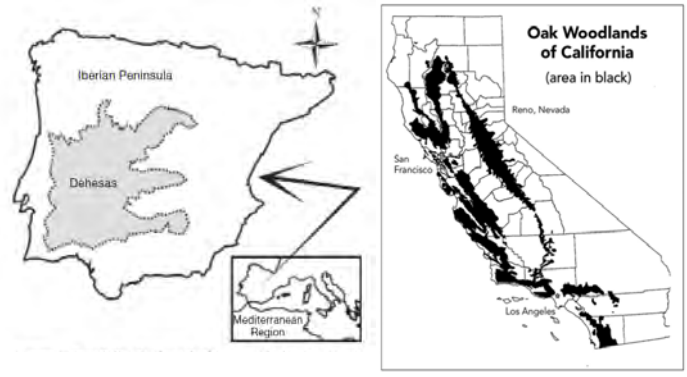


Figure 1: Distribution of oak woodlands in Iberian Peninsula and California. (Allen-Diaz et al. 2007; Gea-Izquierdo et al. 2006)

Ecological Concerns

Pigs can cause ground disturbance through rooting behaviors that can lead to increased potential for erosion and noxious weed invasion. In order to minimize impacts on the land from rooting, many producers place nose rings in the pig snout to prevent deep rooting behaviors. Other ecological concerns include the risk of pigs escaping from enclosures and forming feral pig populations, which have been known to cause environmental consequences in California—see factsheet on proper Feral Pig Management (Macaulay et al. 2013). This can be minimized by providing a daily ration of supplemental feed, which also allows managers to monitor pigs on a daily basis for illness. Heavy use of acorns by pigs would likely lead to reduction in acorns available for wildlife, especially ground-foraging species that eat acorns like deer, mice, and woodrats, which utilize acorns (acorn woodpeckers and scrub-jays take acorns almost exclusively off the tree branch). Additionally, consistent and intensive pig consumption of acorns is likely to impact the regeneration of oak species. Due to these concerns, producers should be cognizant of wildlife use of acorns, noting wood rat dens and areas utilized by deer or other wildlife species. To reduce these ecological impacts producers should consider reserving certain areas of oak woodlands exclusively for wildlife populations, removing pigs from the pasture before all the acorns have been consumed, and using a rest rotation system to reduce the impacts to oak regeneration.

Pig Production

Finishing Styles

The Spanish pork market is famed for a variety of cured hams made from the rear legs of the pig known as *jamón*. The finest and most expensive variety is the *jamón ibérico de bellota*, (literally "Iberian ham of acorn"), which comes from the black Iberian pig breed, and is finished exclusively on a free-range diet primarily composed of acorns and grass. The black Iberian pig breed is not widely available in the U.S., although a couple of individuals have imported purebred stock in recent years (one can be contacted through

acornseekers.com). Many producers in the U.S. choose to use Duroc or Berkshire breeds for acorn fed pork. Crossing with Durocs is common in Spain today, although specific limitations are required for the product to qualify for the *jamón ibérico* designation.

Table 1: Summary estimates for pig production in the Spanish *dehesa*	
Length of time in *montanera* fattening	42-100 days
Average acorn yield/tree	18-31 lbs
Range of acorn yield/tree	1-324 lbs
Acorns consumed per lb of pig gain	22-33 lbs
Pig weight gain per day	1-2 lbs
Weight gain during *montanera*	88-110 lbs
Stocking rate	.16 - .4 pigs/acre
Total weight of acorns consumed per pig during *montanera*	882-1654 lbs
Total weight of grass consumed per pig during *montanera*	185-463 lbs

Production Timing and Weight Gains

There are three traditional phases of Iberian pig production: lactation, growth, and finishing. The finishing stage, known as the *montanera*, is where pigs feed on acorns and pasture. Lactation and weaning can occur between 1-2 months of age, after which animals are castrated and fattened on available feed including pastures, sown fields, stubble, farm byproducts, or grain-based feeds (Lopez-Bote 1998; Benito et al. 2006). The timing for the finishing stage is based upon the maturation of oak acorns, which begins in October and continues to February. In California, acorn fall follows a similar pattern, beginning in October, with most acorns having fallen by December, with the notable exception of coast live oaks, which frequently retain acorns until February and in some cases into March and April (Koenig et al. 2014). Pigs are put onto the oak pasture when they are 12-18 months old and weigh 200-265 pounds. They are fattened on acorns and grass for 42-100 days (Lopez -Bote 1998; Benito et al. 2006). They gain between 1 -2 pounds per day, reaching a finishing weight of 330-350 pounds (Benito et al. 2006). See table 1 for a summary of production estimates.

Vegetation Consumption

Iberian pigs consume approximately 98-99% of their diet in grass and acorns during the *montanera*, with the remainder composed of roots, bushes, berries, soil, and even inorganic rubbish (Rodríguez-Estévez et al. 2009). Pigs spend similar amounts of time grazing on grass and acorns, consuming 15 to 22 lbs. of acorns daily (~4.5 lbs. of that value is the shell which is discarded by the pigs) and 4.4 to 6.6 lbs. of grass daily (Rodríguez-Estévez et al. 2009).

The early phases of grass growth in autumn and winter are important as they include important digestible nutrients, including protein content of 14-17%, which is much higher than the 4-6% found in acorns. Acorns in contrast, provide a much higher energy content (Table 2). Grasses are thought to contribute important fatty acids and *alpha-Tocopherol*, a form of vitamin E, which are believed to contribute to development of flavor characteristics and assist in the curing process (Lopez-Bote 1998). As grasses mature in spring and summer, the concentration of cell walls and compounds such as lignin increase making grass much less digestible for pigs.

Table 2: Chemical composition, metabolic energy, and alpha-Tocopherol of acorn and grass (Garcia-Valverde et al 2007, Lopez Bote 1998, Olea et al., 1990, Rodriguez-Estevez et al., 2009, Ruiz, 1993, Rey et al., 1997).

	Acorns	**Grass**
Dry matter	56-67%	21-27%
Crude protein	4-6%	14-17%
Fat	6-11%	4-6%
Crude fiber	3-6%	20-23%
Ash	2%	7-10%
Metabolic energy (MJ/kg DM)	17.6	10.27
alpha-Tocopherol (mg/kg DM)	20	171

Setting Stocking Rate

Pigs usually consume 10-15 lbs. of acorns for each pound gained in live weight (Benito et al. 2006). In Spain, acorn production on average ranges from 18-31 lbs. per tree (Rodríguez-Estévez et al. 2007, 2009); although, the range of acorn production can be as low as 1.1 lb of acorns/tree and up to 324.1 lb of acorns/tree (Koenig et al. 2013). Considering that Iberian pigs eat approximately 15 to 22 lbs. of acorns per day, the Iberian pig should eat approximately the

acorn production of 0.5 – 1.25 trees/day during *montanera* fattening period. Densities of trees on the Spanish *dehesa* range from 4 to 20 trees/acre, which is a similar range of density of oak woodlands in California, and can support a stocking rate between 0.16 to 0.4 pigs/acre (Benito et al. 2006; Olea & San Miguel-Ayanz 2006).

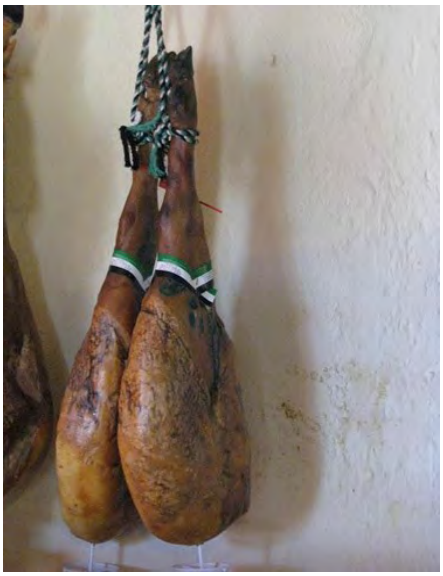
Processing and Marketing

A variety of dry cured meat products are obtained from Iberian pigs: chorizo, loin, shoulders, hams, etc. The most valuable meat product obtained from the Iberian pig is the dry cured ham, which has also the longest processing time (18-36 months) (Lopez-Bote 1998). The Spanish have successfully enhanced the value of acorn-finished pig products by providing protected designation of origin (PDO) status under European Union law for Iberian ham, somewhat similar to the American Viticultural Area (AVA) designation of wine grape appellations in the U.S. Because of the considerable time, effort and land area that is devoted to producing this product, these cured hams are sold at very high prices. In 2013, *jamón ibérico de bellota* sold for about $85/lb for the whole unsliced ham (McLaughlin 2013).

Conclusion

California producers can learn from the Spanish experience in producing high quality pork products fattened on acorns. However, the introduction of pigs into the oak woodland can cause impacts to the ecosystem, and producers should evaluate their pastures for wildlife utilization and adopt appropriate and flexible stocking rates that adapt to seasonal changes in forage productivity of both acorns and grass. Producers should also utilize grazing systems such as rest rotation to allow for oak regeneration and consumption of acorns by wildlife. If particular areas are heavily utilized by wildlife species, producers should consider reserving these areas exclusively for wildlife use. The *jamón* produced from California acorns will develop a flavor unique to the area in which it is raised, providing the opportunity for local food purveyors to market the product in a similar way to wines. When produced in consideration of the needs of the ecosystem, producers can develop a sustainable local meat product with distinctiveness based on the centuries-old methods developed in Spain.

Hogs foraging in a California oak woodland. Photo courtesy of Magruder Ranch.



Jamón ibérico de bellota. Photo courtesy of Luke Macaulay

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Banner photo courtesy of Dr. Jean-Marie Luginbuhl.

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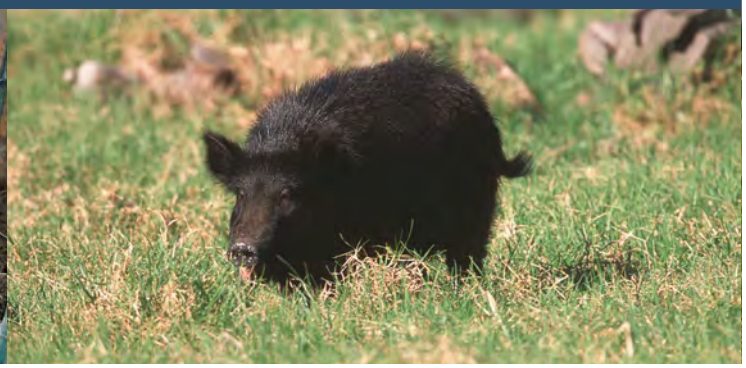

Managing Wild Pigs

By Julie Finzel and Silvana Pietrosemoli

Origin and Appearance: Domestic pigs were introduced to California in 1769 by Spanish missionaries and in the 1920's, Russian wild boar were introduced in Monterey County for sport hunting. The wild pigs found in California today are descendants of the domestic Spanish pigs and the Russian wild boar; as a result, their appearance can vary dramatically. See Table 1 for general physical characteristics of domestic pigs versus wild pigs.

General Characteristics: Wild pigs typically live to be four to eight years old. Full-grown males weigh, on average, 200 pounds, while full grown females weigh about 175 pounds. Wild pigs can grow larger than this, but it is not common. Females are sexually mature at six to nine months of age, though most females do not have their first litter until they are over a year old. The average litter size is five or six young, but litter size and success rates can vary and are highly correlated with annual precipitation.

Biology: Wild pigs live in matrilineal groups called sounders, where up to 80% of females remain with the sounder in which they were reared. Males are nomadic and known to move about within a home range. Wild pigs like to rest and nest in areas with low growing, dense vegetation. Pigs do not have sweat glands, so they wallow in seeps and springs to cool themselves in hot weather. Additionally wild pigs show a dietary preference for a number of riparian plants, so their home range is often dictated by proximity to riparian ecosystems.

Physical Characteristic	Wild Pigs	Domestic Pigs
Hair	Amply covered with coarse, long hair	Sparse, short hair
Ears	Relatively small and erect	Relatively large and floppy
Tail	Straight, covered in hair	Curly, little hair present
Body	Razor-backed, shoulders higher and wider than hindquarters	Wide body, flat back
Tusks	Long and sharp	Relatively short
Head	Longer snout with flat profile	Shorter snout, concave profile
Color	Mostly black, some pied or russet	Usually white, sometimes russet or pink
Young	Dark with horizontal stripes	Same uniform color as parents

Table 1: Physical characteristics of wild vs. domestic pigs

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Wild pig. Photo courtesy of Billy Higginbotham-Texas A&M AgriLife Extension Service

Potential Conflicts between Wild and Domestic Populations

Major disease risk: Pigs, both domestic and wild, have been called a "petri dish" for diseases. They are susceptible to and can carry at least 30 viral and bacteriological diseases and can serve as hosts for up to 37 different types of parasites. As such, wild pigs have the potential to transmit diseases to nearby livestock operations, including domestic pigs, cattle, sheep and goats, as well as local wildlife populations. Pigs can also pose a threat to human health as numerous diseases that pigs can carry and transmit are zoonotic.

Diseases and Transmission: Some examples of diseases carried by pigs include: African swine fever, classical swine fever (Hog Cholera), E. coli, Hepatitis E, Foot and Mouth disease, Plague, Psuedorabies, Salmonella, Swine Influenza Virus, Swine Brucellosis, Toxoplasmosis, Trichinosis, and Tularemia. An outbreak of a disease like pseudorabies in wild pigs could mean serious economic loss for an outdoor pig operation, as well as nearby cattle operations, and a negative impact on domestic pets, and local wildlife. Disease transmission typically occurs from the passing of bodily fluids between animals, though the virulence of the disease causing pathogens varies.

Interbreeding and Crossbreeding: If domestic and wild pigs interact directly there is potential for them to breed, as wild and domestic pigs are from the same species, *Sus scrofa*. In many cases, domestic pigs have been bred for specific production traits that would most likely be diluted by interbreeding with wild pigs. However, a growing number of outdoor pig operations in California have begun to intentionally cross domestic species with Russian Wild Boar in an effort to enhance the animal's ability to utilize forage and thrive in a range or pasture context.

Impact: Wild pigs impact ecosystems by rooting, wallowing, foraging, and hunting. A conservative estimate of wild pig damage is $1.5 billion in economic damage annually across the nation. Their rooting overturns and tills the soil, their wallowing disturbs seeps and springs and they are also known to cause damage to livestock water facilities. Their foraging behavior and diet preferences make them highly competitive with other wildlife species. It is estimated that they consume about 3% of their body weight in food daily; however, they will binge eat with one study reporting 49 toads in the stomach of one harvested pig. Domestic pigs can become feral quickly. It does not benefit the outdoor pig production operation or the natural resources of an area for additional pigs to be added to the wild pig population through the release of domestic pigs.

Rooting damage from wild pigs. Photo courtesy of the Alameda RCD.

Risk of Interaction: Some of the factors that can affect the relative risk of interaction between wild and domestic pigs include the number of wild pigs in the area; proximity to riparian areas; access to desirable feed including hay, grain, scrap food, lawns, etc.; past wild pig issues; current weather conditions (pigs only travel as far as they need to for food and water and a drought year will increase the likelihood of wild pigs invading as they search for

food and water); pig management of neighbors; and, current pig management efforts of the outdoor pig production operation.

One recent study identified the distance between pig paddocks and buildings, closeness to wooded areas, use of electric fences or use of fences lower than 2 ft as risk factors for contact between domestic and wild pigs.

Preventing Interaction between Wild and Domestic Populations

Fencing: The most effective fence to prevent interaction between wild and domestic pig populations would utilize woven or welded wire, strong enough to withstand significant pressure from full grown pigs. A strand of tightly stretched four-barb wire is recommended at ground level or even underground to discourage rooting. It is recommended that the facility maintain a perimeter fence, as well as interior fences for separating pastures. All interior fences should be placed four feet from the perimeter fence to prevent nose-to-nose contact and reduce disease transmission risks between wild and domestic pigs. A single strand of electric wire is not considered sufficient to prevent interaction between wild and domestic pigs, however, it may be sufficient to manipulate the foraging patterns of domestic pigs within a more rigorous perimeter fencing system.

Woven wire fencing between feral and domestic pigs. Photo courtesy of Jared Timmons, Texas A&M AgriLife Extension Service.

Population Management: Managing the local wild pig population and actively reducing numbers is the best way to reduce the likelihood of wild pig to domestic pig disease transmission. Active pig management efforts also discourage wild pigs from visiting and living near the outdoor pig production facility.

Resources

General information:

www.dfg.ca.gov/wildlife/hunting/pig/

http://feralhogs.tamu.edu

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Banner Photo credit from L to R: Wild piglets courtesy of Silvana Pietrosemoli & Feral pig, courtesy of NRCS.

Conservation Practices for Outdoor Hog Systems

By Susan Ellsworth and Sheila Barry

The Natural Resources Conservation Service (NRCS) is an agency of the USDA tasked with promoting conservation on working lands though financial and technical assistance. Farm or ranch conservation planning is one of the many services provided by the NRCS for interested producers. The NRCS' Environmental Quality Incentives Program (EQIP) can then be utilized to help share the cost of specific conservation improvements identified within the conservation plan.

What follows is a description of various practices developed by NRCS that directly support outdoor hog management best practices in California and how they might be utilized. The chart also includes an explanation of how these practices would address potential natural resource concerns. To learn more about the NRCS and its programs, contact your local office by visiting http://offices.sc.egov.usda.gov/locator/app?state=CA.

Resource Conservation Practice	Practice Description	Application in Outdoor Hog System
Compost Facility 	A structure to contain and facilitate the aerobic transition of animal manure and/or plant waste into stable organic matter suitable for use as soil amendment.	Use to manage hog manure and bedding for animals in confined or deep-bedded systems. • Will address potential nutrient loading in soil, runoff or leaching associated with accumulated hog manure
Cover Crop 	Crops including grasses, legumes and forbs planted seasonally to reduce erosion, increase soil organic matter, suppress weeds, manage soil moisture, minimize compaction and support other goals.	Use as part of integrated cropping/hog production system – where cover crop can be grazed after achieving its resource goal. Can also be used between forage crops in pasture systems to build soil or replenish nutrients for enhanced forage production. Cover crops provide the following benefits: • Promote nutrient recycling or redistribution within soil • Reduce compaction in soil after use by hogs • Suppress weeds resulting from disturbed soil • Provide soil cover in rotationally used paddocks after hogs are removed

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Resource Conservation Practice	Practice Description	Application in Outdoor Hog System
Fencing – permanent or temporary 	A constructed barrier to animals or humans. May include permanent fencing such as woven, barbed, smooth and high tensile wire as well as temporary fencing such as electric.	Use to exclude animals from sensitive habitat or riparian areas and/or to create cross fencing to facilitate improved rotation and distribution of animals across a field. Appropriate fencing provides the following benefits: • Facilitates rotational grazing which can help to minimize disturbance, compaction, and nutrient loading associated with permanent systems (animals are not rotated through fields/paddocks) Note: NRCS does not assist with perimeter property fencing.
Field Border/Windbreak 	A strip of permanent vegetation, often trees or shrubs, established at the edge of a field to create a physical barrier with resource benefits both on- and off-site.	Establish at the perimeter of a hog operation to provide the following benefits: • Minimize erosion from wind and water • Create a visual barrier for outdoor hog operation as well as minimizing the impact of odor, noise or dust on neighbors • Intercept dust or other off-site particulate matter from entering the operation • Provide shade, shelter and possibly nesting material and forage for hogs as well as other beneficial organisms • Protect animals and plants from wind damage
Filter Strip 	A strip of herbaceous vegetation used to remove contaminants from overland flow and/or reduce erosion. Filter strips are established adjacent to sensitive areas to minimize impact from contaminants or sediment.	Establish upslope of sensitive habitat and adjacent to heavy use areas such as feeders, waterers, shelters or farrowing areas to provide the following benefits: • Intercept sediments, nutrients, and pathogens in runoff from entering sensitive habitats, waterways or otherwise leaving the production site
Forage & Biomass Planting (for pasture) or Range Planting (for range) 	Establishing herbaceous species suitable for grazing or the production of hay or biomass.	Use to establish forage appropriate for hogs in pasture/range based systems, including hay or other dry forage. Forage planting can assist with the following resource concerns: • Improve soil cover during low forage periods, thereby reducing erosion and improving soil and water quality

Resource Conservation Practice	Practice Description	Application in Outdoor Hog System
Heavy Use Area Protection 	Stabilizing areas heavily used by livestock, such as feeders or waters, by establishing vegetative or permanent cover. May include the use of materials such as gravel or cement.	Establish stable non-eroding surfaces in locations with heavy use such as feeders, waterers, farrowing areas or shelters to provide the following benefits: • Minimize rooting and wallowing, particularly around water facilities or sites for liquid feed such as whey or milk • Minimize compaction and erosion impacts from excessive animal traffic, wallowing, and rooting • Improve livestock health
Mulch 	Applying (or maintain) plant residues, such as wood chips, straw or other materials to the land surface. In some cases this may include inorganic mulches such as plastic.	Apply around high use areas such as feeders, waterers, shelters or farrowing areas to minimize erosion, compaction and nutrient loading.
Nutrient Management 	Analyzing and managing nutrient deposition, including manure, to maintain or improve the condition of soil and vegetation.	Use to assess impacts of hog manure, particularly in high use areas, and consider alternative management and utilization options. This practice may provide the following benefits: • Improve soil, water and air quality • Increase availability of composted hog waste to improve forage quality and quantity.
Riparian Forest Buffer 	An area of woody vegetation such as trees and shrubs located next to or up-slope from riparian areas or waterways. Buffers should generally be combined with filter strips to avoid bare ground between trees or shrubs.	Use to support the health of riparian areas and waterways including the following: • Reduce the amount of sediment, organic material, nutrients or pathogens in surface runoff. • Create shade to lower water temperature, which might also provide shade to adjacent livestock.

Resource Conservation Practice	Practice Description	Application in Outdoor Hog System
Watering Facility 	A permanent or portable structure to provide livestock water.	Use in concert with a rotational grazing plan and/or cross-fencing to help provide the following: • Improve distribution of hogs across a pasture or paddock and more evenly utilize forage • Reduce the number of high impact areas in light of improved distribution Note: facilities must be at least 300' from a creek or spring

Photo credit from top to bottom: Pg. 1 Compost photo courtesy of the ACRCD; Red clover photo courtesy of Rebecca Wilson; Hogs in fence courtesy of Robin Webster; Filter strip courtesy of NRCS; Windbreak photo courtesy of Silvana Pietrosemoli; Forage photo courtesy of Silvana Pietrosemoli; Heavy use photo courtesy of Silvana Pietrosemoli; Mulch Photo courtesy of Hidden Villa; Nutrient management photo courtesy of Long Ranch; Riparian forest buffer courtesy of Root Down Farm; Watering facility photo courtesy of Silvana Pietrosemoli

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Outdoor Hog Production:

Best Practices for Conservation in the San Francisco Bay Area

The following chart contains data compiled from surveys conducted at 10 different outdoor and alternative hog production sites throughout the Greater Bay Area, Northern San Joaquin Valley and Southern Sacramento Valley. Visits were conducted in 2013 and 2014 and used to inform the development of recommendations in this resource guide. Many thanks to the producers who opened their farms and ranches to us.

	Site 1	Site 2	Site 3	Site 4	Site 5
County	Marin/Sonoma	Santa Clara	San Mateo (1)	Stanislaus	Santa Clara
Production System	Farrow to Finish	Farrow to Wean	Wean to Finish	Wean to Feeder	Farrow to Finish
Years raising pigs	20+	7	3	2	6 – depending on current manager
Swine Production Area	30 acres	1/10 acre	200 acres	1/2 acre	10 acres
Breed(s)	Berkshire, Duroc, Old Spot, Glouchester, Yorkshire	Berkshire x	Hampshire, Berkshire, some wild genetics	Duroc, Hampshire, Landrace, Yorkshire	Tamworth, Duroc, Berkshire
HERD					
Boars	5	1	0	1	0
Sows	50	1	0	1	3
Piglets	130	0	0		7
Weaners	150/year	0	0	15/year (none at time of visit)	0
Growers/Finishers	125/125/year	0	50-100/year (none at time of visit)	0	6
Top Hogs	0	0	0	0	6
Gilts	25	0	0	0	0
Weaning Age, Wk	6-8 weeks	n/a	n/a	n/a	8 weeks

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	Site 1	Site 2	Site 3	Site 4	Site 5
FEED					
Commercial concentrated	X	X (.5 coffee can/day/ animal)	X (50-75%)	X (2-2.5 lbs/day/animal)	X (2 coffee cans/day/animal)
Forage	v. minimal	X purchased	X (25%)	X – grown and purchased	X – grown; ¼ of total feed
Bakery waste	X	X	X	X	X
Restaurant waste					
Culled fruit/ vegetables		X	X	X	X
Whey	X		X (only in am or pm)		
Milk, yogurt, cheese	X				X
Brewer's grains	X		X		
Other			X - Wine pressing, black-berries	X – medicated milk	
Market weight, lb	270	30-40	250-300	40	275-300
MANAGEMENT					
Production System	Drylot & Rotational	Drylot	Rotational/Seasonal	Rotational	Rotational & Drylot
Veg Species	Drylot – very little pre-sent; unk for rotational pasture	None present	Eucalyptus woodland; pasture	Irrigated pasture	Cover crop (broad beans, vetch, field peas); wild oat & thistle.
Estimated ground cover, %	10% for drylot; 75% for pasture; 30% oak wdlnds; 60% range	0%	n/a	60%	60%
Estimated height, inches	2" for dry lot	n/a	n/a	2"	2.5'
Length of time in paddock	Continuous for drylot; unk for rotational	Continuous	1-2.5 weeks	Depends	2 weeks
Stocking density, hogs/ac	unk	2/.1 acre OR **20 hogs/ acre**	**30 hogs/acre**	15/.5 acre OR **30 hogs/acre**	6 hogs/.25 acre OR **24 hogs/ acre**
Rest	Unk	None	1-2 years	Yes, depends on above	1 year
Housing/Shelter	Barns, shelters	Shelter	Natural shade	Shelter	Shelter (Quonset hut, tarp)
Bedding	Y			Y	Y – grass
Feeder	Permanent	Permanent	Mobile	Permanent	Mobile
Waterer	Permanent	Permanent	Mobile	Permanent	Mobile - nipple

	Site 1	Site 2	Site 3	Site 4	Site 5
MARKET					
CSA			X		
Farmers Market	X				X – 75%
Restaurants	X				X – a few
Pig share			X		
Local Butcher/Retailer	X				
Marketed as	Milk fed; Moving towards AWA		Forest-raised, GMO free		
Other		Auction		Craigslist, Auction, 4-H	On-site meat sales
RESOURCE MANAGEMENT					
Erosion	Likely	Likely	Unknown	Y	N
Compaction	Y	Y	Unknown	Likely	Possible
Excess nutrients	Likely	Y	Unknown	Likely	Possible
Sediment in waterway	Unknown	Likely	Unknown	N	N
Nutrients in waterway	Likely	Likely	Unknown	N	N
Excessive Wallows	Y	Y	Unknown	Likely	Limited
Excessive soil disturbance	Y	Y	Unknown	Y	Limited
Loss of Veg Cover (25%)	Y	Y	Unknown	Y	N
Impact to upland plant communities	N	N	Unknown	LIkely	N

	Site 6	Site 7	Site 8	Site 9	Site 10
Location	San Joaquin	Mendocino (2)	San Mateo	Yolo	Marin
Production System	Wean to Finish	Farrow to Finish	Wean to Finish	Farrow to Finish	Farrow to Finish
Years raising pigs	10+	5+	4	5+	2
Swine Production Area	15 acres	300 (200 oak wdlnd; 100 pasture)	Approx 5 ac – 10 small paddocks (.5-.75 ac)	60	10
Breed(s)	Duroc, Yorkshire	European Wild, Berkshire, Tamworth	Duroc, Hampshire, Berkshire, Black Wattle	Tamworth, European Wild, Hampshire, Yorkshire	Tamworth, Large Black, Berkshire
HERD					
Boars	0	3-4	0	10	2
Sows	0	0	0	61	9
Piglets	0	0	0	20	27
Weaners	0	0	0	0	0
Growers/Finisher	10400	127 (70 108-240 lbs & 60 37-108)	10	300	28
Top Hogs	0	0	0	0	0
Gilts	0	0	0	0	0
Weaning Age, Wk	n/a		6-8 weeks when purchased	8 weeks	8 weeks
FEED					
Commercial concentrated	X	X	X	X – organic, primary feed	X - limited
Forage	X – grown & purchased (oat/straw)	X – grown	X	X – grown	X - grown
Bakery waste			X		X
Restaurant waste					X
Culled fruit/vegetables				X	X
Whey		X	X	X	X
Milk, yogurt, cheese				X – ice cream	X
Brewer's grains			X		
Other		Mash		Okara, wheat	Barley, Rice bran
Market weight, lb	300		250	200	220

	Site 6	Site 7	Site 8	Site 9	Site 10
MANAGEMENT					
Production System	Deep bedded & Cement	Rotational on pasture & continuous on oak wood-land	Rotational/Seasonal	Rotational & Drylot	Rotational, Drylot & Deep Bedded
Veg Species	Oat hay and wheat straw placed in hoops in bales; cement in flush barn	Rye, oat, foxtail, thistle in oak wdlnd; rye, orchard, harding grass; soft chess, clover, fescue	Eucalyptus, blackberry, poi-son oak	Alfalfa, turnip, mixed grasses in rotational/Dirt in drylot	Annual and Perennial Range (velvet grass etc.)
Estimated ground cover, %	100% in deep bedded due to straw	90% pasture; 75% oak wdlnd	90%, mostly leaf litter, shrubs	75% in pasture; 5% in dry lot	50%
Estimated height, inches	6-12” deep bedding	6” on pasture; 1’ on oak wdlnd	n/a	4” in pasture; n/a in dry lot	2” in pasture; n/a in dry lot
Length of time in paddock	100 days in hoop then 30 days in cement	1 week on pasture; stay in oak wdlnd all fall	1-2 weeks	3-5 mos on pasture; con-tinuous in drylot	1 wk on pasture for weaners; continuous for sows/boars in drylot breeding areas
Stocking density, hogs/ac	200 hogs/.20 acre OR **1000 hogs/acre**	70 pigs/200 acres on oak wdlnd OR **.35/acre**; 20 pigs/.17 acre in pasture OR **120/acre**	10 pigs/.25 acre OR **40/acre**	unknown	varies
Rest	none – old hay removed, replaced with new hay and pigs put back in	Rest oak wdlnd 4-5 months; several weeks +	Wet-season; Sometimes re-seed.	Pasture: 3 mos; limited rest for non-pasture pad-docks	One growing season then reseed and cover with hay
Housing/Shelter	Open-ended hoop barn	Oaks in wdlnd; structure in pasture	Natural shade	Pasture: trees; paddocks: shelters; Farrowing: hoop	Shelters in breeding area
Bedding	Y – deep straw/hay until flush barn then limited straw	Grass		In paddocks, not pastures	Straw
Feeder	Dry/wet self-feeder	Mobile	Mobile	Permanent	Mobile and permanent
Waterer	Dry/wet self-feeder	Mobile trough w. float valve and grate	Mobile	Permanent	Mobile

MANAGEMENT	Site 6	Site 7	Site 8	Site 9	Site 10
MARKET					
CSA			X		X
Farmers Market			X	X	X
Restaurants	X - majority	X		X	X
Pig share					X
Local Butcher/Retailer		X		X	
Other	On-site direct sales to individuals (CDFA slaughter on site)	Marketed from ranch; grocery stores		Retail markets	
Marketed as	Antibiotic free				AWA, Organic
RESOURCE MANAGEMENT					
Erosion	N	In sacrifice area	Y	Y	Y in semi-permanent
Compaction	N	In sacrifice area	N or limited	Y	Likely in semi-permanent
Excess nutrients	Possible	N	N or limited	Likely	Likely in semi-permanent
Sediment in waterway	N	N	Possible	Possible	N
Nutrients in waterway	?	N	Possible	Possible	N
Excessive Wallows	N	N	N	Y	N
Excessive soil disturbance	N	In sacrifice area	N or limited	Y	Y in semi-permanent
Loss of Veg Cover	N/A	In sacrifice area	N, though would be desirable given plant mix	Y, primarily in dry lot areas	Y in semi-permanent
Impact to upland plant communities	N/A	In sacrifice area	Y, limited disturbance to poison oak, blackberry and eucalyptus –desired	Yes, some tree damage	Y in semi-permanent