

Outdoor Hog Production

Best Practices for Resource Conservation in the San Francisco Bay Area



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*



Funding provided by the Natural Resources Conservation Service Conservation Innovation Grant
86-9104-3-179



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).

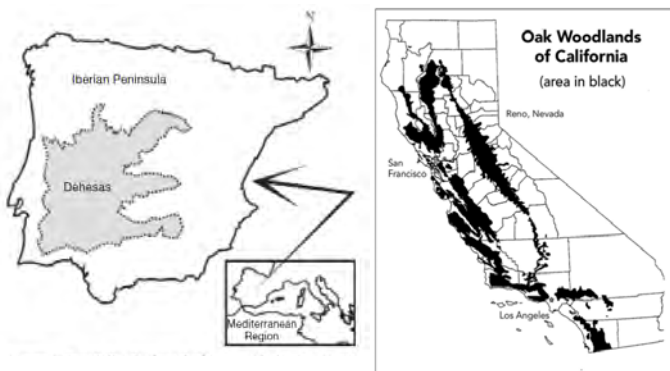


Figure 1: Distribution of oak woodlands in Iberian Peninsula and California. (Allen-Diaz et al. 2007; Gea-Izquierdo et al. 2006)

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 <i>dehesa</i>	
Length of time in <i>montanera</i> 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 <i>montanera</i>	88-110 lbs
Stocking rate	.16 - .4 pigs/acre
Total weight of acorns consumed per pig during <i>montanera</i>	882-1654 lbs
Total weight of grass consumed per pig during <i>montanera</i>	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-Estevéz 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).

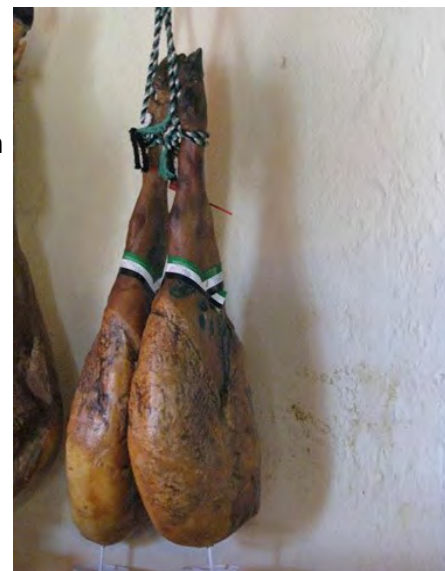
Conclusion

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



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

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.



Jamón ibérico de bellota. Photo courtesy of Luke Macaulay

Literature Cited

- Allen-Diaz, B., R. Standiford, and R. D. Jackson. 2007. Chapter 12: oak woodlands and forests. In: M. G. Barbour, T. Keeler-Wolf, and A. A. Schoenherr [EDS.]. *Terrestrial vegetation of California*. Berkeley, CA, USA: University of California Press. p. 315–330
- Benito, J. et al. 2006. Extensive Iberian pig production grazing systems. Pages 635–645 *Sustainable grassland productivity: Proceedings of the 21st General Meeting of the European Grassland Federation, Badajoz, Spain, 3-6 April, 2006*. Sociedad Española para el Estudio de los Pastos (SEEP). Available from <http://www.seepastos.es/docs%20auxiliares/Actas%20Reuniones%20escaneadas/Proceedings/sessions/Session%204/4.635.pdf> (accessed December 4, 2014).
- Garrison, B. A., W. D. Koenig, and J. M. Knops. 2008. Spatial synchrony and temporal patterns in acorn production of California black oaks.

- Gea-Izquierdo, G., I. Cañellas, and G. Montero. 2006. Acorn production in Spanish holm oak woodlands. *Forest Systems* **15**:339–354.
- Merenlender A., McCreary D., Purcell K. L. (tech coords) Proceedings of 6th symposium on oak woodlands: today's challenges, tomorrow's opportunities. Pacific S. W. Forest & Range Exp. Station General Technical Report PSW–GTR–217. Available from http://www.fs.fed.us/psw/publications/documents/psw_gtr217/psw_gtr217_343.pdf?origin=publication_detail (accessed January 10, 2015).
- Koenig, W. D., M. Díaz, F. Pulido, R. Alejano, E. Beamonte, and J. M. H. Knops. 2013. Acorn Production Patterns. Pages 181–209 in P. Campos, L. Huntsinger, J. L. Oviedo Pro, P. F. Starrs, M. Diaz, R. B. Standiford, and G. Montero, editors. *Mediterranean Oak Woodland Working Landscapes*. Springer Netherlands, Dordrecht. Available from http://link.springer.com/10.1007/978-94-007-6707-2_7 (accessed January 6, 2015).
- Koenig, W. D., and J. Haydock. 1999. Oaks, acorns, and the geographical ecology of acorn woodpeckers. *Journal of Biogeography* **26**:159–165.
- Koenig, W. D., R. L. Mumme, W. J. Carmen, and M. T. Stanback. 1994. Acorn Production by Oaks in Central Coastal California: Variation within and among Years. *Ecology* **75**:99.
- Koenig, W. D., E. L. Walters, I. S. Pearse, W. J. Carmen, and J. M. H. Knops. 2014. Serotiny in California Oaks. *Madroño* **61**:151–158.
- Lopez-Bote, C. J. 1998. Sustained utilization of the Iberian pig breed. *Meat Science* **49**, Supplement 1:S17–S27.
- Macaulay, L. T., P. F. Starrs, and J. Carranza. 2013. Hunting in Managed Oak Woodlands: Contrasts Among Similarities. Pages 311–350 *Mediterranean Oak Woodland Working Landscapes*. Springer.
- McLaughlin, K. 2013, April 6. *Jamón* It Up, Legitimately. *Wall Street Journal*. Available from <http://www.wsj.com/articles/SB10001424127887324557804578377214071453672> (accessed April 3, 2015).
- Olea, L., and A. San Miguel-Ayanz. 2006. The Spanish *dehesa*. A traditional Mediterranean silvopastoral system linking production and nature conservation. *Grassland Science in Europe* **11**:3–13.
- Rodríguez-Estévez, V., A. García, F. Peña, and A. G. Gómez. 2009. Foraging of Iberian fattening pigs grazing natural pasture in the *dehesa*. *Livestock Science* **120**:135–143.
- Rodríguez-Estévez, V., A. R. García Martínez, J. M. Perea Muñoz, C. Mata, and A. G. Gómez-Castro. 2007. Producción de bellota en la *dehesa*: factores influyentes. Available from <http://helvia.uco.es/xmlui/handle/10396/2877> (accessed January 7, 2015).

Banner photo courtesy of Dr. Jean-Marie Luginbuhl.