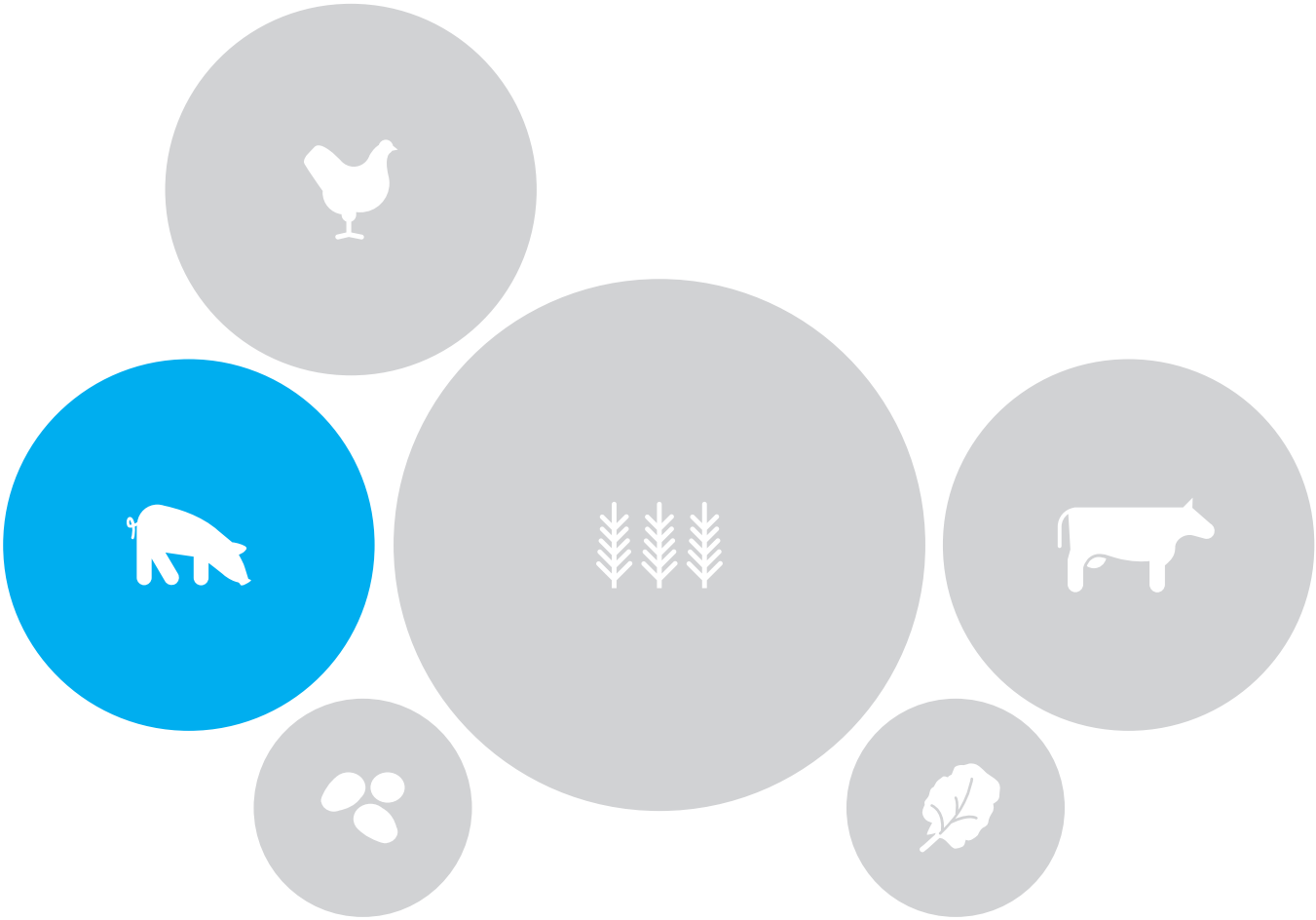

Differentiated Cost of Production in the Northwest:

An Analysis of Six Food Categories

PORK / June 2016

ecotrust

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Project Background

Consumers have demonstrated a willingness to pay a premium for food attributes such as "free-range," "antibiotic-free," "organic," and "local." However, when production systems designed to yield those attributes are authentically implemented on the ground, such methods also tend to bear higher production and processing costs in comparison to conventional production methods. As a result, higher retail prices do not always ensure a sufficient income to the producer, nor constitute a viable supply chain.

Further, institutions such as schools, hospitals, colleges, and jails are noticeably slower as a buyer segment (versus restaurants, retailers, and manufacturers) to respond to customer interest in differentiated products for a variety of reasons, including high price sensitivity. Such buyers are vital players in the quest to get fresh, nutrient-dense food to vulnerable populations, however, so creating frameworks that allow them to access minimally processed, regionally produced food at reasonable prices would serve farmer and eater alike.

Understanding the costs of differentiated production systems in comparison to conventional approaches is vital to identifying opportunities where efficiencies may be gleaned or market value harvested to support a viable regional food ecosystem.

Ecotrust is conducting cost of production analysis in six distinct food product categories, including this one on pork. In each category we define an "ag of the middle" scale and a "differentiated production system" for analysis purposes, meaning: a specific alternative production system (one that spawns product attributes about which consumers care, such as organic, pastured, or grass-fed) will be defined at a particular scale of operation (big enough to participate meaningfully in an institutional supply chain), and be assessed relative to the conventional/commodity/industrial model of production for that category.

While there are certainly many variations of both production systems and scales of operation possible in a thriving regional food system, singling out a specific system allows us to create an economic model that facilitates sensitivity analyses and high level conclusions regarding which regional food sectors could make efficient and effective use of investment.

Note, this project builds on the foundation laid by the Oregon Food Infrastructure Gap Analysis report, released in May 2015. The full report and executive summary can be accessed here: http://www.ecotrust.org/publication/regional-food-infrastructure/, or a quick digital summary of highlights is available at http://food-hub.org/intrepid. The pork chapter from that report is included with this model/report as an addendum.

Introduction and Summary of Findings

The Pacific Northwest is an importer of swine products, suggesting that there may be a market opportunity in expanding regional hog raising to meet local demand for pork. However, to take full advantage of this opportunity would require reversing the dramatic decline in pork production in the region over the last two decades. It would require the rebuilding of a regional pork industry using alternative methods of production relatively new to the region, producing a differentiated product at premium prices to meet demand from regional consumers, predominantly located in metropolitan areas.

To sum up the contents of this paper, rebuilding the Northwest pork industry along these lines would most likely require the following investments:

1. The expansion to medium scale (~1,000 head) of at least 70 small-scale (by national standards) hog raising operations.
2. Development of a widely available, low-cost feed using regionally grown and milled grains and by-products, such as barley.
3. Expansion of the small existing network of locally and regionally focused processing (slaughtering and packing) facilities.
4. The further development of regional brands of fresh and processed pork and pork products (e.g., cured meats and sausages).
5. The ongoing active participation of retailers and other large-scale food buyers in sourcing from regional suppliers.

Thanks go to Paul Klingeman Sr. and Jr., Pure Country Pork in Ephrata, WA, for generous contributions to this research.
All photos by Amanda Oborne.

Some of these activities are already underway: for example, there is a growing group of regional pork processors with strong brands based on unique taste attributes (e.g., Olympia Provisions, Tails & Trotters, Pure Country Pork). Locally and regionally oriented retailers and foodservice operators are actively engaged in sourcing pork from regional suppliers (e.g. PCC Natural Markets, Bon Appetit Management Company).

However, there is little evidence for a current expansion of regionally oriented pork processing facilities, scaling-up of local and regional hog raising operations, or development of a widely distributed, reasonably priced pig feed based on regionally sourced grains or by-products.

While the rebuilding of the Northwest pork industry may be both possible and a worthy goal, it will require a high level of patience and medium- to long-term commitment on the part of investors, entrepreneurs, producers, extension agents, and established businesses at all links of the value chain. There already exist economically viable, locally and regionally oriented hog producers and pork processors, with the potential for expansion; but these individual niche producers do not add up to a fully functioning, locally and regionally oriented, alternative pork value chain. A single market intervention, or investment in a single firm, is highly unlikely to make a significant, systemic difference in reversing the ongoing downward trend in Northwest pork production.

Defining Pork of the Middle

Defining "Agriculture of the Middle" in the context of Pacific Northwest pork has two main components. First, we define the alternative production system that is most appropriate for Pork of the Middle in this region. Second, we define the scale of production that we can classify as Pork of the Middle.

Alternative Production System: Hoop House

This section describes what we mean by "alternative pork" in more depth. Alongside the trend towards market concentration discussed above in Section III.B, alternative or "niche" pork production systems have developed that seek to market pork to consumers concerned with food safety, environmental quality, and specific meat attributes including taste, juiciness, and low fat. Animal welfare, occupational health and safety, and an overall desire for food system reform are some other reasons why consumers may choose to buy pork produced under alternative production systems.

Alternative systems for hog raising and pork production are quite diverse. In general, they range from pasture-based, outdoor raising systems, which are land-intensive and use relatively few, simple shelter structures, to hoop house-based, indoor systems, which use relatively little land and more complex structures for gestation, farrowing, growing, and finishing. Each system has advantages and disadvantages; many producers use hybrid systems in which some pasture-based raising complements indoor, hoop house production.

Further, each system itself is internally diverse: some pastured systems include pigs as part of a multi-crop rotation, while others focus on pigs exclusively. Some hoop house systems rotate pigs through a succession of houses based on different phases of their lifecycle, while others consist of two houses, one for farrowing (sows and piglets) and one for growing pigs to market weight. In general, pasture-based systems tend to be favored by the smallest producers, and hoop houses tend to be used at somewhat larger scales. Though generalizations in this area, as in all areas of alternative agriculture, are difficult to make, we consider the hoop house raising system to hold more potential for "Pork of the Middle" than any other.

Hoop houses have become an increasingly popular form of alternative swine production. A hoop house consists of a series of arched metal frames, secured to ground posts and side walls or concrete walls about 4 to 6 feet above ground level, and covered with a polyethylene tarp that is stretched and secured (Gegner 2005). A standard hoop house size is 30 x 80 feet, or 2400 square feet total. The floor of hoop houses is lined with straw bedding to provide pigs with adequate warmth and an environment for rooting. Wintertime temperatures in hoop houses with a full cohort of pigs in deep-straw bedding have been measured upwards of 80 degrees Fahrenheit (SARE 2003). Straw bedding also allows for a medium in which to compost manure. Hoop houses can hold anywhere from 150-250 growing pigs, but a standard house capacity is 200 pigs, at 12 square feet per pig.

In general, hoop houses cost less per pig to supply shelter than confinement systems (Gegner 2005, SARE 2003); however, raising pigs in hoop houses is more labor- and management-intensive than confinement raising due to the increased needs for managing straw bedding and manure. A 2003 study notes:

Alternative systems relying on deep straw require careful farm management to minimize disease and provide the feed and bedding hogs need at different stages of life. In economist parlance, raising pigs in these systems means more variable costs – feed, bedding, labor – versus fixed costs such as confinement buildings. (SARE 2003)

The role of deep straw bedding in ensuring high animal welfare in hoop house hog raising is highly important. A study released by ATTRA on hoop house production states, “Deep bedding is key to the shelter’s performance. When in doubt, add more bedding” (Gegner 2005). Unlike pastured systems, hoop houses do not take up significant amounts of land, hence the rising cost of land in the Pacific Northwest does not play a major role in determining production costs. For details of the production costs associated with hoop house hog raising, please see Section VII below.

Hoop houses at Pure Country Pork in Ephrata, WA.

Scale of Production

It is difficult to define what the scale appropriate to "Agriculture of the Middle" means in the context of Pacific Northwest pork, because a hog farmer considered "mid-sized" by national standards would be considered very large scale in this region. Table 1 below displays the distribution of hog farm sizes by size class in the U.S. Pacific Northwest in 2012. Two things are noteworthy from this table. First, the overwhelming majority of farms are small: summing the smallest three categories, we find that over 97% carry fewer than 100 head of hogs in inventory. Third, we note that the largest category of farms is over 1,000 head – the "industrial" category of over 5,000 head, as defined by a seminal recent Pew research study (Schaffer, Koonnathamdee and Ray 2012) is not even displayed. Table 2 provides a comparison to the U.S. as a whole, demonstrating the much larger concentration of large farms in other parts of the country. We can conclude that the pork raising industry in the Pacific Northwest is, as of 2012 at least, relatively undeveloped.[1]

Size Class in Head	OR	WA	Total	% of Total
1 - 24	1,014	1,191	2,205	89.1%
25 - 49	85	65	150	6.1%
50 - 99	37	18	55	2.2%
100 - 199	21	10	31	1.3%
200 - 499	12	11	23	0.9%
500 - 999	1	4	5	0.2%
>=1,000	2	4	6	0.2%
TOTAL	1,172	1,303	2,475	

Table 1. Inventory of Hogs by Farm Size Class, U.S. Pacific Northwest, 2012

Size Class in Head	US Total	% of Total
1 - 99	48,700	71.3%
100 - 499	5,000	7.3%
500 - 999	2,300	3.4%
1,000 - 1,999	3,300	4.8%
2,000 - 4,999	5,700	8.3%
>=5,000	3,300	4.8%
TOTAL	68,300	

Table 2. Inventory of Hogs by Farm Size Class, U.S., 2012

1 Pork sales data by farm size in the Pacific Northwest is not sufficiently developed to be displayed here.

Given that the Pacific Northwest lacks a strong sector of mid-sized to large hog farms, to define Agriculture of the Middle in this context requires a rule of thumb based on income. McAdams (2015) defines Agriculture of the Middle producers as those who can support a family of four on at least twice the federal poverty level of $24,250/year; hence, producers who earn $48,500 in net income or more. In Oregon, producers with sales between $250,000 and $499,999 are the first to show an average net income in excess of two times the 2015 federal poverty level, with $80,931 in net income to the operation and $79,848 in net income to the operator (McAdams 2015).

We can use average production and sales statistics to reach a good rule of thumb for Agriculture of the Middle as applied to hog raising. In 2014, the average farrow-to-finish hog producer nationwide received a price of $78.65 per hundredweight of live hog (USDA 2015). In 2014, the average market hog weighed 285 lbs. at slaughter (NASS 2015). Hence, a good rule of thumb for the minimum farm size necessary to reach Agriculture of the Middle is 1,100 market hogs ($78.65 * 2.85 * 1,100 = $246,567). Gross income from 1,100 hogs is slightly less than $250,000, but for a farrow-to-finish producer[2], the difference may be made up by selling sows culled from the farrowing operation (see below for details of farrow-to-finish systems). Yet as Table 1 indicates, an operation with 1,100 hogs would be in the top 0.2% of the size distribution of farms in the Pacific Northwest. Clearly, if Pork of the Middle is to become significant in the Northwest, some scaling-up needs to be done.

Estimates of Regional Consumer Market Size

In this section, we estimate regional consumer market size at the retail and farmgate levels, for pork (conventional plus organic) in the Pacific Northwest. We use the total market size as a benchmark for calculating the market size of differentiated pork at varying premiums. The results of this exercise demonstrate that the size of the consumer market for pork in the Northwest is much greater than the volume of production. These results also demonstrate that reasonable estimates of consumer demand for differentiated pork remain small relative to the size of the total market.

The assumptions for our estimation of the size of the consumer market for organic pork in the Pacific Northwest are as follows. Annual pork consumption in the western United States, which includes the Pacific Northwest, usually tracks lower than national averages. In 2015, national annual average per capita pork consumption was 49.9 lbs. / person / year retail weight (Bentley and Buzby 2015). However, a recent (2005) study of U.S. pork consumption revealed that residents of the western United States consumed only 42 pounds of pork per capita, per year, which was 17.6% less than the national average of that year (51 pounds). Applying this regional difference to the more recent national consumption data, we estimate that Pacific Northwest residents in 2015 consumed 41.2 lbs. of pork / person / year.

2 For the definition of "farrow-to-finish" hog production, please see Section VII, Appendix, p. 10.

Pork prices and consumption vary by cut. The four major cuts of pork for which average retail prices are tracked are ham, chops, bacon, and "All Other" (Hahn 2016). We estimate the pounds of each major cut consumed by Pacific Northwest residents following a recent study that estimated the national percentage breakdown of pork consumption by cut (Davis and Lin 2005). We assume population size of 4.01 million for Oregon, and 7.06 million for Washington, following the most recent population size estimates for those states. We estimate the farmer's share of this market by using the average farmgate share of the retail price, 22.7%, as reported by USDA (Hahn 2016).

Table 3 below presents estimates of regional market size for pork as a whole, the three most important cuts, and for fresh and processed pork as a whole. In the U.S. market as a whole, processed pork represents the majority of pork consumption. Processed pork products include smoked ham, bacon, sausage, lunchmeats, hotdog ingredients, and other similar products. Fresh pork products include fresh ham, chops, steaks, ribs, and offal. The most recent available estimates show that processed pork represents 62% of total market demand for pork, and fresh pork represents 38% of the total market (Davis and Lin 2005). The proportion of consumer spending on fresh vs. processed pork differs slightly from the proportion of consumption of fresh vs. processed pork, because the different types of pork are priced differently.

Table 3 below shows that the total annual retail market size for pork of all types in the Pacific Northwest is about $1.45 billion; the total size of the market at the farm gate is about $330.6 million. The total market size for fresh pork is about $560.4 million at the retail level and $127.2 million at the farm gate; for processed pork it is $896.1 million at the retail level and $203.4 million at the farm gate.

	2015 Annual Regional Per Capita Consumption (lb./person/yr)	2015 USDA Average Retail Price ($/lb)	Retail Market Size, Oregon and Washington ($ million)	Farmers' Share of Retail Market Size ($ million)
Ham3	13.7	$3.08	$467.1	$106.0
Chops	4.4	$3.86	$188.0	$42.7
Bacon	2.6	$5.45	$156.9	$35.6
All Other (Fresh and Processed)	20.5	$2.84	$644.5	$146.3
TOTAL	**41.2**	**-**	**$1,456.5**	**$330.6**
Fresh	15.7		$560.42	$127.2
Processed	25.5		$896.1	$203.4

Table 3. Estimated Retail Market Size, Fresh and Processed Pork, Oregon and Washington, 2015

Existing empirical studies reveal that many consumers state that they are willing to pay positive premiums for differentiated food products, including pork. For instance, a 2002 study at Colorado State (Grannis and Thilmany 2002) measured consumers' stated willingness to pay for

differentiated pork. The results revealed that 29.7% of the consumers surveyed were willing to pay a 10% price premium, and 6.25% of the consumers were willing to pay a 20% price premium, for differentiated pork chops.[3]

Using these figures, we can estimate the potential size of the regional consumer market for differentiated pork by cut at different price premiums. Table 4 below estimates the potential retail market size for pork at 10% and 20% price premiums, using the consumption and price data by cut from Table 3 above. The potential market size for differentiated pork sold at a 20% price premium over the USDA commodity average, across the Pacific Northwest, is approximately $109.24 million, of which approximately $41.51 million is fresh and $67.73 million processed.

Table 4. Estimated Potential Retail Market Size at 10% and 20% Price Premiums, Fresh and Processed Pork, Oregon and Washington

	Annual Regional Per Capita Consumption (lb./person/yr.)	Potential Per Capita Consumption, 10% Premium (lb./person/yr.)	Potential Retail Market Size, 10% Premium (million USD)	Potential Per Capita Consumption, 20% Premium (lb./person/yr.)	Potential Retail Market Size, 20% Premium (million USD)
Ham	13.7	4.1	$152.60	0.9	$35.03
Chops	4.4	1.3	$61.42	0.3	$14.10
Bacon	2.6	0.8	$51.25	0.2	$11.76
All Other (Fresh and Processed)	20.5	6.1	$210.56	1.3	$48.34
TOTAL	41.2	12.2	$475.83	2.6	$109.24
Fresh	15.7	4.6	$180.82	1.0	$41.51
Processed	25.5	7.6	$295.02	1.6	$67.73

In 2015, the average U.S. hog farmer received 22.7% of the retail price on average (USDA, Meat Price Spreads 2015).[4] Assuming this price share transfers to the Pacific Northwest, then from the market size figures given above, the total farmers' gross sales from 10% premium pork would be about $108 million, and the farmers' gross sales from 20% premium pork would be $24.8 million. Table 5 below presents the potential farm sales of differentiated pork by cut from the retail market sizes estimated in Table 4 above.

3 These findings are discussed further below in Section IV.3, Consumer Willingness to Pay.

4 There is no publicly available data on hog farmers' share of retail prices for the Pacific Northwest.

	Potential Gross Farm Sales, 10% Premium	Potential Gross Farm Sales, 20% Premium
Ham	$34.6	$8.0
Chops	$13.9	$3.2
Bacon	$11.6	$2.7
All Other (Fresh and Processed)	$47.8	$11.0
TOTAL	$108.0	$24.8
Fresh	$41.0	$9.4
Processed	$67.0	$15.4

Table 5. Estimated Potential Gross Farm Sales of Hogs at 10% and 20% Price Premiums, Oregon and Washington

The current pattern of hog sales in the Pacific Northwest shows that in order to satisfy regional demand for differentiated pork, substantial industry growth must occur. Table 6 below presents the value of sales of hogs raised in Oregon, Washington, and the regional total between 1997 and 2012. The table shows a fairly dramatic decline in the value of regional hog sales over the 2000s, from $14.4 million in 1997 to only $7.7 million in 2012. Assuming the average farmgate share of the final retail price, the 2012 level of regional hog sales would translate into $34.1 million in retail sales, and satisfy only 2.34% of total consumer demand for pork in the region in 2015. If all of the hogs sold in the region were sold as differentiated pork at a 20% price premium, they would satisfy only 31.2% of the differentiated market. To satisfy the entire regional differentiated market would require an additional 70 mid-sized (~1,100 head) hog producers, selling all of their product at premium prices.

	1997	2002	2007	2012
Oregon	$6,161,000	$3,540,000 (*)	$5,662,000	$3,195,000
Washington	$8,215,000	$6,803,000	$5,921,000	$4,542,000
TOTAL	**$14,376,000**	**$10,343,000**	**$11,583,000**	**$7,737,000**

(*) data may be incomplete due to missing data points

Table 6. Hog Sales by Value ($), Oregon and Washington, 1997-2012

Getting 70 new or existing small producers to scale up to the minimum necessary volume for Pork of the Middle – which is over 1,000 marketed hogs per year - may prove to be beyond the scope of a single investor: a more comprehensive industry-building effort may be called for. The next two sections look at the drivers of supply and demand for the regional pork industry in the Pacific Northwest and identify possible market interventions that could catalyze such an industry-building effort.

Supply Chain Drivers

Market Concentration

Over the last two decades, the pork industry in the Pacific Northwest has declined precipitously. Table 1 below demonstrates the decline in hog production with data from USDA (NASS 2015). Over the period 1997 to 2012, the production of pork in Oregon and Washington fell from $14.3 million to $7.7 million – a decline of 46%.

The most likely culprit for the decline in the Pacific Northwest regional pork industry is rapid market concentration at the national level. Today, fewer firms control a larger share of the U.S. hog market than at any time in our history. This concentration is happening at all links of the chain: raising, slaughtering and packing, and distribution (Hauter 2012). The reasons for the rise of concentrated hog production are many, but the availability of cheap feed due to low commodity prices, weak environmental regulations on manure management, economies of scale in production and processing, mergers and acquisitions at the meatpacker/processor level, and the Justice Department's failures to enforce antitrust laws against meatpackers are all forces moving the industry in this direction. The national trend at the producer level has been dramatic. In 1992, 30% of all U.S. hogs were raised on farms with more than 2,000 animals; by 2007, 95% of hogs were raised on farms this large (Hauter 2012).

In the U.S. hog industry, meatpackers wield a high degree of market power: as of 2012, the top four packers control 66% of all U.S. hogs. The power of the packers has led to the decline of independent hog producers and processors. At the production or raising stage, advance contract purchasing has rapidly replaced negotiated spot market purchasing; whereas in 1993, 87% of all hog sales were negotiated purchases, by 2007, 70% of all hogs were bought on contract, and 20% were owned outright by the packers (Hauter 2012). Contract purchasing reduces the autonomy of hog raising operations and leads to lowered purchase prices. The resulting cost pressures on producers lead them to cut corners in animal welfare, environmental protection, and working conditions (Schaffer, Koonnathamdee and Ray 2012, Hauter 2012). These cost pressures also make it very difficult for small- to mid-scale, alternative pork producers to compete.

The national trends in concentration at the slaughtering and packing levels are evident in the Pacific Northwest. Table 2 below presents data from the U.S. Census Bureau's County Business Patterns dataset for animal slaughtering facilities excluding poultry (NAICS category 311611) in the U.S. Pacific Northwest (Oregon and Washington). From 2000 to 2013 alone, the total number of animal slaughtering facilities declined by 22%. However, the number of large slaughtering facilities (50 or more employees) increased by 50%, while the number of the smallest facilities (less than 5 employees) declined 46%.

Number of Employees	2000	2013	Difference
1 – 4	57	31	-46%
5 – 9	13	19	46%
10 – 19	6	4	-33%
20 – 49	3	3	0%
50 or more	6	9	50%
Total	85	66	-22%

Source: US Census Bureau

Table 8. Number of Animal Slaughtering Facilities (except poultry), U.S. Pacific Northwest (OR and WA)

Market Differentiation

Though the Northwest pork industry has declined overall, one market segment appears to be emerging: sales of organic certified hogs. This nascent regional trend, suggested by the (scanty) data in Table 2 below, mirrors the growth in organic certified hog production nationwide, reflecting increased consumer concerns for health, food safety, environmental protection, and animal welfare. If organic sales are a "leading indicator" of market differentiation, then the hog market, regionally as well as nationally, may be poised for a revival of independent production through differentiated raising practices. The ongoing development of alternative pork production systems, described later in this paper, offer further evidence that differentiation is occurring in the locally and regionally oriented segments of the market.

Sales in Head		
	2011	2014
OREGON	-	-
WASHINGTON	-	652
US TOTAL	12,662	30,944

Sales in $		
	2011	2014
OREGON	$-	$-
WASHINGTON	$-	$208,352.00
US TOTAL	$4,504,215.00	$9,829,940.00

Table 9. Organic Hog Production, Oregon and Washington

Production Costs

Production costs are a major driver of the supply of pork. This section identifies three important drivers of the cost of production for Northwest pork: the supply of available, low-cost feed; the cost of farm labor; and the availability of low-cost processing accessible to small- to medium-sized producers.

1. Feed Supply

The Pacific Northwest appears to be at a disadvantage in pork production due to its long distance from the markets for feed grains conventionally used in hog raising: corn and soybeans. Are there alternative feed blends that can use the small grains – wheat, barley, and oats – that grow well in the Pacific Northwest?

A recent study from Iowa State suggests that small grains including wheat, barley, and oats, can in fact provide useful feedstuffs in swine raising operations (Sullivan, et al. 2005). Compared to corn, small grains are high in crude protein, lysine, and digestible phosphorus, which are all important nutrients for growing pigs. The higher lysine content in small grains entails a lower requirement of soybean meal in the pig's diet. The drawbacks of small grains are that they contain less metabolizable energy than corn, which has affected feed conversion efficiency in some instances. Straw from small grains can also be used as bedding in hoop houses.

The primary drawback of small grains is that they tend to be more expensive than corn, even in the Pacific Northwest where locally produced corn is scarce. The most important small grain for pig feed is wheat; the most important conventional feed grain is corn. Table 6 below reports average per-bushel prices received for corn, wheat, barley, and oats in the State of Washington over the decade 2005-2014 (NASS 2015). During this decade, the price of corn never exceeded the price of wheat. Corn prices tended to exceed barley and oats prices. However, the energy density of barley and oats are lower than that of corn, thus the feed requirements are higher, offsetting the lower unit costs at least partially. The lower soybean meal requirement from a small-grain-based diet provides another source of cost savings, given the high price of soybeans (US average $22.60/bushel in 2014). Prices in Oregon follow similar trends to those in Washington (not shown).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Corn	$2.81	$3.72	$4.50	$4.56	$4.59	$6.08	$6.22	$6.69	$5.29	$5.10
Wheat (All)	$3.32	$4.49	$7.58	$6.26	$4.85	$6.24	$6.78	$8.07	$6.95	$6.55
Wheat (Spring)	$3.70	$4.74	$7.89	$7.10	$5.74	$7.15	$8.08	$8.51	$7.34	$7.22
Wheat (Winter)	$3.21	$4.42	$7.51	$6.08	$4.58	$6.03	$6.40	$7.96	$6.87	$6.42
Barley	$2.16	$2.88	$5.08	$3.49	$2.90	$3.66	$4.85	$5.53	$4.12	$3.54
Oats	$1.65	$1.90	$2.85	$3.08	$2.80	$1.90	$3.15	$3.50	$4.00	$2.55

Table 10. Prices of Small Grains and Corn ($/bu), 2005-2014, WA

Despite higher per-bushel prices, a locally milled feed blend using small grains may be price-competitive with blends using conventional grains. Table 5 below presents the composition of a series of sample diets for finishing pigs (150 – 250 lbs.) developed by a recent Iowa State study (Sullivan, et al. 2005). Six sample diets using three small grains – wheat, barley, and oats - are presented; each grain is assigned to a diet with High or Low levels of that grain. Table 5 presents the author's calculation of unit costs of these diets using 2014 conventional prices per bushel received in Washington State for each of the component grains, using U.S. average prices for soybeans ($22.60/bushel), for which Washington data is not available. Additives include dicalcium phosphate, limestone, salt, a mineral premix, and a fat soluble vitamin mix. The prices of additives are quoted from online retail sources and may be overstated if the hog producer is buying wholesale.

The results suggest that a regional feed based on barley or oats may be competitive with a conventional feed. The feed blend high in barley is the most price competitive ($0.12 / lb, highlighted in yellow) and the blend high in wheat is second-most competitive ($0.14 / lb). The wheat blend is price-competitive because the reduced need for feed additives offsets the higher cost per pound of the grain.

Though not conclusive, this simple thought experiment, based on an academic study of pig diets, indicates that a regionally grown and milled feed blend may be able to provide aspiring Northwest producers with a price-competitive input. Additional research in this area could include estimating the cost of producing a local or regional feed based on spent grains from breweries or dairies, or agricultural waste left in the field after harvesting small grains.

Table 11. Composition and Cost of Sample Feed Blends, Grains Only, WA (2014 prices)

	Lbs. of grain / blend					
Grain (lbs.)	Wheat (High)	Wheat (Low)	Barley (High)	Barley (Low)	Oats (High)	Oats (Low)
Wheat (Winter)	1,769	500	-	-	-	-
Barley	-	-	1,786	500	-	-
Oats	-	-	-	-	800	200
Corn	-	1,215	-	1,223	934	1,508
Soybean	195	244	175	235	225	250
Additives	36	41	39	42	41	42
Total	2,000	2,000	2,000	2,000	2,000	2,000
Total Cost (2014 WA)	$275.68	$298.59	$231.14	$285.29	$279.68	$300.20
Total Cost / Lb (2014 WA)	$0.14	$0.15	$ 0.12	$0.14	$0.14	$0.15
Ranking	2	5	1	4	3	6

2. Labor Costs

Labor costs are a major issue for Pacific Northwest agriculture in general. In particular, legal immigration channels require burdensome visa (H-2A) paperwork, high transportation costs, and high costs of temporary worker housing on top of wages. Labor costs are not the largest component of operating costs for alternative pork; however, the combination of high upfront costs of search, immigration, and housing, and the seasonal nature of much of the work ensures that they remain a burden to many farmers. All Northwest alternative pork producers interviewed for this study cited cost of labor as a key barrier to expansion.

3. Processing Capacity

Processing capacity is a key constraint on alternative pork production systems. Currently, small- to mid-scale alternative pork producers lack sufficient processing infrastructure to scale up production to meet existing niche market demand, leading alternative retailers to source a portion of their pork through conventional channels. Like all processing infrastructure, adequate throughput and utilization requires a critical mass of producers to be viable. Additional research should be done on current capacity to understand constraints and coordinate opportunities.

Drivers of Demand for Regional Pork

Introduction

Table 2 below presents estimates for the dollar value of statewide wholesale market demand for fresh and processed pork by market channel, collected from a recent report released by Ecotrust (Ecotrust 2015). In 2012, the entire State of Oregon produced and sold only $3.2 million worth of pork (NASS 2015), while consuming $170.6 million worth of pork. Even if all pork produced and sold in Oregon was consumed in Oregon (unlikely), the State of Oregon still "imported" at least $167.4 million worth of pork from other states in 2012: 98% of pork consumed in Oregon was not produced in Oregon. Though we do not have similar data for the State of Washington, the story is likely similar: Washington pork producers sold $4.5 million worth of pork in 2012 (NASS 2015), in a state with a population significantly larger than Oregon's - 7.06 million vs. 3.97 million (U.S. Census Bureau 2015).

Market Channel	Fresh	Processed	TOTAL
Retail	$50M	$54M	$108M
Foodservice	$21M	$45.6M	$66.6M
TOTAL	**$71M**	**$99.6M**	**$170.6M**

Table 12. Total Wholesale Demand by Market Channel, State of Oregon (2012)

Clearly there exists the potential for the Pacific Northwest to meet a larger proportion of its demand for pork than it currently does. The difficulty in meeting this market opportunity lies in the fact that the Pacific Northwest lacks a large-scale pork industry. As Section III.A above suggests, there may be good reasons for the region's lack of participation in the current trend toward market concentration: large-scale, industrial hog raising operations have created nuisances, environmental hazards, and conflicts between producers and communities (Schaffer, Koonnathamdee and Ray 2012, Platt 2006). Developing a regional pork industry sufficient to meet market demand will require that producers adopt ecologically responsible, as well as economical, methods of hog raising that are also price-competitive in regional markets. Since this possibility is remote, the development of branded, differentiated pork products at price premiums that consumers are willing to pay seems to be a more viable strategy. The next two sections cover branding and consumers' willingness to pay.

Branded Products

Developing local and regional brands can be one way of stimulating demand for differentiated pork products. Currently, there is no systematic dataset indicating the magnitude of the trend in market differentiation in Pacific Northwest pork. However, there exists a stable, and possibly growing, group of branded pork producers / processors in the Pacific Northwest, offering differentiated products at premium prices. Pure Country Pork is the most significant alternative supplier in Washington State, and offers its products under its own label as well as via popular brands such as Good Food Award winner Tails & Trotters.

As our research on production costs in Section VII of this paper clearly indicates, the prospects of alternative pork becoming price-competitive with commodity pork are remote. The possibilities of branded, differentiated products appear to be more promising. The next section addresses the question of what price premiums the consumer market might bear for differentiated products.

Consumer Willingness to Pay

Existing empirical studies reveal that many consumers state that they are willing to pay positive premiums for differentiated food products, including pork. For instance, a 2002 study at Colorado State (Grannis and Thilmany 2002) measured consumers' stated willingness to pay for differentiated pork. The results revealed that a significant number of consumers state willingness to pay price premiums for differentiated pork products. For instance, of the 1,400 participants, 406 consumers (29.7%) were willing to pay a 10% price premium for "naturally raised" pork chops and eighty-four consumers (6.25%) were willing to pay a 20% price premium. The study defined "naturally raised" as comprising two attributes: no confinement raising, and no antibiotics used.

These estimates should be taken as rough, ballpark figures only; the consumer willingness to pay data presented above from the Colorado State study (Grannis and Thilmany 2002) are subject to limitations. In particular, consumers' stated willingness to pay premiums for differentiated products often does not match their actual economic behavior. Further, estimates of consumer willingness-to-pay vary over time and space; there is no guarantee that Colorado consumers will behave similarly to Pacific Northwest consumers. In short, comprehensive data on the size of the market for differentiated food products at various price points is lacking. Additional research is needed in this area.

Newborn piglets (left) and six-month olds (right).

Conclusion and Recommendations

This study has provided a broad overview of the principal drivers of supply and demand for alternative pork production in the Pacific Northwest, and offered a primer on the most important alternative pork production system, the hoop house. The principal conclusion of this research is that while individual hog raising and pork processing businesses in this region may be profitable, the industry as a whole is in decline and will require a significant effort to rebuild.

The following are four examples of the types of potentially profitable pork-related businesses that may form part of an alternative supply chain for pork in the Pacific Northwest.

- A regional feed supplier using small grains, rotation crops, farm by-products, or waste from breweries, distilleries, or dairies to produce a reasonably priced feed (<$0.15/lb)
- A number of highly skilled small-scale hog raising operations seeking to scale up
- A year-round slaughter/processing plant willing and able to work with multiple small hog farms, and seeking to expand capacity
- A final processor with strong branding capacity, committed to sourcing from local suppliers

To play a catalytic role in rebuilding the Pacific Northwest pork industry to focus on alternative, differentiated production and processing, an impact investor should seek to deploy capital in all four of these types of businesses.

Appendix: A Model of Farrow-to-Finish Hoop House Production Costs

This appendix presents the Excel-based data model we originally developed to predict the costs and returns to alternative pork production. While we believe that the market-oriented information presented above in the main body of this document offers clearer guidance to investors than the detailed production cost data given below, intellectually curious investors may find the information presented in this model useful. If so, keep in mind that these data are to be taken not as precise estimates for predicting production costs, but rather as guidance for understanding the basic economics of alternative hog production systems.

Production System

The production system we have chosen to model in this study is a year-round, farrow-to-finish, hoop house production system. Farrowing refers to the bearing and nursing of a litter of piglets by a sow (mature female pig). The farrow-to-finish system refers to the raising of pigs from the farrowing stage until they are full-grown weight and ready to be slaughtered. It is distinct from two other major types of pig raising systems: farrow-to-feeder, which raises pigs from the farrowing stage until they are at "feeder" weight, around 60 pounds; and feeder-to-finish, which purchases pigs at feeder weight and raises them until they are at slaughter weight.

A typical farrow-to-finish pig raising operation consists of a number of sows (mature female pigs), each of which are bred for 2 or 3 years before culling (selling to be slaughtered). Each year, the sow gives birth to 1-2 litters of 7-10 piglets per year. A well-managed pig raising operation with healthy sows will usually gain about 2 litters per sow, per year, and will experience a 5-10% mortality rate among piglets. Hence, each sow will give birth to 14-20 piglets per year, of which 12-19 will survive to maturity.

The farrow-to-finish system has several advantages for an independent hog producer. First, the system does not require the purchase of large numbers of piglets, but rather a smaller number of sows. Second, the producer controls the entire lifecycle of the pig from its birth and weaning to its growth to slaughter at about 6-7 months (24-30 weeks) of age, allowing for ecologically responsible, economically efficient management practices to be implemented throughout the entire lifecycle. Third, farrow-to-finish systems are compatible with multi-crop farms; a small number of farrowing sows can fit into a crop rotation to provide consistent revenue throughout the year.

In general, farrow-to-finish production systems enjoy lower unit costs, and are thus more profitable, than other types of pig raising systems (Schaffer, Koonnathamdee and Ray 2012). A 2001 study corroborates: "Of the (production) systems, farrow-to-finish has the greatest long-run market potential and flexibility" (Kephart, et al. 2001). However, farrow-to-finish operations are also more capital- and labor-intensive than

other types of pig raising, since the entire lifecycle of the animal must be managed.

In the data model that follows, we assume a production system consisting of 100 sows, each of which bears two litters per year for two years, averaging 8 pigs per litter, at a 7.5% mortality rate. This litter size reflects the average litter size reported in Oregon over the years 2000-2015 (Washington data after 2010 is not available). The average in Washington over the years 2000-2009 is 8.5, which could serve as an alternative assumption.

For a farrow-to-finish production, gilts must be purchased each year. A gilt is a female pig who has not yet borne a litter (farrowed). We assume a system in which each gilt (sow) breeds for two years before being culled (sold). Each year, half of the sows are culled, and half are retained. Hence, our production system requires purchase of 50 gilts per year, and sale of 50 cull sows per year. The purchase price per gilt is assumed to be $210, reflecting the assumptions of a recent study at Iowa State (Kliebenstein, et al. 2004), adjusted to 2015 USD by the Producer Price Index for slaughter hogs and rounded up slightly (from $207). The sale price per cull sow is assumed to be $250, reflecting a price per hundredweight of $50 and a cull weight of 500 lbs. (USDA 2015). Given these assumptions about scale, litter size, and mortality rate, marketed output will be 1,480 hogs per year.

We assume the sows are artificially inseminated, hence there is no need for a boar; instead, boar genetics (semen) must be purchased for each litter and each sow. Artificial insemination is a common practice in the hog industry, due to the land and labor costs associated with boar management, the availability of high-quality boar genetics, and the reduced risk of diseases that boars may transmit (e.g. African Swine Fever, etc.).

The system we are describing is based on year-round, not seasonal, production. We choose to describe a year-round system because it ensures a more consistent flow of pork, which satisfies year-round market demand. However, year-round systems are more expensive per pig, and per cut of meat, than seasonal systems (Kliebenstein, et al. 2004). The factors that make year-round production more expensive are increased labor due to more intensive management; increased piglet mortality and disease; increased feed requirement (less efficient feed conversion); and increased need for hoop house bedding and climate control.

Production Costs

The conventional way to display costs of pork production is in dollars per hundredweight (hundred pounds) of live hog. However, cost units vary. Some authors (Stender, et al. 2009) display costs in terms of dollars per hundredweight of pork, and others display costs in terms of dollars per head, or per hog (Larson, Kleibenstein and Honeyman 2003). However, “dollars per live hundredweight” is the most common cost measure. We assume that the average market hog weighs 250 lbs. at slaughter. This rule of thumb reflects average market weights over 2000-2015 for Oregon, and 2000-2005 in Washington (NASS 2015), and

is a commonly accepted rule of thumb for market weight hogs.

The major cost categories for farrow-to-finish pork production are as follows in order of importance: feed costs, other variable costs, fixed costs, and labor costs.

1. Feed Costs

As noted above, the most important input to pig raising is feed: in farrow-to-finish production systems, feed may comprise up to 75% of total production costs (Kephart, et al. 2001). Feed absorbs a larger proportion of production costs in farrow-to-finish systems than in the other pig raising systems. For example, feed comprises an average of 65% of the cost of feeder-to-finish systems (Schaffer, Koonnathamdee and Ray 2012).

Feed cost is made up of two components: price per pound and conversion efficiency. Feed conversion efficiency is usually expressed as the pounds of feed necessary for each pound of live weight gain. It can range from 3 to 5 pounds of feed for every pound of live weight gain. Considering that each pig grows to 250-300 lbs. over less than 7 months, feed conversion efficiency matters tremendously for hog raisers' production costs. Cold climates, wasteful feeding systems, poorly balanced nutrition, and unhealthy pigs can all reduce feed efficiency. Efficient feed conversion is gained through feeding systems optimized for low wastage and nutritional balance, temperate or warm climates, and healthy pigs. In this model, we assume a feed conversion rate of 4 lbs. feed for each pound of weight gain, which follows a recent study of year-round, farrow-to-finish hoop house production (Kliebenstein, et al. 2004).

The costs of feed can vary considerably based on type and region. The enterprise budgets produced at Iowa State University cite feed costs for three types of feed that matches three stages in the lifecycle of the pig: nursery feed for piglets from weaning up to feeder weight of about 70 lbs., grower feed for feeder pigs up to about 150 lbs., and finisher feed for pigs up to market weight of 240-270 lbs. (Becker, Honeyman and Kliebenstein 1999, Larson, Kleibenstein and Honeyman 2003). Using the Producer Price Index for animal feeds to convert these estimates into 2015 USD, the costs per pound are $0.25, $0.21, and $0.18, respectively. Our simplified model assumes a fixed $0.20 / lb cost for feed. However, organic or specialty feeds may be more expensive: an organic, pastured pork producer we interviewed (Sturtevant 2015) cited $0.26 / lb.

2. Other Variable Costs

Most of the variable costs aside from labor are adapted from the 2004 Iowa State study (Kliebenstein, et al. 2004), with the exception of interest on working capital and boar genetics (semen) for breeding. The costs include breeding sows (gilts), boar genetics (Dhuyvetter, et al. 2014), straw bedding, veterinary and medicine costs, fuel and other utilities, repairs, record keeping, and interest on working capital (Ben-

son and Green 2011). All costs are corrected from 2003 to 2015 USF using the PPI. Interest on working capital is assumed to be 5.5%, evaluated on half of the cost of working capital (all variable costs, including labor).

3. Fixed Costs

We assume that two sets of structures are necessary for the farrow-to-finish operation: (1) farrowing barns, in which sows will gestate, give birth, and farrow piglets to weaning; and (2) finishing houses, in which weaned pigs will feed and grow to finished market weight. Some operations include intermediate houses in which weaned pigs are grown to feeder weight (~70 lbs.); some include a fourth type of house in which feeder pigs are grown from 70 to 150 lbs. For the sake of simplicity, we assume that there are only two types of houses.

We assume that both structures are hoop houses and cost the exact same amount to build and maintain. A 2004 study at Iowa State University (Kliebenstein, et al. 2004) cited $13,000 as the cost to build a hoop house structure; corrected for inflation to 2015 USD using the PPI, we assume $15,350 / house. Each farrowing barn holds 25 sows, each with a litter of piglets, and each finishing house holds 200 market weight hogs at one time, or 400 hogs per year. Hence, four farrowing barns and four finishing houses are needed at the scale of production we are considering.

We assume that miscellaneous equipment for both types of structures, including feeders, waterers, pipes, electric lights and indoor climate control, as well as manure storage and treatment facilities, costs $10,000. Since the land requirement is minimal, we assume the farm has no tractor, but rather an ATV with a trailer to haul equipment and feed. Transportation of finished hogs to market is contracted out and is thus part of variable costs. We assume the ATV and trailer together cost $7,500, and the farm only needs one unit of each.

4. Labor Costs

Labor costs can be measured in one of two ways: hours per pig from birth to slaughter, or hours per litter, including care/supervision/feeding for the farrowing sow. Following a recent study of organic pork production at Iowa State University (Kliebenstein, et al. 2004), we assume each litter (including sow) requires 13 hours of labor to raise, reflecting the authors' reported average for year-round farrow-to-finish, hoop house production. If each litter requires 13 hours of labor, then the total labor requirement per year is equal to the number of sows, multiplied by the number of litters per sow per year, multiplied by 13. The total number of hours is thus 13 * 100 * 2 = 2,600 hours per year, or 1.25 FTE assuming a 2,080-hour work-year. Labor is assumed to be paid $15 / hour.

5. Summary of Production Cost Assumptions

A summary of the assumptions behind our study is given below in Table 11. We assume a purchase price per live hundredweight of $125.00, and a purchase price for cull sows of $250. The purchase price assumption is arbitrary, but allows the model to clear a small profit margin of about 3% (see Table 12 below).

Model Inputs	
Number of Sows (Gilts) Purchased / Year	100
Cost / Sow (Gilt)	$210
Number of Litters / Sow / Year	2
Average Litter Size	8.0
Piglet Mortality Rate	7.5%
Feed-to-Weight Conversion Rate	4
Feed Cost / Lb	$0.20
Live Weight / Finished Hog	250
Person-Hours of Labor / Sow + Litter	13
Hoop House Unit Cost	$15,350
Farrowing Barn Unit Cost	$15,350
Equipment Unit Cost	$10,000
Vehicle Unit Cost	$7,500
Hired Labor? (Y/N)	Y
Hired Labor Wage	$15
Purchase Price / Cwt Live	$125

Table 13. Data Model Assumptions

Model Results

1. Hoop House Production

Model results are given below in Table 12. Notably, feed absorbs a substantial majority of total farm costs (72.6%). This finding is consistent with other studies of farrow-to-finish production systems, which tend to have the highest feed costs as a percentage of total costs (Kephart, et al. 2001). For another example, in the case of outdoor (pastured) farrow-to-finish systems, feed can absorb as much as 85% of total costs (Becker, Honeyman and Kliebenstein 1999). The second most important cost category is Other Variable costs, which absorb 10% of total costs, or $12.37 / hundredweight of live hog. Fixed costs and labor costs are about equal to other variable costs in importance (8.8% and 8.5% respectively). The break-even cost of production is $123.72 / cwt live hog. This estimate is comparable to the one generated by a 1999 study at Iowa State (Becker, Honeyman and Kliebenstein 1999), in which the authors found a break-even price of $133.41 / cwt ($55 / cwt in 1999 USD, adjusted upwards to 2014 USD by the PPI).

At the $125 / cwt price point, the net income of the farm is $17,253 / year. Total returns, including sales of cull sows, are $475,000; the profit margin is 3.6%. The cost of feed is the ultimate arbiter of returns at any price point. For each cent per pound that the feed price falls, returns increase by $16,625; break-even price falls by $4.49 / cwt. If the feed price were to fall to $0.10, the break-even cost of production would be $78.78 / cwt – almost able to break even at the U.S. average market price of $78.65 / cwt.

Table 14. Receipts, Costs, and Returns to Hoop House, Farrow-to-Finish Pork Production

Model Outputs: 100 Sows, $0.20 / lb. Feed					
Returns By Category	Per Litter	Per Finished Hog	Per Cwt Live Hog	Total Returns and Costs	% Total Cost / cwt Weight Gain
Gross Receipts	$2,312.50	$312.50	$125.00	**$475,000**	--
Feed Costs	$1,662.50	$224.66	$89.86	**$332,500**	**72.6%**
Labor Costs	$195.00	$26.35	$10.54	**$39,000**	**8.5%**
Other Variable Costs	$228.83	$30.92	$12.37	**$45,765**	**10.0%**
Fixed Costs	$202.41	$27.35	$10.94	**$40,481**	**8.8%**
Total Cost	$2,288.73	$309.29	$123.72	**$457,747**	--
Total Annual Returns	$23.77	$3.21	$1.28	**$17,253**	--

2. Comparison to National Averages

Table 13 below provides corresponding 2014 annual national averages for farrow-to-finish pork production from the USDA Economic Research Service (USDA 2015). The conventional model presented here assumes 5,000 hogs, sold at the national average market weight of 285 lbs. Sows are not considered in this model budget; all costs are expressed in dollars per hundredweight of live hog. The breakeven cost of production is $58.59 per live hundredweight, less than half the cost of production of the hoop house model described above. Feed costs, in particular, are much lower in the conventional model ($34.07 vs $89.86); differences in feed costs account for 86% of the difference in total costs between the two models.

The average market price per live hundredweight in 2014 was $78.65, which is 37% lower than the barely breaking-even $125 / cwt in our hoop house model above. The annual net returns are over fifteen times higher ($285,855 vs. $17,253). Net returns per hundredweight for the conventional model are $20.06, compared to $1.28 for the hoop house model. Profit margins are over seven times higher (25.5% vs. 3.6%).

Model Outputs: 5,000 Hogs			
Returns By Category	Per Cwt Live Hog	Total Returns and Costs	% Total Cost / cwt Weight Gain
Gross Receipts	$78.65	$1,120,763	--
Feed Costs	$34.07	$485,498	58.1%
Labor Costs	$7.72	$110,010	13.2%
Other Variable Costs	$5.97	$85,073	10.2%
Fixed Costs	$10.83	$154,328	18.5%
Total Cost	$58.59	$834,908	--
Total Annual Returns	$20.06	$285,855	--

Table 15. Receipts, Costs, and Returns to Conventional, Farrow-to-Finish Pork Production (U.S. Average)

Similar returns to alternative pork production can be earned, however, if feed costs are brought down. Consider the hoop house case presented above in Table 10, with two adjustments. First, suppose the pigs are fed a barley-based diet such as the lowest-cost feed blend presented in Table 5, which they purchase for $0.12 / lb. Second, suppose that the producers receive $94.38 / cwt, which is a 20% premium over the U.S. average purchase price of $78.65 reported in Table 11, reflecting the higher premium that consumers have stated willingness to pay from the study reviewed in Section IV.3 above.

The results of this lower-cost, premium price hoop house model are displayed in Table 12 below. The unit costs are $87.77 / cwt live hog. The producer earns $6.61 / cwt, which is still significantly lower than the $20.06 / cwt earned by the conventional producer described above. Feed costs are $53.92 / cwt, which are still 58% higher than the conventional feed costs quoted above. Total annual (net) returns are $36,959. Feed comprises 61.4% of total costs. Gross receipts are $361,706.

Model Outputs					
Returns By Category	Per Litter	Per Finished Hog	Per Cwt Live Hog	Total Returns and Costs	% Total Cost / cwt Weight Gain
Gross Receipts	$1,746.03	$235.95	$94.38	$361,706	--
Feed Costs	$997.50	$134.80	$53.92	$199,500	61.4%
Labor Costs	$195.00	$26.35	$10.54	$39,000	12.0%
Other Variable Costs	$228.83	$30.92	$12.37	$45,765	14.1%
Fixed Costs	$202.41	$27.35	$10.94	$40,481	12.5%
Total Cost	$1,623.73	$219.42	$87.77	$324,747	--
Total Annual Returns	$122.30	$16.53	$6.61	$36,959	--

Table 16. Receipts, Costs, and Returns to Hoop House, Farrow-to-Finish Pork Production, Low-Cost Feed Blend

In conclusion, feed is by far the biggest factor influencing pork producers' returns. However, it is not the only one. Other factors include: Higher feed efficiency (lower conversion rate)

- Heavier slaughter weight
- Lower labor requirement per litter (due to improved management)
- Lower piglet mortality
- Larger litters
- More efficient use of bedding, fuel, and utilities

3. Sensitivity Analysis

Can investments in hoop house pork production create living-wage jobs, while also paying a reasonable return to the owner of the farm? Can living-wage jobs and net farm returns be generated at purchase prices that consumers are willing to pay?

The pork producer we have chosen to model will employ an average of about 1.25 FTE, to tend 100 sows and litters. As stated above in Table 9, we assume that each sow and litter requires 13 hours of labor from gestation to the finished market hogs, and that each sow bears an average of 2 litters per year. Under those assumptions, the amount of labor required for the operation is 2,600 hours per year (=13 * 100 * 2), which is equivalent to 1.25 FTE, assuming a work-year of 2,080 hours. We assume that this labor is hired in at a wage; the farm owner engages in supervision and management tasks including overseeing maintenance and repairs, budgeting and financing.

We conduct a sensitivity analysis showing the net returns that farm owners will earn at different feed prices for a given wage and output price. Table 13 below examines the impact of feed prices on net farm returns, assuming that labor is hired at $15/hr and the marketed output is sold at $100 per hundredweight of live hog, a 28% markup over the average price for live hogs in the U.S. in 2014 (NASS 2015). $15/hr is well above the living wage threshold for a single adult in Grant County, WA; it is also considered to be a living wage for two adults and up to two children, if both adults are working at that wage (Glasmeier 2015).

The results in Table 13 demonstrate the sensitivity of farm returns to feed prices. If the feed price is $0.17/lb or above, the farm loses money. If it is $0.16/lb, the farm is still selling below cost of production, but earns a small positive net return from the sales of cull sows. With feed at $0.15/lb, the farm earns net returns sufficient to support a single adult at a living wage in Grant County, WA. With feed at $0.13/lb, the farm earns $54,486 in net returns, which exceeds a living wage for two adults and up to three children in Grant County, given that only one adult is working and the other is a homemaker (Glasmeier 2015). At a purchase price of $100/cwt, and a feed price of $0.13/lb, a farm producing 100 sows and litters can thus support a farm household in rural, central Washington State, while also paying a reasonable living wage to one full-time and one part-time employee.

Feed Price / Lb	Cost/Litter	Cost/Hog	Cost/cwt Live Hog	Returns
$0.18	$2,055.70	$277.80	$111.12	($28,639)
$0.17	$1,972.57	$266.56	$106.63	($12,014)
$0.16	$1,889.45	$255.33	$102.13	$4,611
$0.15	$1,806.32	$244.10	$97.64	$21,236
$0.14	$1,723.20	$232.86	$93.15	$37,861
$0.13	$1,640.07	$221.63	$88.65	$54,486
$0.12	$1,556.95	$210.40	$84.16	$71,111
$0.11	$1,473.82	$199.17	$79.67	$87,736
$0.10	$1,390.70	$187.93	$75.17	$104,361
$0.09	$1,307.57	$176.70	$70.68	$120,986
$0.08	$1,224.45	$165.47	$66.19	$137,611
$0.07	$1,141.32	$154.23	$61.69	$154,236

Table 17. Farm Net Returns by Feed Price: Labor Costs $15/hr, Output Price $100/cwt

However, these positive returns are highly sensitive to the output price. If the output price drops to $95/cwt (a 21% premium over the 2014 U.S. average) then the feed price that is required to sustain the farm household while also paying its worker/s $15/hour drops significantly. At this price point, the feed price must be $0.14/lb or below for the farm to make positive net returns. To reach the living wage threshold for a farm family with three children, the feed price must now be $0.11/lb or below. However, if the wage is lowered to $10/hr, then the farm can meet this threshold at a feed price of $0.12/lb. A wage of $10/hr is somewhat higher than the living wage for a single adult in Grant County ($9.24/hr).

This brief analysis shows the sensitivity of farm returns to feed prices and output prices. The net returns that the farm owner can earn, and the wage that the farm owner can afford to pay her or his employees, are very sensitive to the price of the most important input, the pig feed, and the price of the output. Farmers working in niche markets can adjust output prices to achieve desired returns if their product has a reputation for high quality or consumers are willing to pay premiums for sustainable production practices. However, relatively few farmers will be able to employ this strategy, since it demands a high level of management skill, and will entail escalating competition if many farmers choose to enter the same high-end market niche.

In short, in order for hoop house pork production to be economically viable at scale in the Pacific Northwest while paying reasonable returns to farm owners and living wages to farm employees, feed must be very affordable and consumers must be willing to pay premium prices.

Feed Price / Lb	Cost/Litter	Cost/Hog	Cost/cwt Live Hog	Returns
$0.18	$2,122.48	$286.82	$114.73	($60,497)
$0.17	$2,039.36	$275.59	$110.24	($43,872)
$0.16	$1,956.23	$264.36	$105.74	($27,247)
$0.15	$1,873.11	$253.12	$101.25	($10,622)
$0.14	$1,789.98	$241.89	$96.76	$6,003
$0.13	$1,706.86	$230.66	$92.26	$22,628
$0.12	$1,623.73	$219.42	$87.77	$39,253
$0.11	$1,540.61	$208.19	$83.28	$55,878
$0.10	$1,457.48	$196.96	$78.78	$72,503
$0.09	$1,374.36	$185.72	$74.29	$89,128
$0.08	$1,291.23	$174.49	$69.80	$105,753
$0.07	$1,208.11	$163.26	$65.30	$122,378

Table 18. Farm Net Returns by Feed Price: Labor Costs $15/hr, Output Price $95/cwt

Bibliography

Becker, Jude M, Mark S. Honeyman, and J. B. Kliebenstein. 1999. Organic Pork Production: A Two-Litter Pasture Farrow-to-Finish Budget. Management/Economics, ASL-R1679, Ames, IA: Iowa State University.

Benson, Geoffrey A., and James T. Green. 2011. Sustainable Permanent Pasture-based Farrow-to-Finish Outdoor Hog Enterprise Budget. Center for Environmental Farming Systems, Raleigh: North Carolina State University.

Dhuyvetter, Kevin C., Glynn T. Tonsor, Mike D. Tokach, Steve S. Dritz, and Joel De Rouchey. 2014. Farrow-to-Finish Swine Cost-Return Budget. Farm Management Guide, Manhattan, KS: Kansas State University Research and Extension.

Dritz, Steve. 1998. "Weaning Weight - Why It's More Important Than You Think." Animal Sciences and Industry. Manhattan, KS: Kansas State University Agriculture Experiment Station and Cooperative Extension Service, March/April.

Ecotrust. 2015. Oregon Food Infrastructure Gap Analysis. Portland, OR: Ecotrust.

Ellis, Shane, and Lee Schulz. 2015. "Livestock Enterprise Budgets for Iowa - 2015." Iowa State University Extension and Outreach. Accessed October 1, 2015. https://www.extension.iastate.edu/agdm/livestock/html/b1-21.html.

Farm Marketing Solutions. 2015. "2015 Pasture Raised Pigs Budget." Farm Marketing Solutions. February 2. Accessed October 1, 2015. http://www.farmmarketingsolutions.com/2015-pasture-raised-pigs-budget/.

Gegner, Lance. 2005. Hooped Shelters for Hogs. Butte, MT: ATTRA: National Center for Appropriate Technology.

Glasmeier, Amy K. 2015. "Living Wage Calculation for Oregon." Massachusetts Institute of Technology Living Wage Calculator. Accessed September 1, 2015. http://livingwage.mit.edu/states/41.

Grannis, Jennifer, and Dawn D. Thilmany. 2002. “Marketing Natural Pork: An Empirical Analysis of Consumers in the Mountain Region.” Agribusiness 18 (4): 475-489.

Hauter, Wenona. 2012. Foodopoly: The Battle Over the Future of Food and Farming in America. New York: The New Press.

Honeyman, Mark, and Liz Weber. 1998. Swine System Options for Iowa. Ames, IA: Leopold Center for Sustainable Agriculture, Iowa State University.

Honeyman, Mark, Frederick Koenig, Jay Harmon, Don Lay, James Kliebenstein, Thomas Richard, and Michael Brumm. 2010. “Managing Market Pigs in Hoop Structures.” Extension.org. April 26. Accessed October 1, 2015. http://www.extension.org/pages/27456/managing-market-pigs-in-hoop-structures#.Vg29uPlVikp.

Kephart, Kenneth B., George L. Greaser, Jayson K. Harper, and H. Louis Moore. 2001. Agricultural Alternatives: Swine Production. Small and Part-Time Farming Project, University Park, PA: Penn State University College of Agricultural Sciences: Agricultural Research and Cooperative Extension.

Kliebenstein, James, Sean Hurley, Ben Larson, and Mark Honeyman. 2004. Cost of Organic Pork Production: A Seasonal Analysis and Needed Price Premium for Continuous Production. Conference Paper, Denver, CO: American Agricultural Economics Association Annual Meeting.

Larson, Ben, Jim Kleibenstein, and Mark Honeyman. 2003. Cost of Organic Pork Production . Ag Decision Maker File B1-80, Ames, IA: Iowa State University Extension.
McAdams, Nellie. 2015. “Summary of Agriculture of the Middle Statistics for Oregon.” Portland, OR: Ecotrust internal report, August.

Meat Inspection Services. 2015. “How Much Meat?” Oklahoma City, OK: Oklahoma Department of Agriculture, Food, and Forestry; Food Safety Division.

NASS. 2015. QuickStats. August 31. http://www.nass.usda.gov/Quick_Stats/.

Plain, Ron, and James Mintert. 2010. “Marketing Slaughter Hogs: Where, How, and When.” Extension.org. Accessed October 23, 2015. http://www.extension.org/pages/27212/marketing-slaughter-hogs:-where-when-how#.Vip8bX6rTct.

Platt, Thomas. 2006. “Expanding Swine Production in Eastern Washington.” Washington State University - Cooperative Extension. Accessed October 23, 2015. http://pnwag.wsu.edu/AgHorizons/notes/sr4no5.html.

Roese, Greg, and Graeme Taylor. 2006. Basic pig husbandry - the weaner. Primefact 72, New South Wales Department of Primary Industries.

SARE. 2003. Profitable Pork: Strategies for Hog Producers. Bulletin, College Park, MD: SARE.

Schaffer, Harwood D., Pracha Koonnathamdee, and Daryll E. Ray. 2012. An Economic Analysis of the Social Costs of Industrialized Production of Pork in the United States. Washington, D.C. : Pew Commission on Industrial Farm Animal Production.

Stender, David, James Kliebenstein, Richard Ness, John Mabry, and Gary Huber. 2009. Costs, Returns, Production and Financial Efficiency of Niche Pork Production in 2008. Ames, IA: Iowa State University Extension.

Sturtevant, Caleb. 2015. "How we raise our pigs, and the costs involved." Brush Prairie, WA: Pers. comm., September 24.

Sullivan, Zebblin, Mark Honeyman, Lance Gibson, Jean McGuire, and Micki Nelson. 2005. Feeding Small Grains to Swine. Ames, IA: Iowa State University Extension.

The Pig Site. 2009. "Maximising Weaning Weight." The Pig Site. December 2. Accessed October 1, 2015. http://www.thepigsite.com/articles/2938/maximising-weaning-weight/.

U.S. Census Bureau. 2015. "Population Estimates: State Totals Vintage 2014." United States Census Bureau. Accessed October 26, 2015. http://www.census.gov/popest/data/state/totals/2014/index.html.

USDA. 2015. "Commodity Costs and Returns." USDA Economic Research Service. Accessed October 21, 2015. http://www.ers.usda.gov/data-products/commodity-costs-and-returns.aspx.

—. 2015. Meat Price Spreads. Accessed November 4, 2015. http://www.ers.usda.gov/data-products/meat-price-spreads.aspx.

—. 2015. "NATIONAL DAILY DIRECT PRIOR DAY SOW & BOAR REPORT." USDA Agricultural Marketing Service. October 22. Accessed October 22, 2015. http://www.ams.usda.gov/mnreports/lm_hg230.txt.

(Footnotes)

1 We assume that the retail price average for ham covers both fresh and smoked.

2 The proportions of spending by value on fresh vs. processed pork are not equal to the proportions of consumption by volume, because the breakdown of cuts of fresh vs. processed pork are different from one another.