Economic analysis of size and feed type of swine production in Hawaii

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Summary

Purpose: To examine the profitability of Hawaii swine production and the industry's potential for future expansion.

Methods: Sixty commercial hog producers were interviewed to collect data on capital investment in and various costs of and returns from swine production. Costs and returns were compared by farm size and type of feeding practice. Factors that significantly affect profitability were determined. Costs and returns of farrow-to-finish operations were also compared between Hawaii and Iowa.

Results: The study showed wide variation across different farm sizes with respect to total economic cost and net return per 100 lb (45.4 kg) of live hog produced. The total economic cost was negatively correlated (r = -.318, P = .016) and net return was positively correlated (r = .336, P = .011) with farm size. The average net return for large herds (> 75 sows) was higher $(P$ =.003) than for small (< 25 sows) and medium (25-75 sows) herds. Factors related to these differences were lower $(P$ < .001) labor use, a lower $(P$ = .006) price for purchased feed, and a tendency to wean more $(P$ = .067) pigs per sow per year in large herds compared to small and medium herds. However, the sample revealed a sizable proportion of small herds that had profitability comparable to some large herds. Although feed costs were lower among garbage feeders, their total economic cost per 100 lb (45.4 kg) of live hog produced was relatively higher than for grain feeders. Overall, grain feeders were not significantly different in profitability from garbage feeders. Garbage feeders did not realize the full benefits of reduced feed costs due to garbage feeding because they paid a higher $(P$ = .002) price for purchased feeds, used more $(P$ < .001) labor, and weaned fewer $(P$ < .001) pigs per sow per year compared to grain feeders. On average, the total economic cost per 100 lb (45.4 kg) of live hog produced by farrow-to-finish operations was nearly three times higher in Hawaii than in Iowa.

Implications: Capturing economies of size and increasing efficiency may be the key to a sustainable swine industry in Hawaii.

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The swine industry is an important contributor to Hawaii's food supply and agricultural income. The industry generates an annual income of $6-$7 million in market hog sales and also contributes to the local economy and employment through pork processing and retail marketing, the feed industry, veterinary supply, and other related activities. In addition, many swine herds recycle food and agricultural wastes and produce a useful organic fertilizer. Because of the recent decline in sugar and pineapple production, the scope of diversified agriculture, including swine and other livestock production has increased in Hawaii. The share of diversified agriculture in the total value of Hawaiian agricultural production has increased from 35% in 1983 to 52% in 1994.[1,2]

Hawaii swine producers differ from their mainland counterparts in several aspects:

> they produce swine in a tropical environment and in many cases, produce swine on open pastures or in semi-confinement systems;
> swine herds in Hawaii are much smaller than those on the mainland;
> because of dependence on imported feeds, feed costs are higher in Hawaii and many farmers feed garbage to reduce feed costs;
> Hawaii swine producers primarily serve the premium-priced hot pork (fresh pork) and luau pig markets; and
> swine play a vital role in Pacific and Asian cultures.

According to the *Statistics of Hawaiian Agriculture* (1994) there are about 350 swine herds in Hawaii with a total of about 6000 sows.[2] Both the number of herds and the annual hog inventory have fallen over recent years. The number of herds has decreased from 650 in 1985 to about 350 in 1994, and the number of hogs has decreased from 55,000 in 1985 to 35,000 in 1994.[2,3] The reported annual kill is 42,000 head.[2]

Because local swine production does not meet the demand for fresh pork, Hawaii currently imports approximately 15,000 live mainland hogs every year for local slaughter. An additional 1000 sows would be required to replace the import of live hogs with local production. With increasing demand, pork imports are increasing every year. The contribution of local production to the total market supply of pork in Hawaii, including chilled and frozen as well as fresh pork, decreased

from 45% in 1970 to 13.4% in 1994.[2-4]

High production costs, especially feed costs, limited land availability, rapid urbanization, increasing waste management and environmental concerns, and price competition with imported live hogs have posed serious challenges to the future of the swine industry in Hawaii. Many producers are retiring, and there is a strong disincentive for new entrants in swine production due to the high opportunity cost of land, high initial investment, and a negative regulatory and permitting atmosphere. These issues have created uncertainties for the industry, raising serious concern among industry participants, including producers, consumers, investors, policy makers, and environmentalists.

Hawaii's swine industry still has potential for expansion. Hawaii producers get a better price than mainland counterparts, especially in recent years, because they produce for different markets. For the period 1985-1991, Hawaii producers received $77.3 per 100 lb (45.4 kg) of live hog versus the national average of $48.9.[2,4-6] United States mainland pork prices have fluctuated widely, whereas those in Hawaii have consistently increased with time, and these higher pork prices have to a certain extent compensated local producers for higher production costs. Feed costs can be reduced by promoting locally available feed resources, such as garbage and culled macadamia nuts and fruits. Some former sugar and pineapple lands can be made available for swine production.

Like other agricultural sectors, the Hawaiian swine industry has experienced structural changes in recent years. As the number of producers decreases and new producers have difficulties getting into the industry, production is shifting toward fewer and larger herds. Cutting costs by capturing economies of size is an important economic factor leading to the increase in farm size. Advances in technology are pushing down production costs, although new technologies are likely to be used more effectively by larger herds than smaller ones. But other factors, such as limited investment capital and management skills, may favor smaller herds.

Profitability and operational efficiency will be key determinants of the future of Hawaii's swine industry. Profitability is measured by analyzing the various costs of and returns from production. There has been a lack of information on swine production costs and returns in Hawaii, and little or no information on economies of size and efficiency measures.

The general objective of this study was to examine the potential for improving profitability and efficiency and expanding Hawaii's swine industry. Specifically, this study attempted to:

> compare production economics of different types of swine operations, including different farm sizes, and grain and garbage feeding;

> determine factors that significantly affect farm profitability; and

> compare the economics of swine enterprises in Hawaii and the United States mainland.

Materials and methods

Sixty swine herds were surveyed during August to December 1994 to collect detailed information on the various costs of and returns from different swine operations. A herd was selected primarily on the basis of the number of sows and the producer's willingness to participate in the survey. The major focus was given to commercial producers (herds with $\geq$ 10 sows) in selecting the sample (Table 1). In Hawaii, the largest 65-70 herds account for more than 80% of the sows. The sample included most of the larger operations (> 75 sows), about 20% of smaller ones ($\leq$ 75 sows), and two-thirds of the total sow population in the state.

The levels of outputs and inputs vary widely with farm size (number of sows). Comparing total costs and returns across individual herds to measure efficiency and profitability is therefore not appropriate. Levels of outputs and inputs need to be normalized before making such comparisons. For swine production, 100 lb (cwt; 45.4 kg) of live hog produced is commonly used as a unit of analysis.[7,8]

Total economic cost and net return, as defined below, were computed per 100 lb (cwt; 45.4 kg) of live hog produced. Although a number of other measures, such as net cash income, net farm income, and returns on total assets are also used to determine farm profitability,[9] this study used net return as a measure of profitability of swine production in Hawaii. Edwards et al. also used this approach to determine factors associated with profitability of farrow-to-finish swine producers in Iowa.[8]

The total economic cost and net return of sample herds were compared by size and feed type. The comparison by size included:

> large (> 75 sows),
> medium (25-75 sows), and
> small (< 25 sows) herds.

Feed type included:

Table 1

Study population and sample of Hawaii swine producers by farm size

| Farm size | Population | | Sample | | |
	Number*	% of farms	Number	% of farms	% of population
>75 sows	21	8.8	19	31.7	90.5
25-75 sows	35	14.7	20	33.3	57.1
<25 sows	182†	76.5	21	35.0	11.5
Total	238	100.0	60	100.0	25.2

*   The number includes farms with known number of sows

†   Of these, 106 farms had fewer than 10 sows.

grain feeders (herds that feed grain-based feeds only), and garbage feeders (herds that feed both grains and garbage or garbage only).

Inadequate sample size did not permit us to further analyze feed type by farm size. Differences in profitability by farm size and feed type were analyzed in terms of differences in several factors, including labor use per 100 lb (45.4 kg) of live hog produced, feed price, hog price, and number of pigs weaned per sow per year. While labor use and feed price are the measures of resource-use efficiency, the number of pigs weaned per sow per year is a measure of productivity. Previous studies have shown that feed conversion efficiency also has a significant impact on profitability of swine production.[7,10] However, the impact of feed efficiency on profitability was not analyzed here because we could not compute feed efficiency for garbage feeders due to the lack of information on the amount and nutritional value of garbage fed. Correlation and ANOVA techniques were used to derive our key results.

Because of the lack of comparable data from most other states, the comparative analysis of costs and returns for swine production between Hawaii and the United States mainland was limited to a comparison with Iowa. Because of inadequate sample of feeder-pig-producing and feeder-pig-finishing herds in Hawaii such comparison was further limited to farrow-to-finish operations only.

Total economic cost and net return are defined as follows:

Total economic cost is the sum of total variable costs, fixed cash costs, depreciation expenses, cost of owner capital, and cost of family labor.

Total variable costs include all variable operating costs, including feed costs, hired labor expenses, veterinary supplies and services costs, breeding supplies and services costs, utilities (water, telephone, and electricity), fuel and gas expenses, repairs and maintenance, office supplies, dues and subscriptions, professional and accounting services, and other miscellaneous operating costs such as gloves, boots, etc. Feed costs include purchased feeds (grains or concentrates) and fees paid for garbage.

Fixed cash costs include property taxes, insurance, interest payments on borrowed capital, and rents.

Depreciation includes capital depreciation and boar depreciation. Capital depreciation was computed as annualized capital by dividing the total value of capital by the estimated total life span in years. The economic life span of swine houses was assumed to be 30 years and the life of automobiles and other equipment was estimated (based on farmers' responses) at 15 years. Boar depreciation was computed as purchase value minus cull value divided by the breeding life of a boar (assumed to be 2 years). Sows and gilts, even those bought from outside the herd, were not depreciated as their purchase or breeding value and cull value were similar.

Cost of owner capital is the opportunity cost of owner capital used in swine production -- the income forgone by not investing the capital in something other than swine production. The average interest rate (7.8%) paid by swine producers for borrowed capital was used as a proxy for the opportunity cost of owner capital. Family labor was valued at $6.94 per hour, the average wage rate for livestock workers in Hawaii.[11]

Net return

Net return is defined as the gross returns less total economic cost plus noncash income (the value of hogs used for own consumption or given away). Gross returns, also known as gross cash income, are the total cash received by farmers. In swine production, gross cash income includes the returns from the sales of suckling pigs (60-100 lb; 27.2-45.4 kg), roasters (100-150 lb; 45.4-68.1 kg), table hogs (180-200 lb; 81.7-90.8 kg), and cull breeding animals to the market and of feeder pigs to other herds for finishing.

Results and discussion

Sample characteristics

Hawaii's swine industry is characterized by small herds and a high degree of concentration. Of the 60 herds surveyed, only 14 had more than 100 sows. Farms with more than 75 sows accounted for 71.5% of the total sow population, 79.4% of the total returns, and 71.5% of the total assets of the 60 herds. Based on the sample herds, the total annual live output of all commercial swine producers in Hawaii was estimated to be about 5440 tonnes, of which 60% came from large (>75 sows) and the remainder from small and medium ($\leq$ 75 sows) producers.

About 75% of the farmers operated on owned land and 25% on leased land (Table 2). Hawaii's swine production is a relatively specialized industry. Swine production was the primary source of income for two-thirds of the sample producers. One-fourth of producers raised swine to supplement their off-farm income.

Overall, family labor was the major source of labor for swine production, especially among medium and small herds. None of the medium herds in the sample reported using hired labor. Among the smaller herds, only three herds reported using some hired labor during the year. The contribution of hired labor to total labor use in these herds was about 23%. Among the large herds, half reported using hired labor. Hired labor on these herds accounted for about 63% of the labor requirement. Forty percent of sample producers reported borrowing money at some point in time. On average, the borrowers were paying an interest rate of 7.8% per annum.

The average capital investment varied from about $34,000 in small herds to about $345,000 in large herds. Capital investment per sow did not differ with farm size. However, the capital investment per sow for grain feeders was more than twice as high as for garbage feeders. Housing constituted about 84% of the total capital investment for large herds, 66% for medium herds, and 70% for small herds. Waste management systems accounted for about one-tenth of the total capital investment.

Half of the sample producers fed imported grains only and half fed

grains and cooked garbage or garbage only. Fifty-seven percent of small herds, 65% of medium herds and 21% of larger herds fed garbage or some combination of grain and garbage. About three-fourths of the herds raised swine to market size and one-fourth produced feeder pigs only. Two-thirds of the producers kept their animals in total confinement, a few producers used open pastures, and one-fourth of the producers had some combination of both systems.

The average weaning age was 34 days, average market age was about 5 months, and average live weight at market was 70 kg (155 lb). Market age and live weight were 6 months and 87 kg (191 lb) for finishers and 57 days and 17 kg (38 lb) for feeder pig producers. Annually, about 28% of sows were replaced with new stock, mostly from within the herd. About 25% of herds reported buying replacement gilts from other sources, mostly from their local counterparts. A few herds,

Table 2

Some characteristics of sample farms

	> 75 sows	25–75 sows	< 25 sows
General information			
No. of farms	19	20	21
Herd size (no. of sows)	151 ±15.6	42 ±3.2	14 ±1.6
Land holding size (ha)	2.8 ±0.5	1.4 ±0.3	0.9 ±0.2
Capital investment/sow (dollars)	2286 ±651	1971 ±590	2461 ±662
No. of farmers using hired labor	9	0	3
Hired labor share in total labor use on farms using hired labor (%)	63	0	23
% of farmers with high school or better education	84.2	80.0	61.9
% of farmers feeding garbage	21	65	57
Herd performance			
Litter size born alive	9.82 ±0.23	10.08 ±0.32	9.60 ±0.42
Litter size weaned	8.26 ±0.13	8.12 ±0.24	7.53 ±0.37
No. of pigs weaned/sow/year	16.14 ±0.83	13.79 ±0.92	13.92 ±1.17
Economic performance			
Return on assets (%)*	13.8 ±5.4	−1.6 ±6.8	−6.9 ±3.4
Profit margin (%)†	32.3 ±4.8	24.4 ±8.4	36.5 ±10.1
Gross ratio (%)‡	64.6 ±4.5	69.4 ±7.3	57.6 ±9.3

* Return on assets was estimated according to Dodson[9] as:

$$\text{Return on assets (\%)} = \frac{\left(\begin{array}{c} \text{Net farm income} \\ - \text{ management charge} \\ - \text{ unpaid family labor} \\ + \text{ interest payments on borrowed capital} \end{array} \right)}{\text{Total assets}} \times 100$$

where management charge was assumed to be 5% of net farm income and total assets was the sum of total capital investment and the value of land used for pig production. Net farm income was computed as: Net farm income = Total cash income - Total variable expenses - Total fixed expenses - Depreciation.

† Profit margin was computed as:

$$\text{Profit margin (\%)} = \frac{\text{Net farm income}}{\text{Gross cash income}} \times 100$$

‡ Gross ratio was computed as:

$$\text{Gross ratio (\%)} = \frac{\text{Total cash operating expenses}}{\text{Gross cash income}} \times 100$$

especially the larger ones, practiced artificial insemination to improve herd genetics. On average, the herds had one boar for every nine sows.

Total economic cost and net return

Total economic cost was negatively correlated with farm size ($r = -.318$, $P = .016$) (Figure 1). The association between net return and farm size was positive ($r = .336$, $P = .011$) (Figure 2). However, the relationship between farm profitability (as measured by net return) and farm size does not imply that all smaller herds were unprofitable. A sizable proportion of smaller herds had the same level of total economic cost and net return as several larger herds (Figures 1-2). The poorer average performance on smaller herds was attributed to wide variability in their costs and returns. The differences in total economic cost and net return per 100 lb (45.4 kg) of live hog produced and related factors for different farm categories are discussed below.

Farm size

As the differences in total economic cost and net return per 100 lb (45.4 kg) of hog produced by herds with 25-75 sows and those with fewer than 25 sows were not significant, data from the herds with 75 or fewer sows were combined.

Feed was the dominant component in the total economic cost on large herds (> 75 sows) and labor was dominant on medium and small herds ($\leq$ 75 sows) (Figure 3).

The differences in total economic costs per 100 lb (45.4 kg) of live hog produced for large herds (> 75 sows) and medium and small herds ($\leq$ 75 sows) were highly significant. The total economic cost per 100 lb (45.4 kg) of live hog produced by medium and small herds was almost two times higher than that for larger herds (Figure 4). The average net return per 100 lb (45.4 kg) live hog produced was $11.60 for larger herds and -$63.70 for medium and small herds (Figure 4). These differences were highly significant.
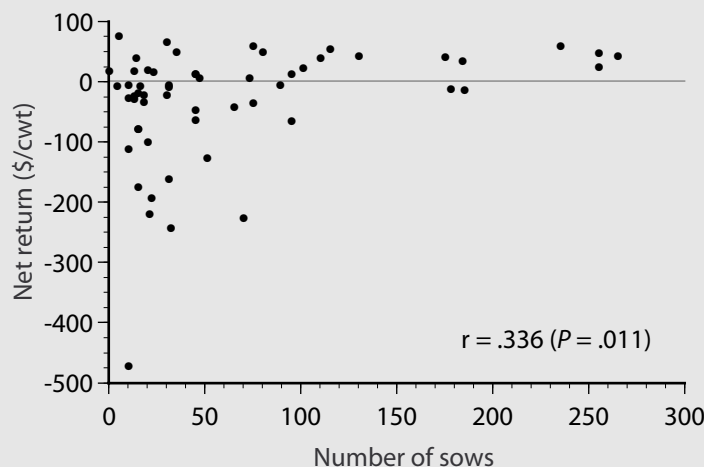
Large herds were found to be more profitable than medium and small ones because large herds used lower labor hours per 100 lb
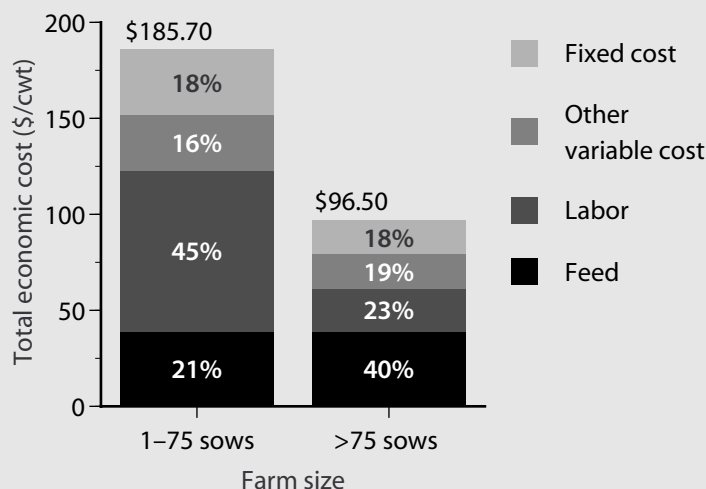
Figure 1
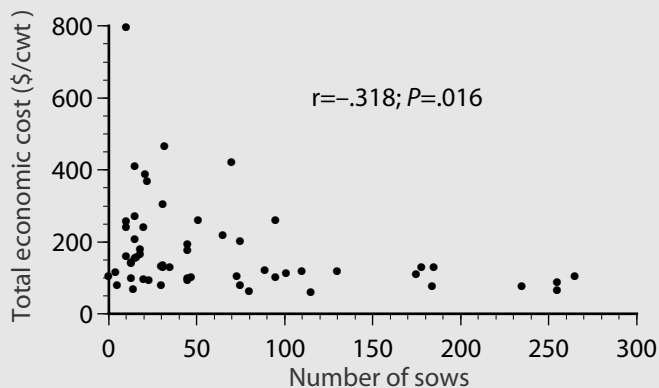
Total economic cost per 100 lb (45.4 kg) of live hog produced by farm size

Figure 2

Net return per 100 lb (45.4 kg) of live hog produced by farm size

Figure 3

Breakdown of total economic cost per 100 lb (45.4 kg) of live hog produced by farm size

(45.4 kg) of live hog produced and paid a lower price for purchased feed. These differences were highly significant. Large herds also had a tendency to wean more pigs per sow per year than small and medium sized herds (Figure 5). Hog price received was not significantly related to profitability.

The results reveal the potential for improving profitability on smaller herds by using labor more efficiently, paying less for feed, and weaning more pigs per sow per year. Farmers may be able to pay a lower price for feed by purchasing it in bulk or through a farmers' cooperative. Farmers should try to wean more pigs per sow per year by improving swine management and health. Increasing herd size can benefit smaller herds by reducing average fixed costs.

Grain feeding versus garbage feeding

Feed is the major component of total economic cost for grain feeders and labor is the major component for garbage feeders (Figure 6).

The average total economic cost per 100 lb (45.4 kg) of live hog produced was not significantly different for garbage feeders ($172.1) and
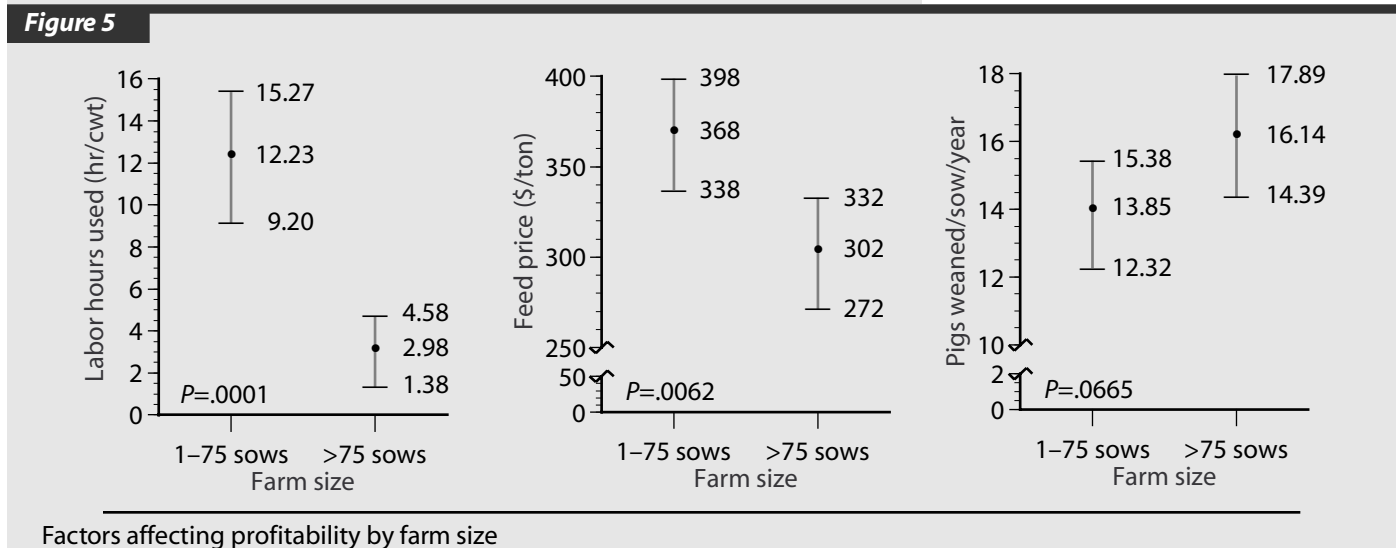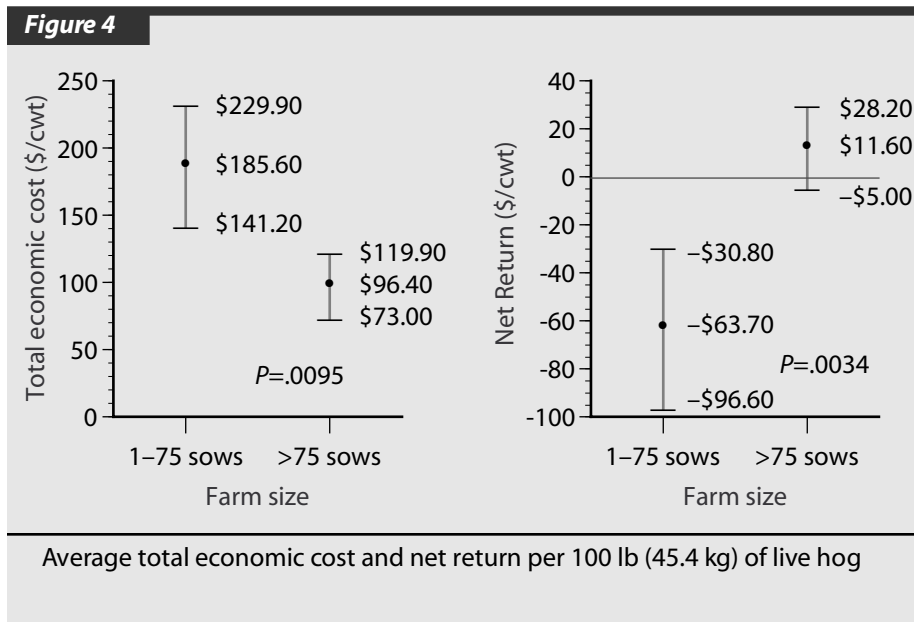
for grain feeders ($143.5) (Figure 7). Similarly, in terms of net return, garbage feeding was not significantly different from grain feeding with a net return of -$54.80 for garbage feeders and -$25.90 for grain feeders (Figure 7). Though garbage feeding reduced feed costs, garbage feeders did not realize its full benefits, because they paid a significantly higher price for purchased feeds, used significantly more labor, and weaned significantly fewer pigs per sow per year (Figure 8). Hog price was not significantly related to profitability of grain and garbage feeders.

Grain feeders can reduce their feed costs by substituting grain with local feed products, including garbage, cull fruits, and vegetables. Garbage feeders should try to use labor more efficiently, wean more pigs per sow per year, and bargain for lower feed prices to take full advantage of reduced feed costs from garbage feeding.

Hawaii versus Iowa

Higher production costs in Hawaii than in the United States mainland and consequent price competition with imported mainland hogs were some of the important concerns among Hawaii swine producers. In order to get some idea of the extent of cost advantage of swine production in the mainland, costs and returns of farrow-to-finish operations were compared between Hawaii and Iowa, the only state for which comparable data were available (Figure 9). The results showed significant cost differences between Hawaii and Iowa. Feed was the major component of total economic cost for Iowa and labor was dominant for Hawaii. All types of costs were higher in Hawaii. Hawaii producers used ten times more labor per 100 lb (45.4 kg) of live hog produced than those in Iowa. Other variable and fixed costs were about four times higher, and feed was two times more expensive in Hawaii. As a result, the average total economic cost per

Figure 4

Average total economic cost and net return per 100 lb (45.4 kg) of live hog

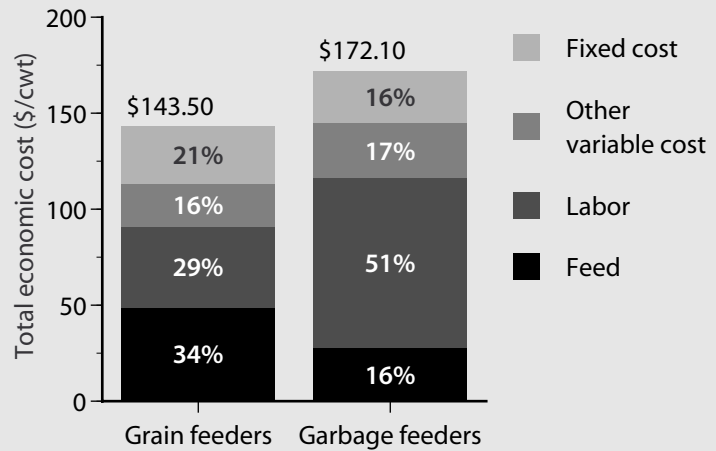**Figure 5**

Factors affecting profitability by farm size

100 lb (45.4 kg) of live hog produced was nearly three times higher in Hawaii than in Iowa. The average net return per 100 lb (45.4 kg) of live hog produced was -$12.20 for Hawaii and -$1.00 for Iowa.

The results suggest that Hawaii swine producers need to reduce production costs to enhance their competitiveness against their mainland counterparts by using their resources more efficiently, especially labor. Feed costs can be reduced by substituting high-cost imported grain-based feeds with low-cost local feed products.

High production costs, growing urbanization and encroachment on agricultural lands, and increasing environmental concerns are the major factors responsible for the shrinkage of the swine industry in Hawaii. The retirement of older producers, combined with a high capital investment and a negative permitting atmosphere for new producers, has further compounded this problem. The present study has identified some ways to deal with these problems.

Capturing economies of size through larger operations and increasing efficiency through good management practices may be the key to a profitable swine industry in Hawaii. In view of the high capital investment for brand new operations, the industry needs instead to fully use its existing operations. Hawaii swine producers could enhance their competitive edge against their mainland counterparts by using their resources in a more efficient manner.
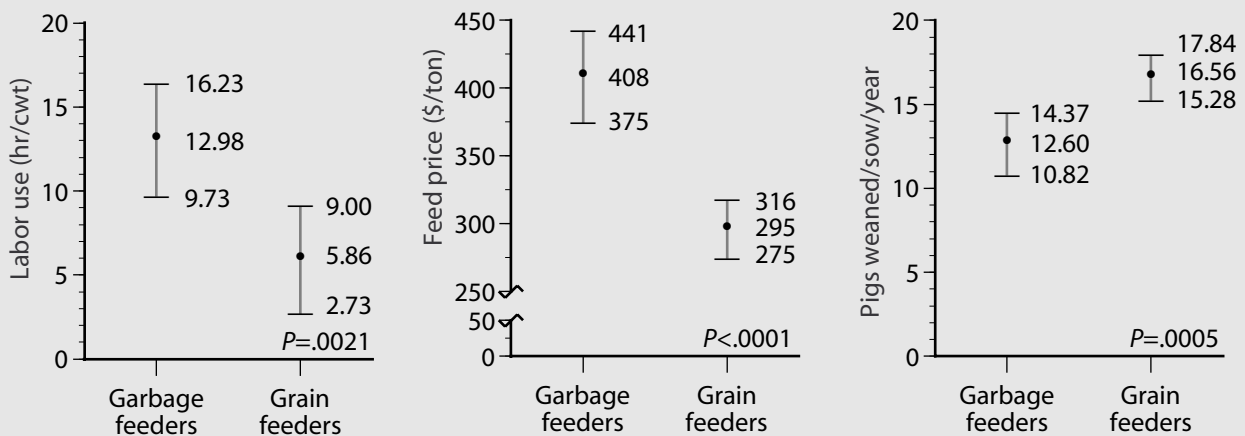
Figure 6

Breakdown of total economic cost per 100 lb (45.4 kg) of live hog produced by grain and garbage feeders

Figure 7
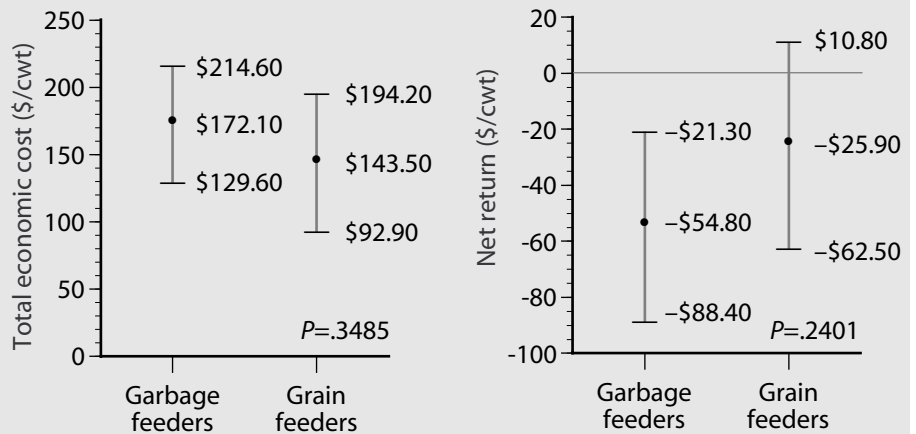
Average total economic cost and net return per 100 lb (45.4 kg) of live hog produced by grain and garbage feeders

Figure 8

Factors affecting profitability for grain and garbage feeders

Implications

The study identifies factors that determine profitability of swine production in Hawaii. These factors are not necessarily unique to Hawaii, and indicate areas that tend to be overlooked and need more attention. In particular, the study found that efficient use of inputs, especially feed and labor, is more important to profitability than maximizing productivity in terms of pigs weaned per sow per year.

Although swine practitioners have learned that health and production management are important to the profitability of an enterprise, they can not solve all the challenges faced by local swine production. The study reveals some important areas on which they need to concentrate their efforts in formulating management strategies for improved performance of producers:

Small and medium herds can increase profitability primarily by concentrating on using labor more efficiently and negotiating a lower feed price. Small herds may also benefit from paying attention to the number of pigs weaned per sow per year.

Small herds can be efficient, but can benefit from expanding to capture economies of scale.

Grain feeders can reduce feed costs by including local feed products (garbage, bakery waste, and cull fruits and vegetables) in swine diets.

Garbage feeders can increase profitability primarily by negotiating a lower feed price, increasing the number of pigs weaned per sow per year, and using labor more efficiently.

Hawaii producers can become more competitive with their mainland producers through reduction in costs by using labor more efficiently and by substituting high-cost imported grain-based feeds with local low-cost feed products.

Overall, the efficient use of inputs, especially feed and labor, is more important to profitability than is maximizing pigs weaned per sow per year.

Acknowledgments

Figure 9
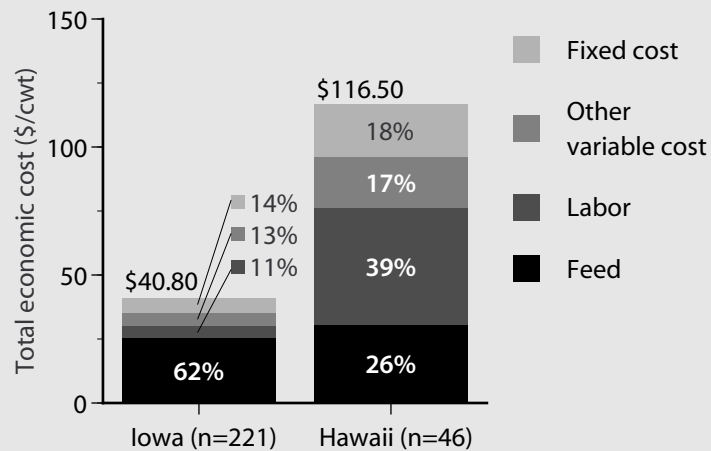
Comparison of costs of farrow-to-finish swine operations in Hawaii vs. Iowa[12]

n   number of farrow-to-finish operations analyzed

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