A financial comparison of small-scale quail and laying hen farm enterprises

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ABSTRACT Smaller scale agricultural production for food, income, and as a hobby is a growing trend among United States (**US**) producers. Laying hens or quail are an economically viable livestock enterprise for small-scale producers with limited resources. In this study, we evaluated the economic feasibility of small-scale egg production (1,000 birds) and compared the profitability under 3 different production systems, and 2 price scenarios. The cost-benefit analysis in this study encompasses calculating and simulating all costs and returns associated with chicken and quail production over a 10-yr period. Two prices were evaluated, farm gate prices that US commercial producers face, and US farmers' market prices more often faced by small-scale producers. In all 3 production scenarios (chicken with the option of natural molting, chicken without molting, and raising quail) small-scale egg production is economically viable when farmers' market egg prices were used to calculate the Net Present Value (**NPV**). Using farmers' market prices, raising quail has the highest NPV. Raising chickens without molting has the second highest NPV, while raising chickens and allowing them to undergo molting has the lowest NPV. Contrarily, when farm gate egg prices are used in the estimation, only raising quail had a positive NPV. Although the quail enterprise resulted in the highest NPV under both price conditions, there may be marketing difficulties based on the producer's location. Producers located near cities, or Asian populations where quail eggs are more popular may be successful with small-scale quail operations.

Key words: quail, chicken, small-scale, net present value, molting

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INTRODUCTION

The poultry industry in the United States (**US**) is highly diverse, spanning backyard to small-scale to large-scale commercial production. Raising chickens, quail, and other poultry on a smaller scale for food, income, and as a hobby is a growing trend among US residents (Tobin et al., 2015). Approximately 8 million US households had chickens in 2018 (Gibson, 2019), with that number rapidly increasing due to COVID (Lesley, 2021). While chickens remain the most common poultry among small-scale producers, other game birds, such as quail, are now being raised commercially for their meat and/or egg production. The United States Department of Agriculture (**USDA**) census data estimated that about 736 million quail were raised in the United States in 2017 (USDA, 2019). Raising quail may be a more profitable alternative to chickens due to their higher egg price and salvage meat values. However, quail housing needs differ from chickens, and the purchase price for chicks is higher. In the United States, the average purchase price for chicks is $3 per chicken, while the average price for a quail chick is $4.25 (Hy-Line North America, 2022; Ideal Poultry, 2022; Jackson Farms BLRW, 2022; Keith Smith Co., 2022; Nelson Poultry Farms, 2022). In addition, small-scale producers face marketing challenges for their quail eggs and meat due to the location and population-specific nature of markets for quail products in the United States (Clauer et al., 2005).

Potential small-scale producers often face limits when acquiring capital, land, equipment, and labor, but still have an interest in agricultural production (Stokes et al., 2005). However, the demand for quality foods produced locally has expanded, creating market opportunities for small-scale producers (Painter et al., 2015). New farmers' markets are emerging rapidly across the country, allowing small producers to reach customers directly (Painter et al., 2015). US government support for farmers' markets has also increased. Farmers' markets authorized to accept the Supplemental Nutrition Assistance Program are on the rise (Salisbury et al., 2018), increasing the low-income population's access to locally grown and high-quality foods (USDA, 2017). The USDA also has direct programs such as the Farmers' Market Promotion Program (**FMPP**), which aims to increase access to

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Table 1. Scenarios used in analysis.

Scenarios	Weeks of molting	Layer replacement	Age at first laying	Output
CWM[1]	8 weeks	Every two years	15 weeks	Chicken eggs, salvage meat
CNM[2]	-	Every year	15 weeks	Chicken eggs, salvage meat
Quail	-	Every two years	8 weeks	Quail eggs, salvage meat

[1]Chicken with molting.
[2]Chicken without molting.

locally produced agriculture products. FMPP provides direct financial support to agricultural businesses and cooperatives, and producer networks under capacity building projects, and community development training and technical assistance. Through FMPP, the USDA has awarded over $58 million from 2008 to 2015 to support about 879 projects across the country (USDA-AMS, 2017). Total funds awarded in recent years have increased significantly, with about $89.44 million awarded between 2017 and 2021.

Although economic analysis of poultry operations has been conducted by past researchers, existing analyses have been mainly focused on large-scale egg production (Painter et al., 2015; Bir et al., 2018; Patterson et al., 2021). There is limited research on the profitability of egg production using other poultry species, such as quail. Quail may have unique marketing challenges, and not every local population will have high demand for quail products; however, it is important to present alternative enterprise options given today's production challenges. Thus, this research will provide economic analysis for small-scale producers who are considering choosing between alternative poultry species, extension professionals who work with agriculturalists, and those interested in the local food supply.

This study evaluated production differences and compared the profitability of raising laying chickens and quail on a production scale of 1,000 birds. The cost-benefit analysis in this study encompasses calculating and simulating all costs and returns over a 10-yr period, then comparing simulated net present values (**NPV**). NPV is a capital budgeting technique used to discount the projected cash inflows to their present value. It is a common method of evaluating multiple alternatives because it accounts for both the time value of money and the size of the stream of cash flows over the life of the investment (Kay et al., 2016).

Three different egg production scenarios were compared, including 2 chicken scenarios and one quail scenario. Even within traditional chicken egg production, producers can make different production decisions. Natural molting in chickens causes a drastic reduction in egg production, or sometimes a complete break in egg laying, which impacts producer revenue negatively (Berry, 2003). Producers can avoid the negative impact of molting if the birds are replaced more frequently, thus preventing the chickens from undergoing molting. However, replacing chickens also increases the production cost for the producer. Therefore, 2 chicken scenarios were considered, one with molting and one without molting. In all 3 scenarios, the main output is eggs with a salvage meat value after the productive life of the bird. The analysis also accounts for variability in both input and output quantity and prices, providing a range of potential financial outcomes with associated probabilities.

MATERIALS AND METHODS

The expected simulated NPV of 2 chicken scenarios, and one quail scenario for a small scale operation was estimated, including 1) raising chickens (layers) and allowing the birds to undergo molting naturally (CWM, thereafter); 2) raising chickens (layers) without molting (CNM, thereafter); 3) raising quail (Quail, thereafter) (Table 1). Fundamentally, the cost that the producer will incur and the corresponding benefits that will accrue from scenarios CWM and CNM are similar, with slight differences. Under the CWM scenario, the producer allows the laying birds to undergo natural molting. Thus, the birds will be replaced every 2 years over the project period. Under the CNM scenario, the producer is expected to replace the birds every year; thus, avoiding the birds' natural molting process. Under the CWM scenario the producer has lower replacement bird expenses; but, they also have decreased revenue from lower egg production during the molting period.

The quail scenario provides an opportunity for producers to lower their cost of production. This is because quail require less housing space and have a lower feed requirement; but, are prolific layers similar to chickens. Additionally, quail meat and eggs are niche products, commanding higher prices when compared with chicken products. However, depending on the producer's proximity to a larger population, it may be challenging to sell quail products. We are conducting this analysis under the assumption that all products can be sold, which requires the producer to evaluate their individual situation.

Housing

The amount of space required per bird ranges between 1.5 and 2 square feet (ft^2) for larger size birds such as chickens, while quail require only 1 to 1.2 ft^2 (Cunningham and Fairchild, 2010; Bir and Zook, 2021). In this study, we used 2 ft^2 per bird for chicken and 1 ft^2 per bird for quail (Table 2). Additionally, young birds would be kept in brooding houses for the first few weeks, requiring about 0.5 and 0.3 ft^2 per bird for chicken and quail, respectively. Following these space requirements,

Table 2. Chicken and quail production input quantities and prices.

Item	CWM[1]	CNM[2]	Quail
Housing			
Space requirement for brood house (ft2 per bird)	0.5	0.5	0.3
Space requirement for main house (ft2 per bird)	2	2	1
Space unit cost ($ per ft2)	8.82	8.82	8.82
Equipment, Material, and Utility			
Number of feeders in brood house	25	25	25
Number of feeders in main house	50	50	50
Number of drinkers in brood house	25	25	25
Number of feeders in main house	50	50	50
Drinker price ($ per drinker)	20	20	20
Feeder price ($ per feeder)	20	20	20
Monthly utility cost ($ per month)	40	40	40
Initial bedding materials ($)	360	360	360
Egg cooling and storage equipment ($)	2,000	2,000	2,000
Day-old-chick (DOC)			
Number of DOC	1,040	1,040	1,040
DOC purchase price ($ per bird)	3	3	4.25
Mortality rate (%)	4	4	4
Feed			
Amount fed- Starter feed for 0−6 wk old bird (lbs. per bird per week)	1	1	0.8
Amount fed- Grower feed for 7−15 wk old bird (lbs. per bird per week)	1	1	0.8
Amount fed- Layer feed for birds over 15 wk (lbs. per bird per week)	1.5	1.5	1
Labor			
Labor (hours per wk)	20	22	20
Labor hourly cost ($ per h)	7.25	7.25	7.25

[1]Chicken with molting.
[2]Chicken without molting.

2 acres of land would be adequate to raise about 1,000 chickens (layers). Although quail are smaller in size, we assumed the producer will also raise 1,000 quail.

Historical data on housing costs were collected and adjusted to reflect inflation. Cunningham and Fairchild (2010) reported $8.6 per ft^2 as the housing cost for poultry production in 2010. We inflated this cost to 2022 values ($11.76 per ft^2) using the US Bureau of Labor Statistics inflation calculator (US Bureau of Labor statistics, 2020). The housing cost value by Cunningham and Fairchild (2010) included the cost of equipment such as drinkers, feeders, and heating units in their analysis. Compared to housing, equipment such as drinkers and feeders need more frequent replacement. In order to reflect the timing of re-purchasing spent equipment, we excluded the cost of equipment from Cunningham and Fairchild (2010)'s housing estimate. In their analysis, they stated that 25% of their estimated cost was equipment; therefore, we adjusted our housing cost to $8.82 per ft^2, so the cost of equipment could be accounted for separately. The total anticipated housing costs for the chicken and quail scenarios were amortized using a 7% discount rate.

Equipment, Materials, Utility Requirements, and Labor

The number and cost of feeders, drinkers, and relevant egg storage equipment follows the PennState extension service recommendation, with 20 adult birds per feeder and drinker (Table 2) (Clauer and Shoop, 2020). The main housing units will require 50 drinkers and 50 feeders, while the brood houses will require about 25 drinkers and 25 feeders for each production scenario. We assumed 20% of the drinkers and feeders will be replaced every 5 yr (Banrie, 2012). Additionally, a one-time cost of $2,000 for egg cooling and storage equipment was included (Cunningham and Fairchild, 2010).

The initial cost of bedding materials to cover the housing units is estimated at $360 (Banrie, 2012). Although there are different litter management methods, the reuse of litter for several years has become predominant among small-scale producers (Banrie, 2012). This implies that the producer will practice partial house-cleanout by removing a limited amount of the old litter at the end of each year. In this analysis, we assumed the producer will remove 30% of the litter after every year, resulting in a $108 per year cost. The value of litter/manure from poultry production can range from $3.90 to $60 per ton depending on its use, location, quality, and the price of other commercial fertilizers (Lichtenberb et al., 2002; Cunningham and Fairchild, 2011; Kissel et al., 2015). We assumed the cost of litter removal and bedding replacement would be offset by the market value of poultry manure (Lichtenberb et al., 2002; Cunningham and Fairchild, 2011; Kissel et al., 2015); therefore, the cost of litter removal and bedding replacement is not included in this analysis. It was assumed that one operator's labor would be enough to maintain 1,000 birds at 20 h per week (Cunningham and Fairchild, 2011). Although labor can be valued differently based on other labor opportunities, we set the labor cost at minimum wage.

Day-Old-Chick Costs

Given the 4% mortality rate that is assumed in this study, 1,040 day-old-chick (**DOC**) were purchased to start (Table 2). Because all DOC should be from hatcheries certified by National Poultry Improvement Plan (**NPIP**), we used the average purchasing price of $3 per bird for chicken, and $4.25 per bird for quail (Hy-Line North America, 2022; Ideal Poultry, 2022; Jackson Farms BLRW, 2022; Keith Smith Co., 2022; Nelson Poultry Farms, 2022).

Feed Costs

Chickens and quail require different rations at various growth stages. The 0 to 6 wk old birds will be fed starter feed, while the 7 to 15 wk old birds will be given grower feed (Table 2). Birds that are older than 15 wk will be given layer feed. It is recommended starter feeds contain 18 to 20% protein, grower feeds contain 15 to 16% protein, and layer feeds contain 16% protein for laying hens (Hermes, 2016). The recommended protein requirements for quail are slightly higher than for chickens. In this study, we used 19% protein content for chicken starter

Table 3. Chicken and quail feed formula and ingredient pricing for 2,000 lbs feed.

	Chicken ration	Quail ration
Starter feed[1]		
Corn (lbs.)	1,347	1,132
Soybean meal (lbs.)	575	790
Calcium carbonate (lbs.)	8	8
Mineral mix (lbs.)	70	70
Grower feed [2]		
Corn (lbs.)	1,593	1,250
Soybean meal (lbs.)	340	525
Calcium carbonate (lbs.)	7	165
Mineral mix (lbs.)	60	60
Layer feed[3]		
Corn (lbs.)	1,435	1,250
Soybean meal (lbs.)	345	525
Calcium carbonate (lbs.)	170	165
Mineral mix (lbs.)	50	60
Prices		
Corn ($ per lb.)	stochastic (see Table 4)	
Soybean meal ($ per lb.)	stochastic (see Table 4)	
Calcium carbonate ($ per lb.)	0.78	
Mineral mix ($ per lb.)	0.81	

[1]Starter feed is fed at 0−6 wk of age.
[2]Grower feed is fed at 7−15 wk of age.
[3]Layer feed is fed at greater than 15 wk of age.

feed and 24% for quail starter feed. The chicken grower and layer feed were set to 15 and 15.5% protein, respectively. For quail, the protein content is 18% for grower and layer feed.

Table 3 presents the feed ingredients and amounts required to achieve the target protein level for 2,000 lbs of feed. The actual amount of corn meal and soybeans included in each ration to achieve the recommended protein level is based on the assumption that corn contributes at least 8% and soybean meal contributes at least 48% of the total protein level required (Batal and Dale, 2016). Hermes (2016) suggested higher amounts of calcium and minerals help eggshell formation. We followed this guideline and increased the calcium and mineral content in the starter and grower feeds from about 4 to 11% in the layer feeds (Hermes, 2016).

In calculating the feed costs, we used fixed prices for calcium carbonate ($0.78 per lb) (Univar Solutions, 2022) and mineral mix ($0.81 per lb) (New Country Organics, 2022) (Table 3). Prices for corn meal and soybeans are stochastic to better reflect fluctuations in feed prices. The 2007 to 2021 corn meal and soybean prices (Figure 1) were used to identify the maximum, mean, and minimum values used in the analysis (Table 4). We simulated the weekly corn meal and soybean price per ton using a triangular distribution within the Excel @Risk software. @Risk is a program that allows for a distribution of results with probabilities using Monte Carlo analysis (Palisade, 2022). The feed cost is calculated based on the ration requirements in Table 3. Fixed calcium carbonate and mineral mix prices and simulated corn meal and soybean prices were used. The average cost of starter feed for chickens is $316 per ton[1], while the quail average starter feed cost is $335 per ton. The grower feed requires less protein content, and its average cost is about $287 per ton and $414 per ton for chicken and quail, respectively. Chicken layer feeds require less protein but more mineral components, costing an average of $398 per ton. The layer feed formulation for quail does not differ from the grower feed formulation and has the same average cost of $414 per ton. The final cost of feed per pound included a 15% miscellaneous cost to account for price variability.

[1]One ton is equivalent to 2000 lbs.

Weekly Egg Production

Egg production each week is based on the assumption that the producer will select the breed of bird that is most efficient in converting feed into eggs under their management system. Common breeds that are excellent layers available on the market for small scale producers are leghorns, sex-links, and Rhode Island reds. Their egg production ranges between 250 and 320 eggs per year (Clauer, 2012). Since the number of eggs produced per year varies across breeds and other factors, we collected data reported in the literature and from poultry websites (The Happy Chicken Coop, 2002; Patterson, 2022). Again, a triangular distribution was used for egg production with a minimum of 222, a mean of 307, and a maximum of 350 eggs per yr per bird. The quail simulation assumed a triangular distribution for egg production with a minimum of 250, a mean of 281, and a maximum of 342 eggs per wk per bird.

This simulation lasts for ten years (520 wk). In both the CWM, and CNM scenarios, chickens begin laying eggs at 15 wk old, while quail begin laying eggs at 8 wk old under Quail scenario (Table 1). At the beginning of year one, there is a period when eggs will not be produced for all scenarios. In subsequent years, we assumed the producer would be able to time the rearing of new chicks with the culling of spent hens, resulting in no gap in production. In the CWM scenario, hens will undergo molting 5 times over the 10-yr simulation. During the molting period, we made the conservative assumption that the birds would produce zero eggs for 8 wk (Berry, 2003).

Egg Farm Gate and Farmers Market Prices

Small scale egg producers can sell their products directly to consumers (often at farmers' markets), or through traditional commercial avenues. In this regard, our analysis considered both farm gate prices and farmers' market prices for eggs. A minimum of $1.17 per dozen, average of $1.86 per dozen, and a maximum of $3.01 per dozen, consumer price index adjusted values of 2007−2021 farm gate chicken egg prices, were used to simulate weekly farm gate prices following a triangular distribution (NASS, 2022; Table 4). Quail egg prices were more difficult to determine because the USDA does not collect quail egg price data. An online search was used to gather quail egg prices. The minimum price was $1.35 per dozen, the average was calculated as $2.45 per

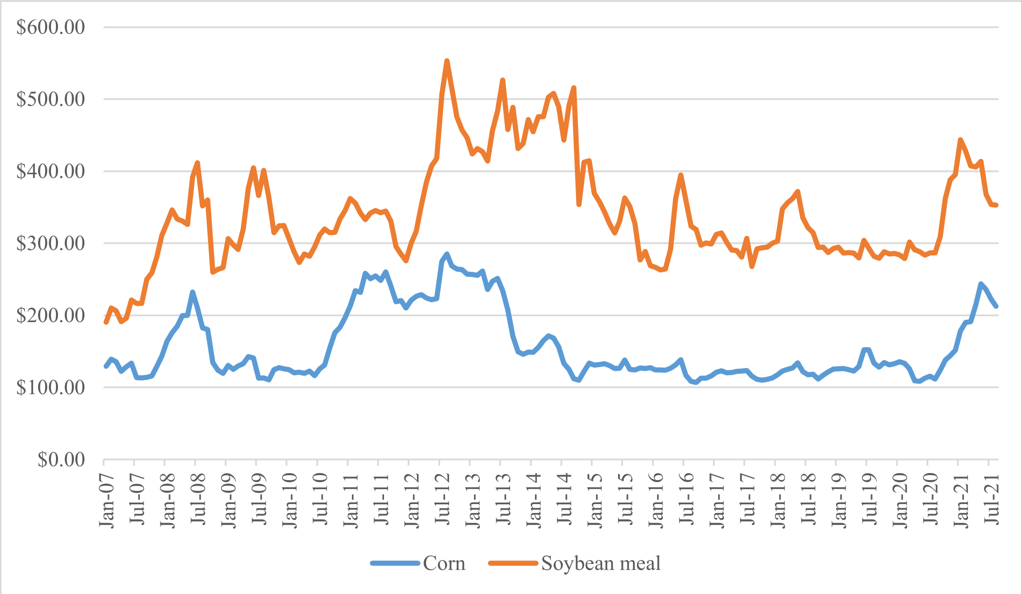

Figure 1. Monthly corn and soybean meal prices (per ton) 2007−2021.

dozen, and the maximum was $4.66 per dozen (Amazon, 2022; Etsy, 2022; Harding Gamebird Preserve, 2022; Walmart, 2022).

Data on farmers' market egg prices are scanty and vary widely based on the market's location. According to Salisbury et al. (2018), prices for food items are generally more expensive in farmers' markets, and farmers' market prices averaged 34% higher than prices from retail outlets. Estabrook (2011) found that eggs in farmers' markets are about 43% higher than eggs in retail outlets. This is attributed to the fact that commercialized egg production enjoys economies of scale, which helps reduce their cost of production. In this analysis, we assumed that egg prices are 40% higher in farmers' markets than in retail outlets (Table 4).

Table 4. Distribution of stochastic variables.

Variables	CWM[1] & CNM[2]	Quail
Egg production (number per year per bird)		
maximum	350	342
mean	307	281
minimum	222	250
Egg farm gate ($ per dozen)		
maximum	3.01	4.66
mean	1.86	2.45
minimum	1.17	1.35
Farmers' market egg price ($ per dozen)		
maximum	4.52	7.76
mean	2.79	4.09
minimum	1.75	2.26
Corn price ($ per lb.)		
maximum	0.14	
mean	0.08	
minimum	0.05	
Soybean meal price ($ per lb.)		
maximum	0.28	
mean	0.17	
minimum	0.10	

[1]Chicken with molting.
[2]Chicken without molting.

Meat Salvage Values

The second stream of revenue considered in the analysis is the sale of salvage meat. Meat from salvage hens at the end of their productive life usually has low market value. Semwogerere et al. (2018) reported that, compared to broiler chickens, spent layers have lower carcass and portion weights resulting in a lower market value. We assumed a moderate price of $1.50 per spent chicken as reported by Patterson et al. (2021). Meat from quail at the end of egg production generally has a higher market value. The salvage value for quail was set at $3.00 per bird (Clauer et al., 2005).

Economic Model

The financial comparison of the 3 scenarios is based on the expected net present value (NPV). For each scenario, the cost component consists of the fixed costs and the variable costs. The main fixed cost components considered include housing, equipment (feeders and drinkers), interest charges, and cost of egg cooling equipment. The variable cost for the producer includes the cost of DOC, feed, utility, bedding material, and labor. Because the amount of land used is constant across the 3 scenarios, the cost of land is not included in this analysis. Depending on the current price of land in any given area, a producer may not generate enough income from these scenarios to make a profit. Therefore, the NPV includes all costs other than land.

The expected net return R_s per week was estimated as:

$$E[R_s] = \sum_{w=1}^{M} \left(Revenue_w - Cost_w \right) \Big|\, s \qquad (1)$$

where s is either: $s = 1$ is CWM, $s = 2$ is CNM, $s = 3$ is Quail. R_s is the summation (Σ) of the $Revenue_w$ generated in week w less the $Cost_w$ generated in week w.

Revenue per week (*Revenue*) under scenario s is a function of the number of eggs *(E)*, price of eggs *(PE)*, and the salvage value of meat (*Salvage*):

$$Revenue_s = \sum_{w=1}^{M} [(E_w * PE_w) + Salvage_w] \Big| s \quad (2)$$

where E_w is the number of eggs produced in that week, and PE_w is the price of eggs in that week. Both E_w and PE_w are stochastically determined. *Salvage* is the revenue from spent birds in that particular week w.

Cost per week under scenario s ($Cost_s$) is:

$$Cost_s = \sum_{w=1}^{M} (VC_w + FC_w) \Big| s \quad (3)$$

where VC_w is the variable cost in each week. Variable cost is mainly driven by the feed cost in each scenario. In this analysis, the feed cost is based on historical prices of feed ingredients (corn and soybean meal) and is stochastically determined. Other expenses included in the variable cost are utilities, labor, and the cost of wood shavings for bedding. FC_w is the fixed cost component of the total cost. This cost includes housing cost, the cost of feeders and drinkers, interest payments, and other equipment. This cost is given on a per-week basis because it was assumed the fixed costs were being paid over their useful life.

To estimate the NPV for each scenario, we follow the mathematical formula:

$$NPV_s = \sum_{w=1}^{M} \frac{E(R_s)}{(1+r)^t} \Big| s \quad (4)$$

where $E(R_s)$ is the expected weekly net return for scenario s and r is the discount factor. We used a discount rate of 10% consistent with Bir et al. (2018).

RESULTS

Table 5 presents the results from our analysis when farm gate prices are used. In the CWM, the mean NPV is negative \$58,330 and has a standard deviation of \$3,449. The probability of a positive NPV is 0%. Similarly, in the CNM scenario, the mean NPV is negative \$51,476 and has standard deviation of \$3,566. The probability of a positive NPV is 0%. In the third scenario where the producer raises quail and accepts farm gate prices, the simulated mean NPV is positive \$109,389 and has a standard deviation of \$5,036. The probability of a positive NPV for the quail scenario is 100%. Using the farm gate prices, the quail scenario is the only option with a positive mean NPV.

Simulated mean NPVs using the farmers' market price data were positive in all scenarios (Table 5). In the CWM scenario, the mean NPV is positive \$188,843 and has standard deviation of \$4,645. The probability of a positive NPV is 100%. Similarly, in the CNM scenario, the mean NPV is positive \$216,436 and has standard deviation of \$4,850. The probability of a positive NPV is 100%. In the third scenario where the producer raises quail, the simulated mean NPV is positive \$327,893 and has a standard deviation of \$8,330. The probability of a positive NPV for the quail scenario is 100%. Using the farmers' market prices, the analysis shows that all the 3 options/scenarios have high positive mean NPVs. However, the third scenario, raising quail has the highest mean NPV.

DISCUSSION

In general, small-scale production of both chickens with and without molting is unprofitable if the producer must sell at commercial/farm gate. This is because small-scale producers do not benefit from economies of scale like large-scale industrialized producers. Quail production on the other hand is economically viable based on simulated positive NPVs even when the producer must sell at commercial/farm gate prices. This can be attributed to the fact that commercial/producer quail prices do not differ much from the reported retail prices at the farmers' market, or when sold direct to the retailer or consumer. The higher salvage value of the spent hens is another benefit of quail production. When farmers' market prices are used in the analysis, all mean NPVs are positive. This implies that small-scale egg production is economically viable when producers sell their eggs at farmers' markets or other higher value direct to consumer markets (Estabrook, 2011; Salisbury et al., 2018). An individual producer's ability to be successful is strongly dependent on selling all their product at those higher prices. Market analysis of the demand in any given area, or ability to access larger metropolitan areas

Table 5. Simulated Net Present Value (NPV) under different scenarios and egg prices over 10 yr.

	NPV				Probability of a positive NPV
	Mean	Maximum	Minimum	Standard deviation	
Sell eggs at farm gate price					
CWM[1]	−\$58,330	−\$42,068	−\$72,406	\$3,449	0%
CNM[2]	−\$51,476	−\$37,195	−\$67,505	\$3,566	0%
Quail	\$109,389	\$129,849	\$89,504	\$5,036	100%
Sell eggs at farmers market price					
CWM[1]	\$188,843	\$207,407	\$170,747	\$4,645	100%
CNM[2]	\$216,436	\$236,806	\$194,871	\$4,850	100%
Quail	\$327, 893	\$368,036	\$291,787	\$8,330	100%

[1]Chicken with molting.
[2]Chicken without molting.

needs to be considered before embarking on enterprises that rely on direct-to-consumer sales.

Despite the positive mean NPVs in all scenarios when farmers' market prices are used in the analysis, raising quail has the highest NPV compared to raising chickens. Similarly, raising chickens and replacing the birds frequently (no molting) has higher mean NPVs than raising chickens and allowing the birds to naturally undergo molting. Thus, raising quail is expected to be a more profitable venture than raising chickens. However, the percentage of small-scale producers that raise chickens is higher than raising quail. As noted by Clauer et al. (2005), small scale quail producers need to acquire new and/or necessary production and marketing skills for quail production. Comparatively, many small-scale producers may already have the necessary skill to raise chickens as well as increased availability of resource materials on chicken production.

The main driver of quail profitability is the lower cost of quail production reflected in the less expensive housing and feed requirements. The estimated cost of housing per quail is about $1.00 per year while it will cost the producer about $1.70 per chicken per year. Similarly, the cost of feeding an adult chicken (layer) is also significantly higher than the cost of feeding an adult quail. In our estimation, the weekly cost of feeding an adult chicken (layer) is 44% higher than the weekly cost of feeding an adult quail (20 cents). Research has shown that since 2002, the use of corn in production of ethanol and other biofuels has put upward pressure on feed prices for livestock and poultry, the cost of poultry feed increased from 30 to 70% of the total cost of production (Donohue and Cunningham, 2008). Therefore, it is likely that an alternative poultry enterprise which requires significantly less feed but is as productive as chickens will be more profitable if a market for the eggs/spent birds exists.

In comparing the chicken production options only, allowing the hens to undergo natural molting is less profitable compared to raising chickens without molting. The additional costs associated with raising chickens with no molting are the cost of purchasing day-old-chicks and the extra cost of labor associated with raising additional chicks. In our estimation, over the 10-yr period, the option of replacing the chickens every year instead of replacing them after 2 yr, will cost an additional $15,600, and result in additional labor costs of $7,540. We assumed replacing the chickens every year will require an additional 2 h per week in labor associated with chick rearing. However, these additional costs have associated benefits from the continuous egg production throughout the year. In this research, we assumed complete cessation of egg production during the 8 wk of molting, which translates to additional revenue of about $47,616 on average using farm gate prices in the non-molting scenario over the course of the project.

Throughout the analysis, it is apparent that the price at which the small-scale producer can sell their eggs is critical in determining the viability of the enterprise. For example, for both chicken scenarios, the mean NPVs only became positive when farmers' market prices were used in the analysis. Whereas farmers' market prices present enormous opportunity to the farmers, it is not without challenges. First, farmers' markets are only in a few locations. Thus, depending on the location of the farm, the producer might incur additional cost (labor and/or transportation) which can reduce the NPV of the project. Second, some farmers' markets also require expensive licensing, and have fees for selling. All these factors can result in a lower NPV based on individual circumstances.

Additionally, for the quail enterprise, depending on consumer preferences near the producer it may be difficult to sell all of the eggs and spent birds produced. It was also assumed that quail farm gate prices and farmers' market prices were similar. If commercial quail production were to increase, farm gate prices would likely decrease. However, based on previous literature, there would likely still be a premium for farmers' market quail eggs. Another important note is that the market for quail eggs is likely to be less stable than for chicken eggs. Chicken eggs are a commonly consumed and popular product in the United States. It is unclear what future demand for quail eggs will be. Producers should be aware of the demand for quail eggs in their geographical area before starting a quail enterprise. Saturation of the market could occur if several quail egg producers enter the same region and begin competing at the local farmers' markets and other direct to consumer outlets. However, US tastes and preferences are continuously changing. Future research is needed to determine regional demand for quail eggs, and to project future consumption trends.

CONCLUSIONS

In this study, we evaluated the economic feasibility of small-scale egg production and compared the profitability under 3 different production scenarios. We found that in all 3 production scenarios (chicken with the option of natural molting, chicken with the option of no molting, and raising quail) small-scale egg production is economically viable when farmers' market egg prices were used to calculate the NPVs. Using farmers' market prices, raising quail had the highest NPV. Raising chickens without molting had the second highest NPV while raising chickens and allowing them to undergo molting has the lowest positive NPV.

In contrast, when commercial/farm gate egg prices were used in the estimation, only the third scenario; raising quail had a positive NPV. Commercial/farm gate egg prices are low for chickens. Commercialized producers are able to reduce their cost of production through economies of scale, and can remain profitable despite lower egg prices. Therefore, it will be unprofitable for small-scale chicken producers to sell at the same price. However, quail egg farm gate prices do not differ much from their retail prices. Consequently, when small scale producers sell their quail eggs at commercial/farm gate prices, they will still be able to make profit.

In our analysis, quail production has a higher probability to be more profitable than chicken production. However, prior to starting quail egg production, the producer must thoroughly research possible markets for their products. Demand for quail eggs is location specific. Due to the above reasons, further research on developing marketing plans for these different production operations is recommended. Additionally, quail production has unique challenges. Producers may need additionally support from extension publications and classes to be able to successfully raise the less traditional quail.

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DISCLOSURES

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

Amazon. 2022. Quail eggs. Accessed Jan. 2022. https://www.amazon.com/s?k=quail+egg&crid=2XGBKW8Z1DSGF&sprefix=quail+egg%2Caps%2C88&ref=nb_sb_noss_1.

Banrie. 2012. Poultry litter management. Accessed Jan. 2022. https://www.thepoultrysite.com/articles/poultry-litter-management.

Batal, A., and N. Dale. 2016. Feedstuffs Ingredient Analysis Table: 2016 edition. University of Georgia, GA. Accessed Feb. 2022 http://feedstuffs.farmcentric.com/mdfm/Feeess50/author/427/2015/11/Feedstuffs_RIBG_Ingredient_Analysis_Table_2016.pdf.

Berry, W. D. 2003. The physiology of induced molting. Poult. Sci. 82:971–980.

Bir, C., and D. Zook. 2021. Simple budgeting and pricing calculations for backyard hens AGEC-1995. Accessed Jan. 2022. https://extension.okstate.edu/fact-sheets/simple-budgeting-and-pricing-calculations-for-backyard-hens.html.

Bir, C., M. N. Thompson, E. W. Tyner, J. Hu, and N. J. O. Widmar. 2018. "Cracking" into the debate about laying hens housing. Poult. Sci. 97:1–10.

Clauer, P.J. 2012. Modern egg industry. Accessed Jan. 2022. https://extension.psu.edu/modern-egg-industry.

Clauer, P., and E. Shoop. 2020. Space should increase as birds grow. Accessed Jan. 2022. https://extension.psu.edu/space-should-increase-as-birds-grow.

Clauer, P.J., G.L. Greaser, R.M. Hulet, and J.K. Harper. 2005. Bobwhite quail production. Accessed Jan. 2022. https://extension.psu.edu/bobwhite-quail-production.

Cunningham, D.L., and B.D. Fairchild. 2011. Broiler production systems in Georgia costs and returns analysis. Accessed Jan. 2022. https://secure.caes.uga.edu/extension/publications/files/pdf/B%201240_3.PDF.

Cunningham, D.L., and B.D. Fairchild. 2010. Broiler production systems in Georgia costs and returns analysis. Accessed Feb. 2022. https://secure.caes.uga.edu/extension/publications/files/pdf/B%201240_3.PDF.

Donohue, M., and D. L. Cunningham. 2008. Effects of grain and oilseed prices on the costs of US poultry production. J. Appl. Poult. Res. 18:325–337.

Estabrook, B. 2011. The farmers' market myth. Accessed Feb. 2022. https://www.theatlantic.com/health/archive/2011/05/the-farmers-market-myth/238661/

Etsy. 2022. Quail eggs. Accessed Jan. 2022. https://www.etsy.com/search?q=quail%20eggs.

Gibson, K. 2019. The biggest source of salmonella outbreaks? It's clucking in US backyards. Accessed Sep. 2022. https://www.cbsnews.com/news/the-biggest-source-of-salmonella-outbreaks-in-u-s-may-be-in-your-backyard/.

Harding Gamebird Preserve. 2022. Egg prices. Accessed Jan. 2022. https://www.hardinggamebirds.com/chick-egg-prices/

Hermes, J. 2016. How to feed your laying hens. Accessed Jan. 2022. https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw477.pdf.

Hy-Line North America. 2022. Accessed May 2022. https://hylinena.com/.

Ideal Poultry. 2022. Accessed May 2022. https://www.idealpoultry.com/.

Jackson Farms BLRW. 2022. Accessed May 2022 https://jacksonfarmsblrw.business.site/?hl=en

Kay, R., W. M. Edwards, and P. A. Duffy. 2016. Farm Management. 8th ed. McGraw Hill Edu, New York, NY.

Keith Smith Company. 2022. Accessed May 2022. https://www.keith-smith.com/

Kissel, D.E., M. Risse, L. Sonon, and G. Harris. 2015. Calculating the fertilizer value of broiler litter. Accessed Jan 2022. https://secure.caes.uga.edu/extension/publications/files/pdf/C%20933_3.PDF.

Lesley, C. 2021. 5 Ways 2020 changed the backyard chicken industry. Accessed Sep. 2022. https://www.thepoultrysite.com/articles/5-ways-2020-changed-the-backyard-chicken-industry.

Lichtenberb, E., D. Parker, and L. Lynch. 2002. Economic value of poultry litter supplies in alternative uses. Accessed Sep. 2022. https://www.researchgate.net/publication/228381593_Economic_value_of_poultry_litter_supplies_in_alternative_uses.

NASS. 2022. NASS quick stats. Accessed Jan. 2022. http://www.nass.usda.gov/QuickStats/.

Nelson Poultry Farms. 2022. Accessed May 2022. https://www.nelsonfamilyfarms.us/products.

New Country Organics. 2022. Mineral mix. Accessed Jan. 2022. https://www.newcountryorganics.com.

Painter, K., E. Myhre, A. Bary, C. Cogger, and W. Jemmett. 2015. Break-even analysis of small-scale production of pastured organic poultry. Accessed Feb. 2022. https://ucanr.edu/sites/CESonomaAgOmbuds/files/207450.pdf.

Palisade. 2022. @Risk software. Accessed Jan. 2022. https://www.palisade.com/risk/.

Patterson, H.P., P.G. Martin, K.E. Shoop, F.L. Kime, K.J. and K.J. Harper. 2021. Small-scale egg production (organic and conventional). Accessed Feb. 2022. https://extension.psu.edu/small-scale-egg-production-organic-and-non-organic.

Patterson, R. 2022. Best chickens for eggs and meat: dual purpose chickens. Accessed June 2022. https://www.thehappychickencoop.com/best-chickens-for-eggs-and-meat/.

Salisbury, K., K. Curtis, and C. Durward. 2018. Is local produce really more expensive? A comparison of direct market and conventional grocery produce pricing. J. Food Distrib. Res. 49:13–21.

Semwogerere, F., J. Neethling, V. Muchenje, and L. C. Hoffman. 2018. Effects of production systems on the carcass and meat quality characteristics of spent laying hens. Poult. Sci. 97:1990–1997.

Stokes, S.J., D.G. Hanson, K.J. Harper, and F.L. Kime. 2005. Financing small-scale and part-time farms. Accessed Jan. 2022. https://extension.psu.edu/financing-small-scale-and-part-time-farms.

The Happy Chicken Coop. 2002. Leghorn chicken: all you need to know. Accessed May 2022. https://www.thehappychickencoop.com/leghorn-chicken/.

Tobin, M. R., J. L. Goldshear, L. B. Price, J. P. Graham, and J. H. Leibler. 2015. A framework to reduce infectious disease risk from urban poultry in the United States. Public Health Rep 130:380–391.

Univar Solutions. 2022. Calcium carbonate. Accessed Jan. 2022. https://www.univarsolutions.com/calcium-carbonate-tech-16147443?-gIVoRvUAR15bAqAEAQYASABEgIELfD_BwE=&infinity=ict2%7Enet%7Egaw%7Ecmp%7E18058469001%7Eag%7E%7Ear%7E%7Ekw%7E%7Emt%7E%7Eacr%7E7573347583.

US Bureau of Labor statistics. 2020. CPI calculator. Accessed Sep. 2022. https://www.bls.gov/data/inflation_calculator.htm.

USDA. 2019. 2017 Census of agriculture. Accessed Jan. 2022. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf.

USDA. 2017. Comparison of SNAP Authorized Farmers and Markets FY2008 and FY2016. USDA, Washington, DC.

USDA-AMS, 2017. Farmers market promotion program 2016 report. Accessed Feb. 2022. https://www.ams.usda.gov/reports/farmers-market-promotion-program-2016-report.

Walmart. 2022. Quail eggs. Accessed Jan. 2022. https://www.walmart.com/search?q=quail+eggs.