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Small-Scale Pastured Poultry Grazing System for Egg Production

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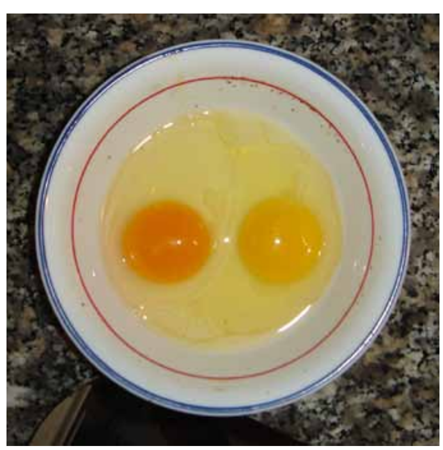
Raising you own food can be fun, rewarding, and also a great educational tool to teach children about simple animal husbandry responsibilities and the food production chain. There is a strong need in today's society to build upon the connections between the farms and ranches involved in agricultural production as the main sources of our food. With a greater interest in supporting local food production systems and community discussions about becoming more food self-reliant, small-scale poultry grazing systems can be integrated into many small farmsteads in our tropical ecosystems. With the closure of many commercial poultry operations in Hawai'i and in other Pacific island nations, small farms will play an important role in improving community food security and sustainability and will be a vital link toward building a network of people involved in the production and marketing of high-quality artisanal foods.

The objectives of this publication are to discuss the overall benefits of pastured poultry grazing, to provide basic guidance for developing a small-scale system, and to help you define your expectations about such a system.

Benefits

The pastured poultry grazing system is not a new production model but rather is one that incorporates many natural systems in a holistic approach to benefit the ecological, social, and economic goals of individual operators. The possible benefits of starting your own pastured poultry unit include

- providing fresh meat and/or egg products with a minimal carbon footprint or the need to import food miles
- recycling of household food residuals reduces our waste stream to the landfill and our environment
- developing an agricultural "ethic" in our children, by providing an understanding of where food comes from
- developing livestock husbandry skills and builds responsibilities in caring for animals that produce food
- introducing and integration of the natural systems (mineral, water, and plant growth cycles) involved in agriculture
- providing a sense of pride when providing high-quality foods in the community
- providing a potential source of additional revenue for the farmstead
- requiring less money than other larger systems and a relatively small production area
- providing a fun relaxation activity for families and a rewarding system to operate
- producing functional foods with highly nutritious compounds unique to forage-based production.



Fresh pasture-produced egg (left) compared to a typical imported egg.

Limitations

Although there are numerous benefits with these production systems, there are also some limitations, including the following:

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- Grazing environment and forage availability: The area should have adequate rainfall to sustain forage growth through most of the year. Variation in rainfall, elevation, and soil quality will affect the suitability of the system.
- Landscape terrain: The pen is limited to relatively flat areas and should not be used on steep, uneven, or rough terrain. Improper site selection will make livestock access and movement of the cage more difficult. Uneven terrain may allow predators to enter under the pen and prey on the hens.
- Livestock management: Livestock systems require frequent care and attention. You will need to allocate time for animal husbandry activities, such as feeding, checking the water supply, harvesting eggs, moving the cage, and others tasks.
- Local zoning varies by counties: Check local zoning regulations and/or subdivision covenants, conditions, and restrictions to see if livestock is allowed in your area.

Rotational grazing management

Oftentimes the controlled grazing aspects of the pastured poultry units are overlooked. Controlled grazing, also known as rotational grazing, intensive grazing management, or managed intensive grazing, adds many benefits to the landscape and operation, including the following:

- Animals are exposed to fresh, green forage regularly.
- Replacing imported feeds with supplemental, high-quality forages reduces operational feed costs.
- Forage cover crop reduces bare ground exposure and soil erosion and encourages water percolation and water holding capacity of the soil.
- Rotational grazing increases the plant's rest and recovery period, stimulating plant vigor and growth.
- A well developed forage plant community reduces weed competition.
- Distribution of manure is done by the birds and through the rotational system.
- No manure buildup results in significant odor and vector reduction.
- Nutrients from the manure (organic and mineral compounds) stimulate the nutrient cycling processes through the soil, building soil microbial activity, fertility and quality, thus benefiting plant growth in the grazing area.
- Solar disinfection by ultraviolet radiation reduces human exposure to pathogens contained in the manure.
- A chicken's innate behavior to scratch encourages soil surface aeration and organic matter incorporation into the soil.
- Animals become docile through daily exposure to humans.

Pasture poultry grazing pen designs

There are many examples of pasture-based poultry production systems and designs. Key driving forces behind the expanding knowledge base of this production model are led by farmer and author Joel Salatin of Virginia (http://www.polyfacefarms.com) and the American Pastured Poultry Producers Association (http://www.apppa.org), based in Pennsylvania.

The unit design and data on the forage crop used, egg production, and economics are specific to this case study. The discussion in this publication is intended to help you in the basic understanding of the system and be a guiding document for your pastured poultry project. Therefore, this publication will not cover specifics in raising the birds from chicks to the initial laying production stage. The case study site was located at 1500 feet elevation in a 35-inch annual rainfall belt where temperatures range from a low of 53° to 90°F in mid-summer.

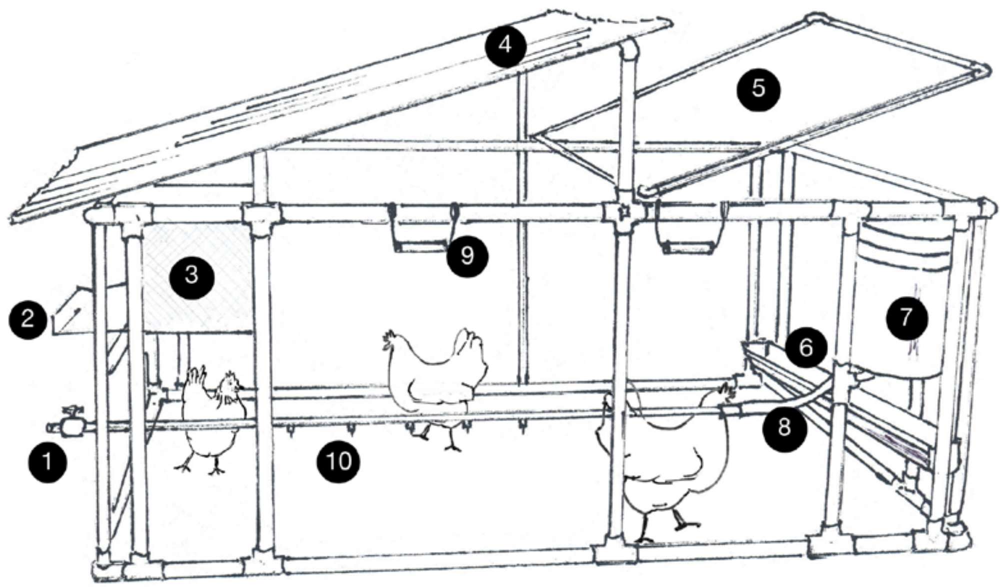
Case study in egg production

The pastured poultry grazing unit, also referred to as a "chicken tractor" or "grazing cage," is a an open-bottom mobile pen that includes a water system, feeding trough, roosting rod, nesting box with egg collection system, and shelter for poultry. The open-bottomed pen provides access to grazing by the mature hens while providing protection from predators (dogs, mongoose, hawks). In this system the birds are not allowed to roam freely on the farmstead property but are managed under your control in the grazing system. Control of the animals prevents unwanted damage to your vegetable or flower garden beds and soiling of household living areas.

Design preferences

Scan the Internet and you will see a multitude of design options. The basic design used in this case study was based on pastured broiler grazing cages observed at a Sustainable Agriculture Research and Education conference visit to a Texas farm. The pen in this study was modified with a nesting box and an egg collection system and reduced in dimension and scale.

Figure 1. Diagram of grazing cage identifying the various components.



(1) Valve (to flush out water reservoir)
(2) Egg tray
(3) Nesting box
(4) Partial roof cover
(5) Top cover (shown in open position)
(6) Feed trough
(7) Covered water reservoir
(8) Flexible hose connector
(9) Pull handles
(10) Nipple waterers

Materials and supplies

An exact parts size list is not given for the grazing cage construction; however, by reviewing the parts list (see Appendix 1) and using the diagram in Figure 1 as a guide, the unit is relatively easy to build by a do-it-yourself enthusiast.

The weight of the cage will vary with the type of construction materials used. A PVC cage is relatively light compared to lumber. The use of lighter gauge wire netting and aluminum or plastic roofing material will help to reduce the overall weight of the pen. The heaviest single component of the system is the water contained in the 5-gallon bucket. The easiest time to move the pen is when the water system is empty. Observe and match your cage rotation with the water consumption patterns. For example, if the cage rotation is every 3 days, fill only enough water in the system for a 3-day consumption period. This may keep you from straining your back or getting hurt while moving the unit. Another option to facilitate pen movement is to strategically add wheels to the unit, or keep a piece of pipe nearby to roll it on.

Breeds and egg color

Individual operators have their own preferences, such as for a particular color or certain type of food. Similar preferences apply with poultry breed choices, so breeds will not be discussed here. Another consideration, in relation to breed type, is the natural color of eggs, which usually range from white to brown, can be light blue or green, and may have solid color or be speckled.

Density

The area of the pen floor space may vary, but some recommendations are provided here. In this case study, four hens were housed in the grazing cage, providing an area of 8.75 ft^2 per bird. Optimum space requirements

Table 1. Relationship between stock density and rotation frequency for a 35-ft^2 cage.

Number of hens	Space per hen (ft^2)	Total daily forage consumption* (oz)	Rotation frequency (days)
2	17.5	0.76	6
4	8.8	1.52	3
6	5.8	2.28	2
8	4.4	3.04	1.5
10	3.5	3.80	1.2

*Forage yield estimates and per-hen grazing estimates of the perennial peanut for a 5 x 7-ft grazing cage are 4.6 ounces and 0.38 ounce per day, respectively.

specified by M.E. Ensminger (1971) for battery cage layer systems range from 2.5 to 3.5 square feet per bird for general-purpose breeds. Higher bird density will result in greater feed and forage demands, thus increasing the rotation frequency of the grazing cage unit. See Table 1 for examples.

Providing feeds and forages

A commercial layer feed was used as the main portion of the diet. The forage component in the pastured poultry grazing system provides a supplemental source of nutrients but will not provide all of the energy, protein, and mineral requirements for optimum egg production. As an omnivore, a chicken does not have the ability to utilize structural carbohydrates for energy, as do ruminant animals (cattle, sheep goats, etc.).

Feed requirements will vary with the size of the laying hens, with smaller breeds ranging in bodyweight from 3 to 4.5 pounds and requiring 66–110 grams (2–4 ounces) of dry matter intake per day for optimum production. Larger breeds may reach mature bodyweights in excess of 7 pounds and require feeding levels of 155–165 grams (5.5–6 ounces) per day. Do not feed more than the recommended level, as you will not get more production out of the hens. Offer just enough feed so that the hens consume all feed offered within 30 minutes.

Additionally, fresh food scraps provide a good diversity in the hens' diet. The omnivorous chicken can basically consume the same foods as we do. If the hens are fed to a point of satiety, grazing behavior will be reduced.

Figure 2. Pastured poultry grazing cage in action. Photo shows recovery of perennial peanut groundcover at 0, 5, and 12-days post-grazing.

You will need to fine-tune and balance grazing behavior and consumption of the feed ration. One strategy is to move the cage prior to feeding, so that the hens will seek out the diversity in the next offering of forages, such as weeds, flowers, or insects, in the new grazing area before consuming the commercial grain mix.

Forage choices

There are many types of forage that you can select for the system; the best advice is to start with utilizing the forages that are established in your grazing landscape and continue to experiment with other forages with a goal of increasing forage biodiversity over time. Most any stoloniferous-type forage grasses and legumes will be grazed by chickens and will enhance grazing cage moves in the pasture rotation. Avoid incorporation of bunch-type grasses, such as guinea grass (*Panicum maxi-*

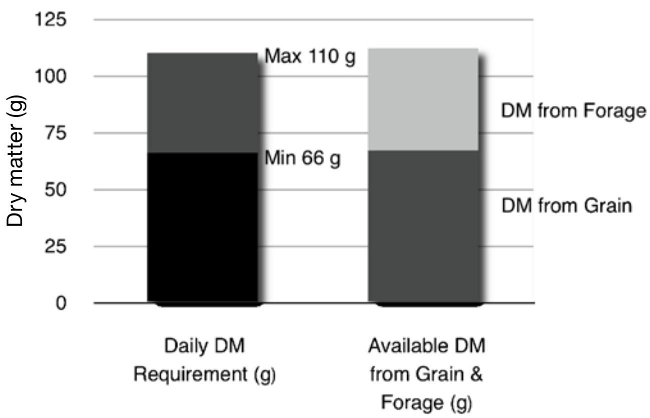


Figure 3. Range of daily dry matter required by a mature laying hen (left) and amount of dry matter provide from grain and forage.

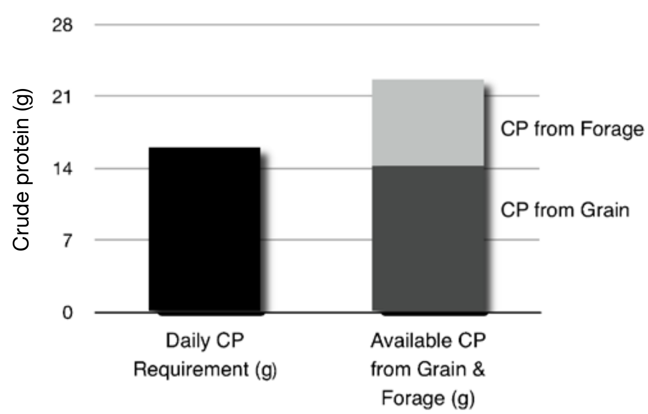


Figure 4. Daily crude protein requirement per hen (left) and amount of crude protein provided from grain and forage.

mum) and/or shrub-type forage legumes (pigeon peas, *Cajanus cajan*) into the grazing area as, these plants will make it difficult to move the pen. One of the challenges of tropical pastoral ecosystems is to establish and maintain high-protein or nitrogen-rich sources of forage within the plant community. Protein-rich feed ingredients are one of the costliest components of a complete livestock feed ration. Thus, in this case study, the legume called perennial peanut, *Arachis pintoi*, was used as the base forage. The perennial peanut is favored due to its innate ability to fix nitrogen from the atmosphere, adaptability to a wide range of environmental conditions, persistence due to a strong root system, seeding ability, and non-twining growth characteristic.

Forage production and composition

The chemical analyses from two samples taken of the perennial peanut are presented in Appendix 2. The grazed clip sample estimates the birds' consumption based on a visual appraisal of a three-day grazing residual, i.e., the forage sward was clipped to mimic the actual grazed residual. The total biomass clip sample represents the entire column of forage taken from the top of the forage canopy down to soil level, approximately 9 inches deep. The strata of the harvested column consisted of approximately 25% leafy material and 75% stems. The grazed clip analysis was used in the available nutrient calculations.

Nutrients provided by forage

In the case study, the hens were fed a commercial layer mixed ration daily, approximately one cup per day. This amount averaged 2.5 ounces or 70.9 grams/hen/day. The 5x7-foot grazing cage dimension provided 1.2 pounds of fresh forage for the four laying hens over a period of three days. The perennial peanut forage provided the following portions of the hens' daily nutrient requirements: crude protein 52.5%, calcium 24.5%, phosphorus 25.7%, and the amino acids lysine 60.9%, and methionine 37.1%. See Table 2 for nutrient contributions.

Grazier's notes

Reduced forage production

During times of slow forage growth, due to drought or seasonal effects, the pen rotation should be slowed down, allowing more time for the plants to recover. However, the immediate grazed area will result in heavy animal impact (grazing and scratching) and bare ground exposure. During this period you will need to add a bed of carbon materials on the floor of the pen, such as leaves, grass clippings, or mulch, to cover the bare ground and prevent unwanted weed establishment. This technique of dry litter bedding will allow extended rest periods for the other grazed sections.

Figure 5. (Left) Actual grazing residual prior to rotation of the grazing cage. (Right) Using calibrated vegetative hoops (Synergy Resource Solutions, Bozeman, Mont.), an estimate of forage removal by the hens can be calculated.

Table 2. Daily nutrient requirements of laying hens and nutrients provided by commercial feed and forage components of the diet.

Nutrients	Minimum daily requirements* per laying hen (g)	Available daily nutrients from grain, per hen (g)	Available daily nutrients from forage, per hen (g)	Total available daily nutrients per hen (g)	Daily nutrients available from forage (%)
Dry matter	66–110	67	45	112	41–68
Crude protein	16	14.2	8.4	22.6	52.5
Calcium	3.8	5.0	0.9	5.9	24.5
Phosphorus	0.35	0.6	0.09	0.69	25.7
Lysine	0.7	0.6	0.43	1.03	60.9
Methionine	0.35	0.28	0.13	0.41	37.1

*National Research Council Subcommittee on Poultry Nutrition, 1984

Weed control

If you have a particularly weedy area, the concentration of hens over an extended period of time will help to reduce the weed stand by grazing and scratching. The hens can remove the forage sward to bare ground. If this happens, it would be a good time to plant a desired forage species (during the growing periods).

Other feedstuffs

Pigeon pea (*Cajanus cajan*) is a tropical/subtropical legume that can be grown separately in a feed bank system where the harvested pea can be left on the stem and fed intact to the hens. The hens will shell the pods and eat the peas.

Papaya (*Carica papaya*) fruit is an excellent supplemental feed source.

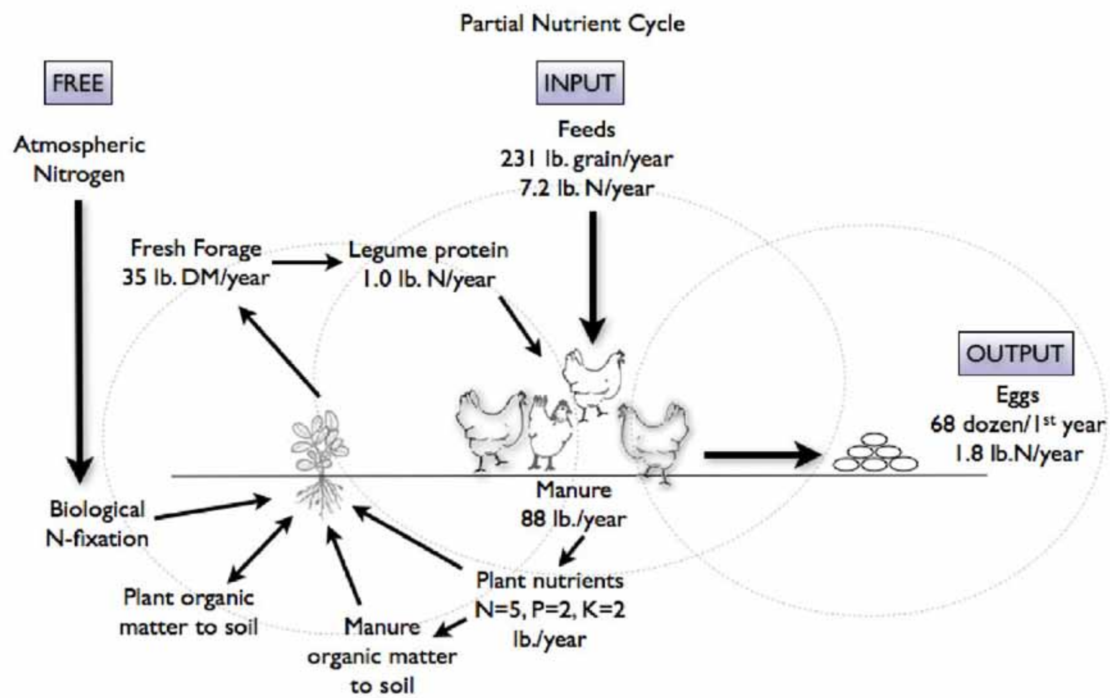
Grain sorghum (*Sorghum* spp.) volunteer seedlings became established in the grazing area and were readily grazed by the hens.

Ti (*Cordyline terminalis*) leaves can also be fed as a supplement. Hens will pick on the leaves and bark of harvested mature and seedling ti plants.

Other leafy perennials, such as edible hibiscus (*Abelmoschus manihot*) and tropical asparagus (*Sauropis androgynus*), provide diversity to the hens' diet.

Household food residuals can also be fed. Items such as bread, rice, vegetables, fruits, and some meats were fed.

Figure 6. The partial nutrient cycling that occurs in the grazing system.



Nutrient cycling potential

During an annual cycle, one mature laying hen will produce approximately 88.3 pounds and 1.36 cubic feet of manure (25% dry matter). Removing the moisture from the manure results in 22.1 pounds of dry matter, 1.21 pounds of nitrogen, 0.45 pounds of phosphorus, and 0.50 pounds of potassium. The organic carbon to nitrogen ratio of the layer manure is 7. Thus in this case study, four hens would produce approximately 88 pounds of dry manure and 5, 2, and 2 pounds of nitrogen, phosphorus, and potassium per year, respectively. The small contribution of nutrients and organic matter will start to stimulate the nutrient cycling in the rotational grazing area. As production continues over time, the nutrient cycling will continue to build and improve the soil and forages in the area.

Manure management

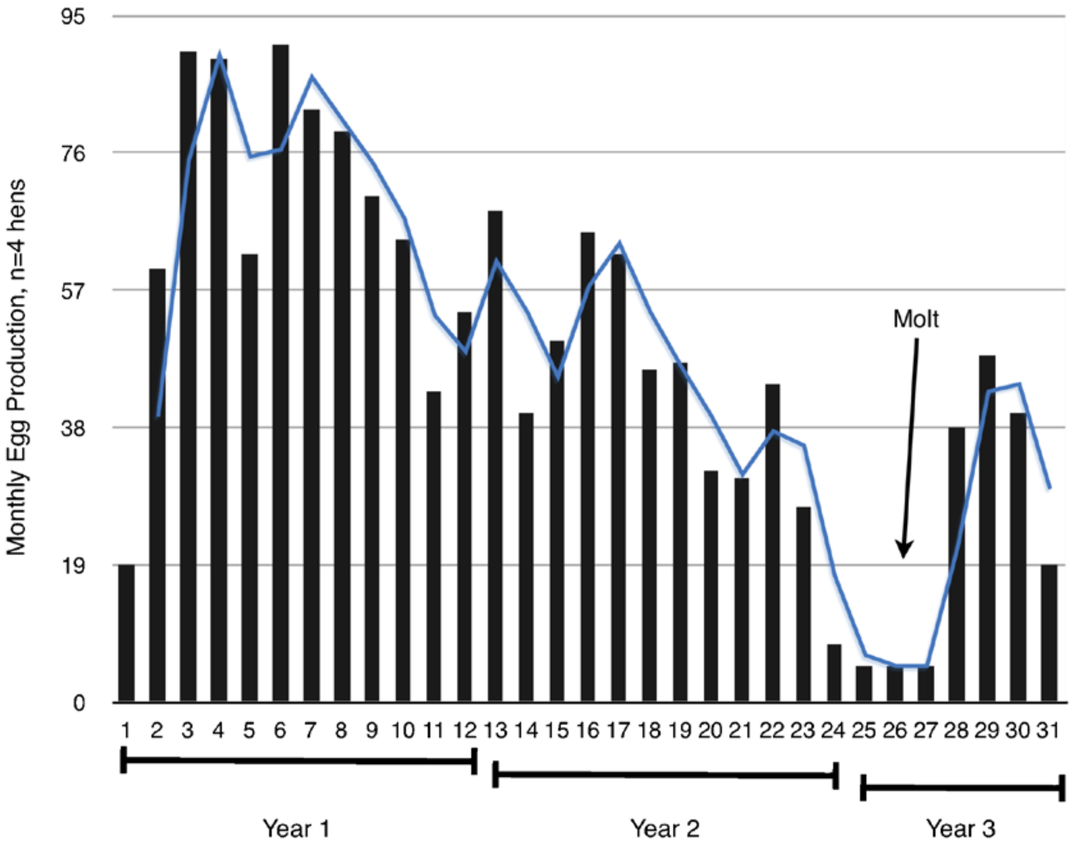
There is no manure management problem with the system. The hens do the distribution of manure, thus no buildup occurs. Odors and vector concerns are virtually eliminated.

Egg production and economics

It is well documented that as the hen ages, her egg production will drop. In commercial egg farms, most laying hen's productive lifespan is approximately two years. Figure 7 shows the egg production of the hens over the span of the data collection period.

Pastured poultry egg production will probably not match the productivity of environmentally controlled commercial operations; however, with pasture supplementation, the direct costs of feed per dozen eggs may be competitive with commercial production guidelines in the first year of production. Table 3 describes the commercial flock production goals (Ensminger 1971) and results of productivity and cost per dozen eggs. Key values include the amount of feed required to produce a dozen eggs and conversion factors. Keep in mind that in this case study, a full economic cost-of-production analysis was not conducted; it would include the cost of the chicks, pullet development, cage materials, pasture development, labor, and other costs. Due to the decline in production by Year 3, layers should be replaced in two- or three-year cycles.

Figure 7. Monthly egg production over a 2.5-year production run, started in October.



Estimating your cost per dozen eggs

The data generated from this demonstration can be used to estimate feed cost per dozen eggs produced. Manufactured feed prices have dramatically increased in recent times, nearly 40% over the span of the data collection period. This section will give you an idea of what you can expect from your homestead pastured poultry production in determining feed cost per dozen eggs produced relative to the price of eggs in the marketplace. Use values derived from Table 3.

Method 1: Multiply the feed/dozen value by the cost per pound of feed to calculate the cost per dozen.
Method 2: Multiply the cost/bag of feed by the conversion factor to calculate the cost per dozen.

The cost per dozen produced will increase with the age of the hens; use the appropriate value for the age of the hens.

Example: Assumption: Cost for a 50-lb bag of feed is $20.00 ($0.40 per pound).
For Method 1, multiply 0.40 x 3.36 = $1.34/dozen
For Method 2, multiply 20 x 0.06696 = $1.34/dozen

Other considerations

Animal health

No serious animal health issues and concerns were observed during the case study. However, be vigilant in your observation of the hens, as issues may arise.

Pecking order

Sometimes, when establishing the pecking order of the clutch, several hens may single out and pick on another hen. Minor beak trimming, to remove the sharp points, may help to reduce injury to the hen. If picking continues, it may be due to other causes. Most common reason is

Table 3. Data on production and costs.

	Commercial production goals*	Year 1	Year 2	Year 3
Average eggs/hen/day	0.66	0.56	0.36	0.19
Average eggs/hen/year	240	204	131	69
Large eggs or better	75%	NA	NA	NA
Feed/dozen, lb	4.5	3.36	5.22	9.92
Conversion factor	-	0.06696	0.10417	0.19737
Feed cost/dozen[1]		0.99	1.54	2.91

*From Ensminger 1971; NA = No egg sizing was done; [1]Based on $14.50 per 50-pound bag

related to mineral nutrition; where oftentimes a simple topdressing of table salt (1–2 teaspoons) over the feed for a couple of days will solve the problem.

Bathing box
A dusting box filled with soil, sand, or ground basalt may be added to the pen. The hens will use it to bathe themselves.

Parasites
In poultry grazing systems, the birds' exposure to diseases and parasites is higher, so you need to be vigilant in daily observation of the health of the hens.

Environmental effects
In cooler and higher rainfall environments, a plastic tarp secured around half of the pen will help to protect the hens from the cold, wet weather.

Conclusion
A pastured poultry grazing system for egg production is a simple and low-cost way to incorporate livestock into your farmstead operation to produce a high-quality protein food source and improve your family's and your community's food self-reliance. As you start to produce your own food, you become attuned to and cognizant of the sources of food that are grown by the farmers and ranchers in our communities.

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Appendix 1. Materials list for pastured poultry grazing cage (dimension: 5 ft wide by 7 ft long)

1-inch PVC parts for cage
10 elbows
32 tees
2 crosses
120 ft PVC pipe

½-inch PVC parts for cage cover
4 elbows
12 ft PVC pipe

Other materials
PVC primer
PVC glue (dry-fit parts before permanently gluing all connections)
1 box each of 1-inch self-tapping screws and lock washers
35 ft "chicken netting" hardware wire, 3 ft wide
PVC "clips" (made from 1½-inch PVC pipe segments, cut laterally into thirds)

Water system
5-gallon bucket
Rubber washer
Flexible hose
2 barbed couplers, ½ MPT x ½ barbed end
½-inch FTP cap, cut off cap end, use to secure barbed coupler to bucket
Gate value
Coupler, ½ S x ½ FPT
Automatic water bowl or nipple (www.farmtek.com, www.enasco.com)
Other commercial water systems: Ziggity Systems, Inc., Lubing Systems, L.P.

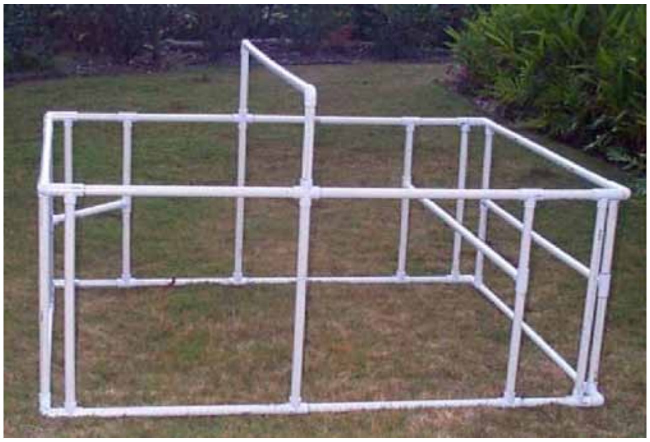
Feeder
5-ft vinyl rain gutter; set feeder at a slight angle to allow directional drainage of rainwater; drill a few holes in the bottom to allow water drainage.
2 gutter end caps (purchase or cut two pieces of wood to match the profile of the gutter)

Roof
10-ft corrugated roofing panel (aluminum or fiberglass panel preferred due to material weight)

Nesting box
1 cubic foot cube with wire mesh floor, interior painted black.
Option: purchase a plastic container and adapt it as a nesting box.

Pull handles
String a short piece of ½-inch PVC pipe through several strands of soft, heavy-gauge wire to form a pair of handles. Place the pair of handles on each side of the pen.

Construction notes and hints
Hardware wire. Base the height of the cage sidewalls (not including roof line) on standard hardware wire width. Three feet height is adequate for hens. The cage is not meant for the operator to crawl in and out on a daily basis.
PVC clips. Cut "clips" from 1-inch diameter PVC pipes. Cut a 1½-inch section of pipe, then cut it laterally to make three clips.
Roof material. Aluminum or fiberglass panel is preferred due to its light weight; however, it may cost more than standard galvanized panels.
Feed trough. Use plastic rain gutter as feed trough. Set the trough at a slight angle to allow directional drainage of rainwater. Also, drill a couple of holes in the bottom to allow water drainage.
Before final gluing. Dry-fit all parts before permanently gluing the connecting sections and joints.
Final note. Keep in mind that the grazing cage is bottomless to allow forage grazing.



Basic framework of the grazing cage.

Detail showing construction of reinforced corner design with water container support.

A simple plywood and wire nesting box allows easy retrieval of eggs. Only one nesting box is required, as the hens will share it.

Appendix 2. Chemical composition of perennial peanut, grazed and total biomass analyses.

	Graze clip (n = 3)	Total biomass clip (n = 1)
Yield, dry matter basis, lb/ac	1,493	11,840
Dry matter as harvested, %	23.83	37.95
Crude protein, %	18.5	13.2
Neutral detergent fiber, %	32.0	30.3
Acid detergent fiber, %	25.9	24.9
Lignin, %	6.5	6.2
Starch, %	3.3	21.0
Water soluble carbohydrates, %	14.1	11.4
Simple sugars, %	10.9	11.9
Crude fat, %	2.8	1.2
Ash or total mineral, %	10.59	5.24
Total digestible nutrients, %	63	37
Relative feed value	200	213
Calcium, %	2.03	1.08
Phosphorus, %	0.19	0.20
Magnesium, %	0.48	0.24
Potassium, %	1.53	0.95
Sodium, %	0.006	0.015
Sulfur, %	0.18	0.12
Chloride, %	1.04	0.37
Iron, ppm	95	343
Zinc, ppm	41	28
Copper, ppm	9	6
Manganese, ppm	16	30
Molybdenum, ppm	< 0.1	<0.1
Lysine, %	0.94	0.67
Methionine, %	0.29	0.21

Analysis by Dairy One, Ithaca, NY. www.dairyone.com