IDENTIFICATION AND DESIGN OF SUSTAINABILITY IMPROVEMENTS TO POULTRY PRODUCTION

by

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Abstract

The goal of this Honors Project in collaboration with the Sustainable Development Teaching and Research Farm is to create a plan for the improvement of poultry production infrastructure. Design of the new facility focuses on providing a space on the farm that allows for implementation of the latest standards and practices in sustainable poultry production. Principles from academic discourse were combined with the goal of certification in A Greener World's Animal Welfare Approved program for meat and layer chickens. Design choices aim to improve educational value, reduce environmental impact, and introduce new elements of production. The proposed facility incorporates streamlined record keeping, improved capacity for on-farm rearing of chickens, and provisions for sustainable grazing techniques to meet these goals. The designs are delivered in the form of several key planning documents. Expense estimates and a full bill of materials were created to guide the future planning of construction. Detailed structural plans in an appropriate scale are also provided, including design elements optimizing ease of construction and practical function.

Introduction

Currently, the Teaching and Research Farm operated by Appalachian State University raises multiple livestock species for market and educational value. Where practical, the latest production techniques are applied by faculty and students in the context of sustainable livestock courses. The farm's facilities regularly undergo updates as needs and opportunities emerge in production. This gives students the chance to gain experience with theory in a practical setting, reinforcing classroom instruction. In this way, they can take ownership of their education and experiment with any appropriate methods they find compelling.

On-farm poultry production is a staple of the operation, including two heritage breeds of chickens raised in two small houses. Currently, the chickens have access to an adequately large pasture area for forage and maintaining high livestock activity. The existing facilities are limited, both in total number of chickens and overall streamlining of operations. The two sheds are entirely devoted to housing the chickens, requiring all equipment and records to be stored elsewhere. Additionally, there is no integrated capacity for rearing chickens from egg to maturity on-farm. Having decentralized processes imposes serious limits to expansion of production and educational capacity on the farm.

In the larger context of sustainable poultry, improving production has been a widely explored topic in light of heavily industrialized conventional methods. While it is common to hear arguments centered around livestock production as wholly unethical, sustainability seeks a more moderate solution. The goal is to approach agriculture in a more holistic manner which mimics natural processes—processes that are rarely without fauna (Mann and Sherren, 2018). To achieve this, a more integrated approach than the elimination of livestock is critical. One key value brought by these methods over conventional or crop-only systems is replication of natural grazing that facilitates nutrient cycling within the ecosystem (Vaarst et al., 2015). Additionally, research has shown that integrated livestock systems offer numerous benefits with regard to restoration of degraded land, worker health, and improved animal welfare (Beker et al., 2004, Senthilselvan et al., 2011, Su et al., 2017). Such systems are a worthy goal for any program seeking to emulate the highest principles of sustainable development.

Educational Value

As an educational tool for the Teaching and Research Farm, the primary goal of poultry production facilities is to maximize the use of course time and emulate best current practices. The most basic issue with current facilities is that with resources spread over the farm, significant amounts of educational time are taken away from student's engagement with poultry production. The lack of room in the sheds also means that students can only modify pasture for trials with sustainable techniques. Experimentation with nesting, brooding, breed introduction, or on-farm hatching cannot be done without additional space in a separate location. This limits the flexibility of faculty to expose students to aspects of poultry production beyond housing and livestock maintenance.

The facilities also limit the farm's ability to participate in the most current poultry production programs. New standards and certification groups are being introduced nationwide with the goal of enhancing livestock welfare. As an educational resource focused on preparing students for the current field of sustainable agriculture, hands-on familiarity with emergent practices is a key goal. One such program that is already included in the classroom instruction of livestock management courses is the Animal Welfare Approved

(AWA) certification offered by A Greener World. AWA guidelines exist to bring farms producing all manner of livestock products up to the highest standards of health and monitoring for a more ethical industry (Mundy, 2018). Certification under these guidelines is already feasible for many of the other livestock varieties raised on the farm, but the strict requirements for poultry present a significant obstacle.

Among the largest concerns with pursuing AWA certification are the myriad standards for detailed record keeping. The certification program specifies that written plans for all aspects of management are kept both up to date and readily available for the program's auditors (Mundy, 2018). The various indoor workspaces around the farm are completely separate from the poultry production area, hindering the organization and implementation of this standard. A major goal of this project is to build in a clean and central area in which records are kept.

Specifically, the various recording and planning programs housed in a compliant facility are:

- Health management plan and records of health problems
- Veterinary treatment agreements, records, and medicines
- Hatching and rearing records
- Forage area (grazing system) and feed management plans
- Soil testing, pest control, and other "housekeeping" plans (Mundy, 2018).

Clearly, this is broad set of requirements that could quickly become cumbersome if not streamlined for ease of access. Considering that introducing students to this volume of management paperwork is a monumental task, creating the best possible conditions is a priority. Providing one area for the storage and preparation of these resources not only saves time and effort, but also allows for more effective supervision and guidance. It ultimately aids ensuring the standard for competent livestock workers (here students under professional supervision) is met beyond any doubt (Mundy, 2018).

To address this facet of AWA compliance, the new facility design revolves around one integrated instructional space. Where areas for teaching and work were separate previously, the main room of the proposed facility is laid out for flexibility. Extensive cabinets and counter space take priority, while also allowing adequate area for the instruction of groups of students. This ensures that time goes to gaining experience and managing poultry rather than gathering materials, as all resources can be stored in one place. To further centralize production, care was taken to include area for consumables in the same place as the paperwork.

To streamline veterinary care and records, a refrigerator was incorporated so that paperwork can be updated as supplies as used. In the same space there is also adequate area to store additional poultry feed, another resource formerly removed from its records. An entire wall and dedicated room are allocated for hatching and brooding chicks in accordance with AWA's goal of birth to slaughter rearing on one farm (Mundy, 2018). All of these serve the dual role of not only meeting new standards, but also furthering students' exposure to a more comprehensive kind of operation.

Management of Worker and Poultry Welfare

A key concern with poultry production is ensuring the welfare of workers and livestock through careful management. For decades, the primary risk factor associated with poultry has been ammonia (NH_4) production incidentally by systems, and its accumulation in poultry houses (Anderson et al., 1964). Studies of the effects of ammonia have shown that its presence lowers chicken productivity, causes many direct negative health impacts, and increases susceptibility to disease (Beker et al., 2004). The consensus is clear that ammonia control is a major concern for poultry producers in order to ensure ethical farming. Tragically, many of the contributing factors to this issue were identified long before conventional chicken production became what it is today; specifically, drivers of high ammonia levels include confinement indoors, longer intervals for litter removal, and a lack of free roosting activity (Anderson et al., 1964). It is common knowledge well beyond the sustainability and livestock discourses that these risky practices almost define what modern chicken rearing is.

With regard human health, the standards are no better. Systems that operate on the very risk factors identified over 60 years ago also put the health of workers at risk. As the birds suffer, so do their tenders: levels of reduced lung function from ammonia, endotoxin exposure, and high dust levels parallel effects seen in birds (Senthilselvan et al., 2011). Multiple studies have documented damage to the lungs of workers in poultry barns, increasing with seasonal confinement and flock age (Senthilselvan et al., 2011). Findings on the dangers posed to employees have increased in severity over time, with more significant risks expected to emerge as analytical methods evolve (Senthilselvan et al., 2011). This undoubtedly poses liability risks to existing farms as well as a major future obstacle.

Another incentive for utilization of sustainable poultry foraging practices is that more time outside improves indoor hygiene, and with it the safety of farm labor (Castellini et al., 2012). The overall reduction of risk due to flexibility and opportunities for direct management are hallmarks of holistic grazing practice, and attract many farmers to training on updated techniques (Mann and Sherren, 2018). Both productivity and overall welfare of livestock are closely tied to human welfare. This leads directly to demand in the industry for increased safety through improved housing design (Broucek and Bohustav, 2015). In accordance with historical conclusions, the focus is on designing production facilities to minimize confinement, facilitate ease of litter rotation, and allow for direct flexible management of the process as a whole.

These findings on the avoidance of ammonia and other potential hazards appear in the AWA guidelines the Teaching and Research farm aims to follow. One standard claims that ammonia levels should be minimized beyond what is commonly detectable to a human, as risks exist at any concentration the nose can sense (Mundy, 2018). The guidelines mandate that to avoid this, designs must account for ease of managing litter and bedding. Given that research also shows links to the size of a space, the proposed facility has oversized chicken rooms for both ease of cleaning and reduction of confinement. The AWA guidelines require 1.8 square feet of space per bird, translating to a maximum capacity in the new facility of 80 birds per room, or 160 total. This is far beyond any plans for expansion the farm has, but the extra space will ensure the health and safety of students and poultry.

One additional health benefit for the livestock derived from standards occurs as a by-product of the educational improvements to the site. In increasing both the extent and ease of accessibility to health records, students and farm managers will be able to better identify any negative health patterns in the future. The Laying Hen AWA standards specifically list record tracking for this purpose as a means to identify any social, environmental, or incidental problems with an operation (Mundy, 2018). Thus, designing to allow tighter control of factors influencing the health of birds and students became a priority.

Pasture Management

Beyond the welfare issues associated with poultry production, sustainability also focuses on creating positive environmental impacts while putting out high quality products. One of the ways this is accomplished is through grazing techniques that enhance or replicate natural processes. Enhanced grazing management is a broad category of practices, all utilizing some form of rotational grazing and integration of multiple livestock species. This represents a paradigm shift towards holistic practices that increase ecological health through more intensive management (Mann and Sherren, 2018). One of the issues with conventional livestock production addressed through these practices is the need to handle waste off-site.

Export of waste disrupts natural nutrient cycling processes by removing nutrients from the land while increasing carbon intensity from the transport of livestock wastes and feed (Vaarst et al., 2015). What this means is that nutrient processes related to the growth of poultry are often entirely divorced from the cycles of soil and primary production that generate feeds. In fact, a study developing an assessment method for the relative sustainability of poultry systems found that external feed costs are 60-70% of overhead and represent the largest environmental load posed by production (Castellini et al., 2012). A tremendous opportunity for heightened system sustainability exists here, as both farm expenses and ecological responsibility can be managed through one factor.

The benefits of emergent grazing techniques extend beyond feed costs and the environment; they affect to other aspects of farm operations as well. By combining natural foraging of poultry with other livestock—an integrated grazing system—expenses can be lowered for equipment required to maintain pasture and less fertilizer will need be applied (Patrizi et al., 2018). Shifting more farm resources from external sources (equipment, fuel, fertilizer and feed) to on-farm natural processes is the ultimate goal of sustainable agriculture.

One integrated livestock study described this goal as a movement towards a closed-loop system that thrives on combined effects of production systems (Patrizi et al., 2018). The authors go on to describe these labor-intensive methods as an excellent way to ensure high food production in a world with a growing population and shrinking resources; limited non-renewables and excess labor. A study of organic farms utilizing sustainable grazing practices also reported that they used significantly less energy than conventional farms (Castellini et al., 2012). This vision realizes the goal of sustainable farms to address both their own consumption and contemporary issues with the environment.

This environmental impact improvement is not limited to existing poultry pasture, offering additional benefits in ecological restoration. Currently, recommendations exist for China’s degraded ruminant rangeland to use integrated grazing in order to repair decades of damage to soils (Su et al., 2017). This situation is not unique to those regions whatsoever, as ruminant livestock monoculture is standard practice globally. After introducing chicken foraging to livestock rotation, a marked decrease in soil bulk density—the standard metric for compaction—was observed (Su et al., 2017). Not only did compaction decrease, but net primary productivity and vegetative cover rebounded despite the introduction of additional species (Su et al., 2017). This is particularly promising as those results imply that the addition of chickens to a grazing rotation program could yield more forage and capacity to absorb nutrients from manure.

The capacity to handle additional nutrient input is crucial, as the move toward natural nutrient cycles is an industry sustainability goal (Vaarst et al., 2015). A system without degradation would have both a higher absorptive capacity for nitrogen and higher nitrogen inputs while maintaining a net balance. Poultry integration aids both sides of the equation, balancing nitrogen input deficiencies from the export of nutrients consumed by ruminant livestock with higher inputs from chicken manure (Su et al., 2017). Overall, a larger nitrogen budget in proper balance moves pasture towards ecological recovery as well as long-term resiliency in accordance with sustainability principles.

These benefits of contemporary sustainable grazing programs are already a priority for the Teaching and Research farm, and are in use with some existing livestock. Cattle and swine rotate through pastures during the growing season to minimize degradation from overgrazing, and to meet soil management standards. While adequate, based on current findings there is room for improvement with the integration of poultry into these practices. Such action is recommended by the AWA program to ensure quality forage and maximize poultry health (Mundy, 2018). Current guidelines also stress the importance of managing soil health, and waste runoff control; though this is not mandated to come from grazing practices, outside literature strongly suggests that they are the best way to meet those goals (Mundy, 2018, Su et al., 2017).

The primary way the new facility would accomplish this is through a seemingly unrelated AWA requirement: catching birds to move them should be feasible with little to no chasing to avoid stress (Mundy, 2018). With the existing small sheds, nearly all capture involves groups attempting to work chickens in open pasture, a process that both takes excess time and increases stress. To rotate poultry behind other livestock (here, cattle and swine) they will need to be caught in a mobile unit that transports and temporarily houses them in a remote pasture (Mann and Sherren, 2018). By increasing the accessibility of the chicken rooms and enclosed yards, capture for movement to integrated grazing sites would be more efficient. In improving the means to work birds in a new facility, the many proven benefits of integrated sustainable grazing become attainable.

Preservation of Diversity through Heritage Breeds

Resiliency benefits from sustainable practices extend to the livestock themselves, specifically in their ability to cope with disease and varying environmental conditions. This is severely lacking in conventional designer breeds, which are highly susceptible to many health problems if not kept in carefully controlled conditions (Castellini et al., 2012). Higher maintenance requirements are an energy burden to farms in the form of climate control and medication, but also present more broad risks.

An industry focused on genetic monoculture increases the likelihood of a rapidly spreading disease wiping out poultry, but also by definition reduces overall genetic diversity (Vaarst et al., 2015). This is a serious problem since there is less genetic stock from which naturally adapted breeds can be selected to meet future demands. Sustainable grazing and livestock integration lend themselves to the use of multiple heritage breeds to take advantage of poultry’s natural foraging behaviors (Vaarst et al., 2015). A more immediate benefit to farms is that multiple species can be used to fill multiple roles, and ensure that at least one breed will maintain high levels of production under differing seasonal conditions (Castellini et al., 2012).

This is one goal of sustainable poultry production that is fully employed on the Teaching and Research farm, which uses two breeds of chicken well adapted to cooler climates. The breeds enable dual-purpose production, meaning they are suited for both meat and eggs (Mundy, 2018). In addition to the responsibility of farmers to preserve heritage breeds, these birds increase overall sustainability by eliminating the need to kill males in a layer operation (Vaarst et al., 2015). The AWA guidelines highly recommend this for the same reasons, but this is also a missed opportunity on the farm due to limited hatching capacity. While breed choice occurs as required, a model based on rearing males from egg to slaughter for meat and females for eggs is only partly embodied (Mundy, 2018).

Increasing the ability to hatch and brood chicks is not necessary for certification, as it is only a recommendation; however, there are many benefits justifying its inclusion in the design. For certification under AWA regulations, birds must spend their entire lives on an AWA facility, something simplified by rearing on only one farm (Mundy, 2018). Limiting the movement of livestock also provides biosecurity benefits, as any imported animal can serve as a vector for disease or pests (Mundy, 2018). For these reasons, space for an incubator and hatcher is provided in the main workspace in addition to a dedicated room for raising chicks until they can join the flock. This adds the benefit of reducing effort required when monitoring the flock, as all ages are housed in the same facility.

The utility offered from raising two heritage breeds already supports the farm’s production, but increased control could aid the farm in several ways. As chickens freely forage in the same undivided pasture, there is little biosecurity to prevent pests or disease from spreading between breeds (Mundy, 2018). Despite having two houses, there is essentially no distinction between flocks. Maintaining them in distinct rooms with segregated forage areas would aid both flock monitoring and selection of birds for integrated grazing. For AWA certification, biosecurity and the ability to selectively allow birds to forage based on their environmental tolerances is key (Mundy, 2018). This dictated the overall design of two separate chicken rooms opening into divided and enclosed forage areas.

Product Quality and Market Access

Considering the actual meat produced, analysis shows that due to foraging of insects and worms from pasture, meat from these systems contains higher levels of healthy fatty acids and antioxidants (Castelleni et al., 2012). This increases the competitiveness of farms in a market dominated by cheap conventional poultry, indicating that higher prices for sustainably produced meat yield tangible consumer benefits. Scientifically proven meat quality translates into market security for farms, giving their products selling points beyond an ethical label. This consumer appeal translates into important gains for farms, as increased prices combined with reduced expenses yields higher net income (Castellini et al., 2012). Economic benefits are an excellent tool to encourage the adoption of sustainable practices for farmers and bring responsible production into the mainstream.

This higher access to forage is the main selling point of AWA certified meat and eggs to the consumer outside of the production ethics. Requirements ensure that access to outdoor areas is provided to birds at all times unless there is a specific reason for temporary confinement (Mundy, 2018). One factor deemed an appropriate reason to keep chickens indoors in the certification guidelines—despite the loss of activity, forage, and cleanliness associated with confinement—is predation pressure (Mundy, 2018). To avoid sacrificing product quality and farm health due to the presence of predators, a fully wire enclosed yard is included in the design. While birds can still access the rest of the pasture when managers deem it appropriate, they are guaranteed outdoor forage time within the two separate yards.

Conclusions

Without a major upgrade to the farm's infrastructure, the standards set forth by the AWA are unattainable. The chicken sheds currently in use were not designed to the specifications AWA lays out, which are largely space and efficiency oriented. The opportunity here lies in the pasture the chickens are currently located in, which provides more than adequate foraging area under the new guidelines. Appropriate land already in use on the farm means that the benefits of certification could be attained with the construction of a replacement for the existing sheds. Beyond the benefits of AWA certification, there are still many areas of improvement with respect to overall sustainable production techniques. In light of recent work extolling environmental, health, and economic benefits, a change is needed to allow the farm to embody the best model of a sustainable poultry operation.

By providing a design for a facility tailored to these needs, the Teaching and Research Farm will be able to improve both production and education in the near future. With a certified a higher quality of meat and eggs, farm income from these products should aid in the continual improvement of facilities in keeping with developments in sustainable production. In terms of education, students will one day enjoy an increase in time spent immersed in a facility that can provide experience on par with any sustainable operation they encounter in the future. Additional opportunities to take responsibility for comprehensive record keeping, egg to maturity chicken rearing, and intensive grazing management will connect strongly with the principles covered in the department’s curriculum. Overall, the goal of this project is to further production’s representation of what the farm stands for: being a prime example of the best sustainable practices for students and the community.

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Designs and Planning Materials

Grand Total	**Construction Stages:**	**QTY**	**Supplier**	**Unit Cost (from Quotes)**	**Estimated Total/item**
11569.034					
Lowes	**Setting posts/floor**				
8721.35	2x10 joist hangers	72	NRBS	1.208	86.976
NRBS	Concrete mix	24 bags	NRBS	4.878	4.878
2000.588	NRBS Donated Posts/Joists/Flooring	N/A	N/A	N/A	N/A
Sherwin Williams					
245	**Framing**				
	2x4x8	182	NRBS	2.922	531.804
	2x4x14	10	NRBS	2.922	29.22
	2x4x16	33	NRBS	5.627	185.691
	7/16x4x8 OSB sheathing	24	NRBS	7.217	173.208
	9x150 House wrap	1	NRBS	78.439	78.439
	2x8x14 yellow pine	4	NRBS	10.544	42.176
	2x8x12 yellow pine	16	NRBS	10.515	168.24
	2x8x10 yellow pine	8	NRBS	8.339	66.712
	2x8x20 yellow pine	4	NRBS	not in quote	96
	2x8x8 yellow pine	12	NRBS	not in quote	120
	7/16x4x8 OSB Sheathing	26	NRBS	7.217	187.642
	2x8 rafter ties	50	NRBS	0.309	15.45
	Wires/Misc.--With building dried in/framed				
Wiring	12/2 romex UF-B 250 ft	1	Lowe’s	66.49	66.49
	14/3 romex NM-B 250 ft	1	Lowe’s	73.78	73.78
	3/4" gray elect. Conduit 10ft	12	Lowe’s	2.47	29.64
	1g cover	4	Lowe’s	0.59	2.36
	2g cover	12	Lowe’s	1.19	14.28
	toggle switch	4	Lowe’s	0.59	2.36
	receptacle	24	Lowe’s	0.51	12.24
	1g box	4	Lowe’s	0.32	1.28
	2g box	12	Lowe’s	0.79	9.48
	8' LED double light strips	5	Lowe’s	76.49	382.45
Insulation	R19 roll insulation 24"OC	896 sq ft	Alt. Source		441.52

Alt. Source	R13 batt insulation 2x4 walls 16"OC	800 sq ft	Alt. Source		439.89
	R19 faced insuation 16" OC floor	600 sq ft	Alt. Source		331.14
Gutters	5" white aluminum gutter	104 ft	Lowe’s	6.62	72.82
Alt. Source	gutter hangers	52	Lowe’s	1.52	79.04
	gutter seamers	12	Lowe’s	4.66	55.92
	outside corners	4	Lowe’s	8.49	33.96
	gutter dropouts	2	Lowe’s		
Metal	Barn Red plain ribbed galvalume Metal Roofing:				
Alt. Source	3x14	8	Lowe’s	30.45	243.6
	3x12	9	Lowe’s	26.1	234.9
	3x10	4	Lowe’s	21.75	87
	3x8	12	Lowe’s	17.4	208.8
	20' Barn Red ridge cap	4	Lowe’s	41.05	164.2
	1.5" red roofing screws hex head	800	Lowe’s	0.14	112
	15# roofing felt 36"x144'	3	Lowe’s	16.95	50.85
	1" button cap nails	1	Lowe’s	25.95	25.95
	Int. Sheathing/ ext. finishing				
interior	1/2" Sheetrock (4x8 sheets)	54	Lowe’s	8.02	433.08
	4x8 interior plywood beadboard	18	Lowe’s	21.85	393.3
	Vinyl floor covering	576 sq ft	Lowe’s		400
exterior	1x8x8 fascia	14	Lowe’s	10.26	143.64
	HardiePlank lap siding	100	Lowe’s	8.35	835
	w/Hardie corner trim	20	Lowe’s	10.14	202.8
	Doors, Windows, int.				
Porch	2x6x12 treated	6	Lowe’s	9.61	57.66
	5/4x6x12 treated	6	Lowe’s	8	48
	3 step stringers	2	Lowe’s	9.33	18.66
	4x4x10 treated posts	4	Lowe’s	12.01	48.04
Doors and Windows	36x48 horizontal slide window	6	Lowe’s	125	750
	Single Hung window 32x36 approx	2	Lowe’s	100	200

	Prehung 36x80 half light doors	3R/1L	Lowe’s	207.90/196.33	800
Cabinets, counters, shelving	10' kitchen countertop straight	1	Lowe’s		106
	36" base cabinet (unfinished oak)	2	Lowe’s	119	238
	24" base	2	Lowe’s	87.3	174.6
	30" top wall cabinet	2	Lowe’s	84.15	169.7
	2x4x8	12	Lowe’s	2.96	35.52
	15/32 pine sanded 4x8 plywood	4	Lowe’s	23.72	94.88
	3/8" CDX plywood	22	NRBS	16.416	361.152
	Yards				
	4x4x10' treated	8	NRBS	10.262	82.096
	2x4x12' treated	21	NRBS	7	147
	3/4" poultry staples	5 lbs	Lowe’s	3.16	3.16
	3/32" vinyl coated galv. Steel Cable	100 ft	Lowe’s	18.98	36
	turnbuckle	8	Lowe’s	1.92	15.36
	clamp	8	Lowe’s	0.99	7.92
	gate spring	2	Lowe’s	8.32	16.64
	gate latch	2	Lowe’s	3.3	6.6
	gate pull	2	Lowe’s	3.9	7.8
	t hinge	4	Lowe’s	4.07	16.28
	vinyl coated chicken wire	1	Wire Cloth Man 5x150 165		165
	bird netting	1	Strombergs 2" 25x50 61		61
	Misc. Hardware				
	16d nails	2	Lowe’s	11.9	23.8
	8d nails	1	Lowe’s	11.9	11.9
	1 1/2" galv. hanger nails	4	Lowe’s	3.91	15
	1/2" T50 staples	2	Lowe’s	9.59	19
	Paslode 3" framing nails	2	Lowe’s	57.59	115
	Hitachi 2 1/2" finish nails	1	Lowe’s	33.29	33.29
	White silicone paintable caulk	12	Lowe’s		22.77
	Great Stuff	6	Lowe’s	3.83	23
	Paslode fuel cells	4	Lowe’s	11	23

Paint	Ext Brown	5 gal	Sherwin Williams		100
	Ext trim white gloss	2	SW		25
	Int sheetrock primer	1	SW		60
	Int walls	5 gal	SW		30
	Beadboard stain	1	SW		30

Materials Estimate List: This table was developed to provide a total cost estimate as well as organize material sources and construction stages. Over the course of the project many quotes were received from New River Building Supply and Lowe's; this sheet facilitated decision-making. For several items, it is noted that the final decision was to seek a contractor (gutters, roofing tin, and insulation) for a reduced cost and more efficient installation.

Major Prep/Orders	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
A,B,G	Post setting prep (Skilled Labor)	Post prep (Skilled Labor)	Cementing Posts (Selected Labor)				
C,D	Flooring and Framing (Selected Labor)		Framing (Selected Labor)		Framing/Flooring Workday this weekend (Selected Labor)		
E,F	Week for Tin, Insulation, Wiring and gutter installs (Contractors and Skilled Labor)				Workday to finish walls and panelling this weekend (Open Workday)		
	Paint and installation of interior (Selected Labor)						

Construction Stage Orders: Material Headings From Estimate Sheet

ORDER A

Setting posts/floor

ORDER B

Framing

ORDER C

Wires/Misc.

ORDER D

Int. Sheathing/ Ext. finishing

ORDER E

Doors, Windows, Int.

ORDER F

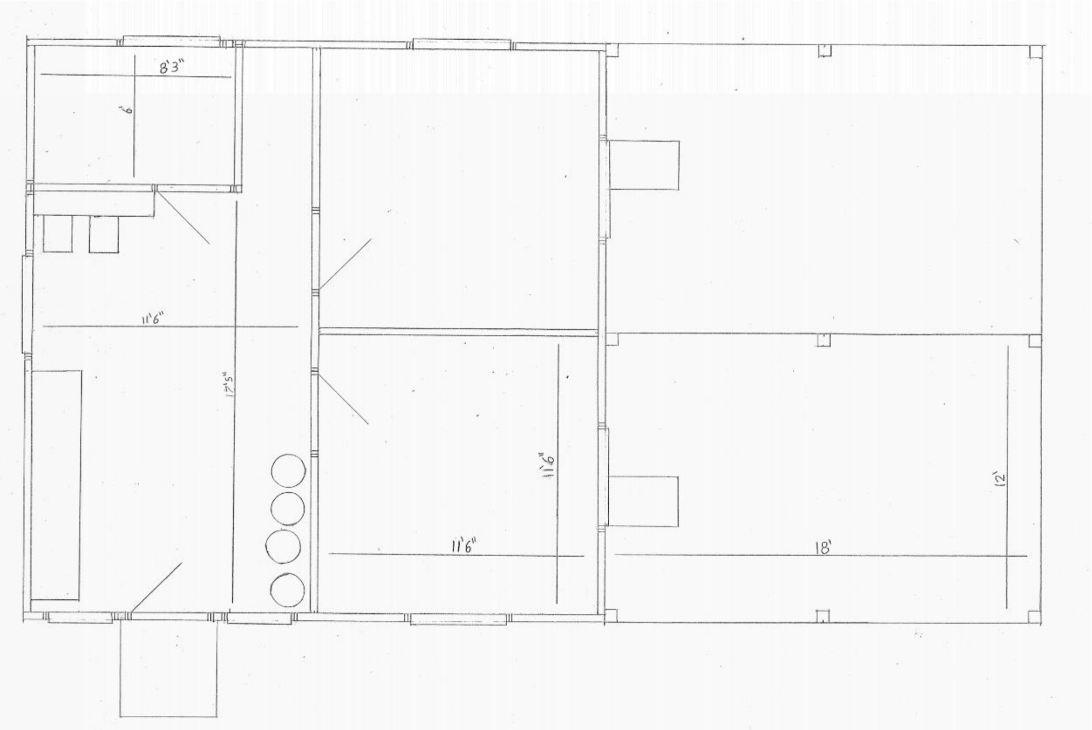
Yards

ORDER G

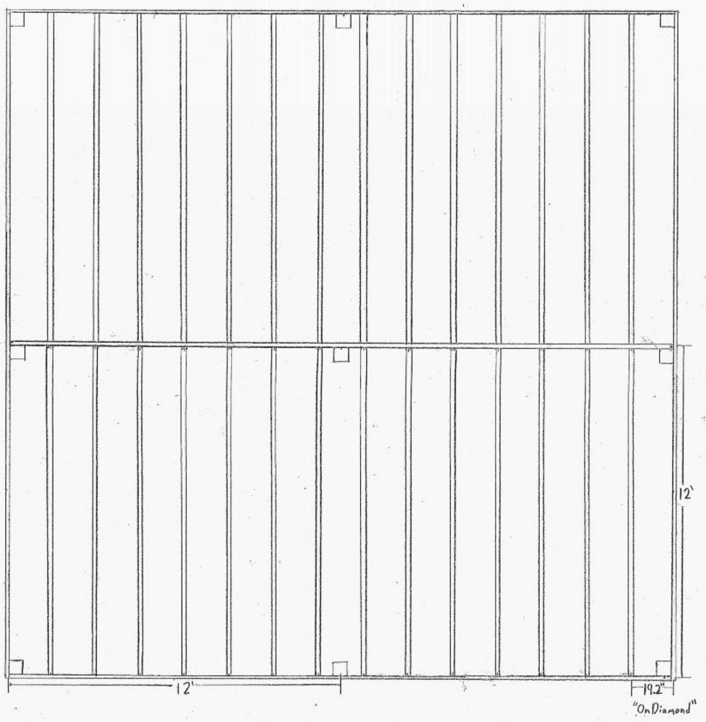
Misc. Hardware

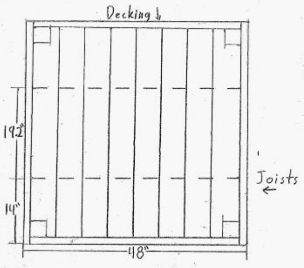
Construction Schedule: This calendar and order schedule was originally tied to specific construction dates; however, with the postponed construction it will be a useful guide. The schedule guides the planning of construction workdays and orders, breaking materials into smaller jobs for budgeting purposes. Decisions about what labor to use for what tasks is also important:

- Skilled Labor—Jobs requiring precision and knowledge, to be carried out by Farm Managers and Myself only
- Selected Labor—Jobs that can be safely carried out by supervised students with some prior knowledge. These are opportunities to give students from selected courses hands-on experience with more intensive parts of the project.
- Contractors—Jobs like roofing, gutters and insulation will be completed by hired specialists, so a week is allotted to allow for their availability.
- Open Workday—Simple jobs, in this case hanging paneling, which can be safely supervised if done by any student volunteer. This allows for an open request to Sustainable Development student volunteers to learn about construction and take ownership of the new facility.



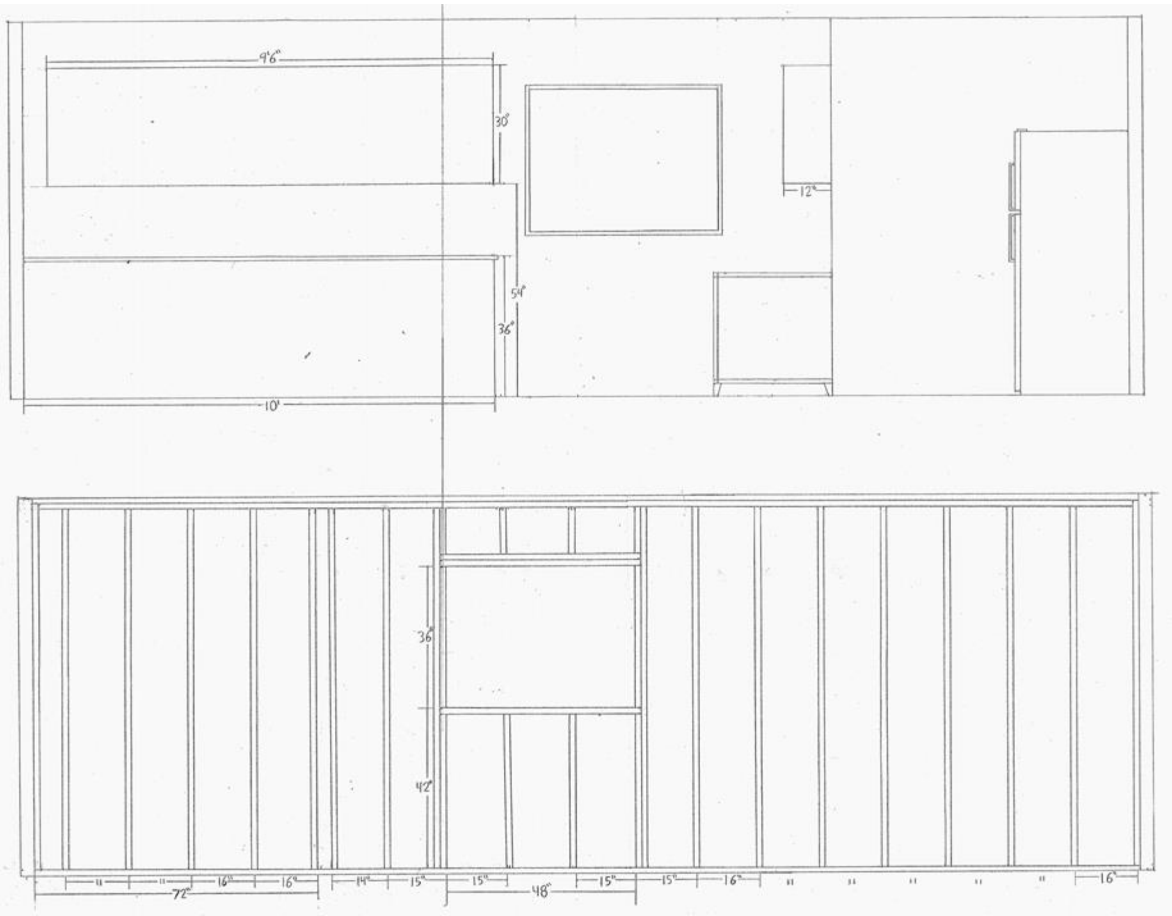
Facility Floor Plan: Overall scale layout of the proposed facility showing all rooms, yards, and features. The upper left corner is the brood room for rearing chicks until they can join the flock. Beneath it is a five-foot set of wall cabinets sitting above the hatcher and incubator, adjoining the alcove for a medicine storage refrigerator. The front door leads to the porch, and is flanked by full cabinets and floor space for feed storage. To the right are the two chicken rooms, opening via ramps into twelve-by-eighteen foot enclosed poultry yards.



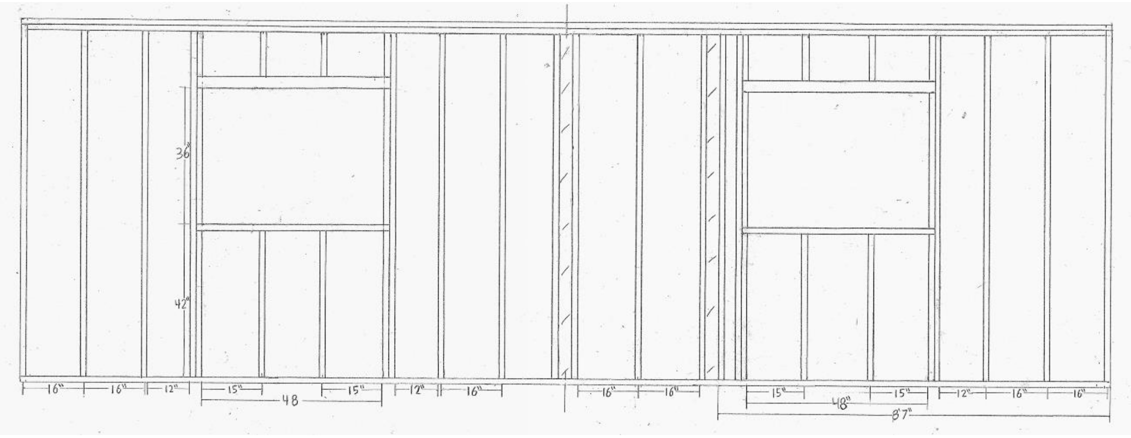


Floor Joists and Posts: These are scale plans for the posts, border boards, and floor joists that support the facility. They are 2x20 joists spaced at the traditional “On Diamond” interval. The smaller plan is a 1:12 scale plan for the four-by-four porch, with four posts, decking, and two joists centered on the “diamond” interval.

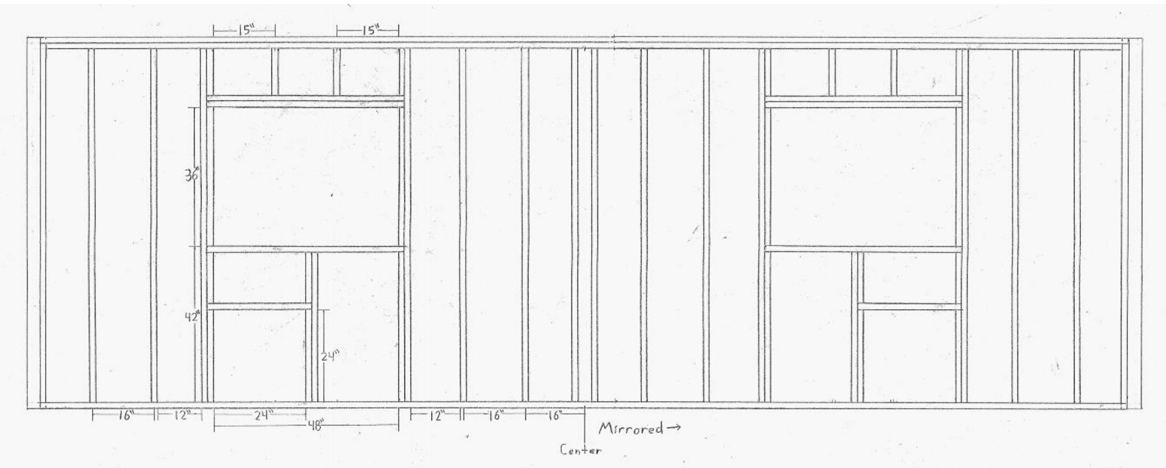
Interior and Exterior Views of Front Wall: The top perspective shows the front wall from the inside. A chicken room is shown on the left, featuring an AWA compliant roosting frame and nest boxes. The right side shows the front door and windows, as well as the ten-foot lower cabinets and nine-and-a-half-foot upper cabinet. These will be used for equipment as well as storage space for the extensive operational record-keeping required under AWA guidelines. The space to the left of the door offers room for feed barrels as well as wall space for the addition of shelves if needed. The bottom drawing is the structural plan for the front wall, shown from the outside looking in.



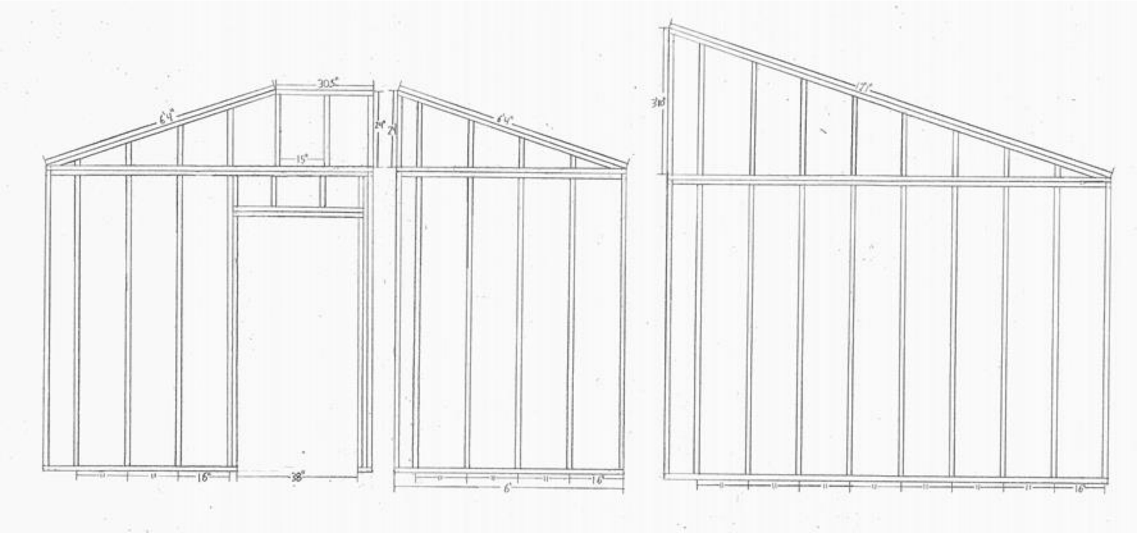
Interior and Exterior Views of Main Workspace Wall: The left side of the wall features large upper and lower cabinets with a ten-foot countertop. These offer record keeping space, equipment storage, and room for educational resources. The right side of the wall contains the brood room, upper small cabinet, incubator, and alcove for the medical fridge. The bottom drawing is the structural plan for the main workspace wall, featuring a 3-way joint for the brood room wall six feet from the left corner.



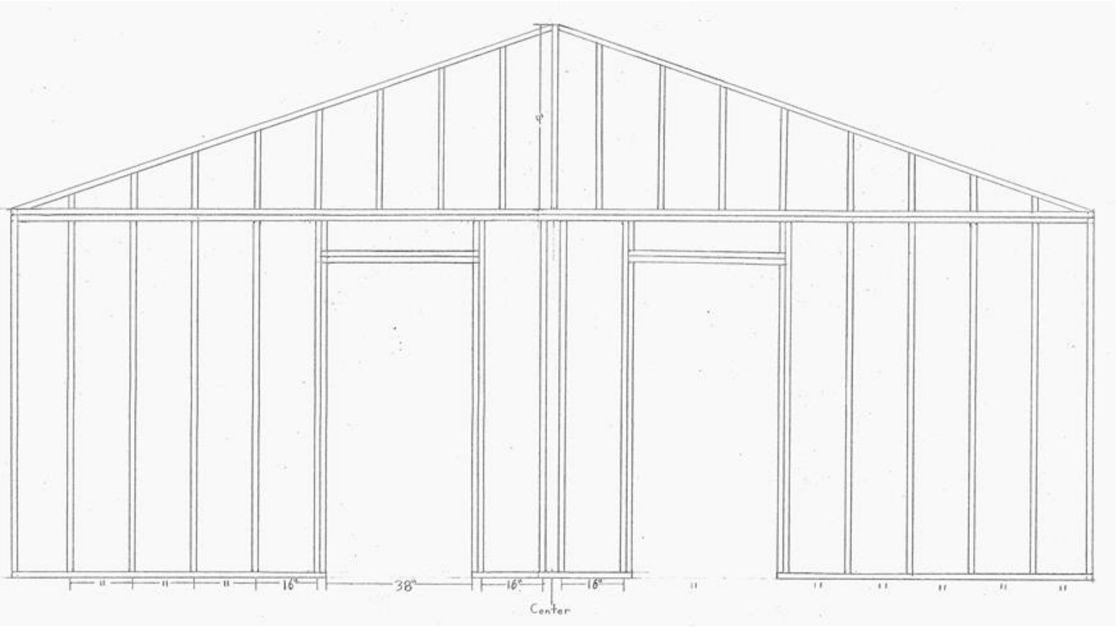
Back Wall Structural Drawing: This is the structural plan for the rear wall of the poultry facility viewed from the outside. The left side of the wall is a chicken room, the center is a 3-way joint for the dividing wall, and the right 3-way joint and window are for the brood room.



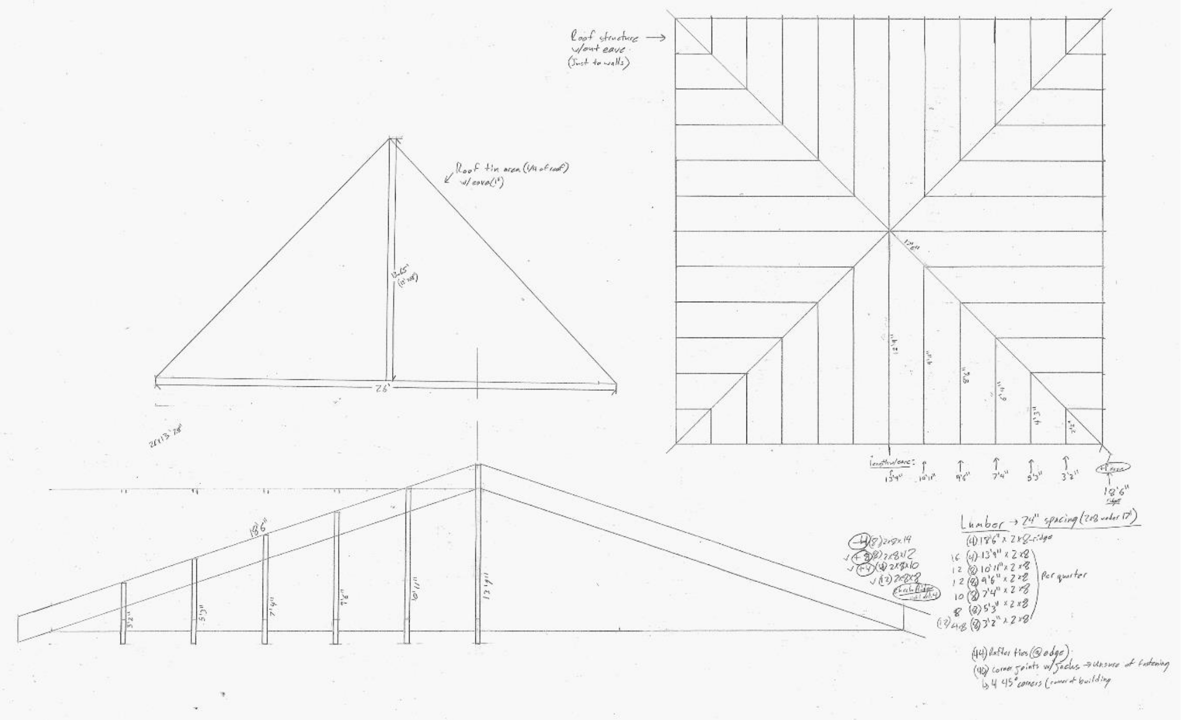
Poultry Yard Wall Structural Drawing: This is a structural drawing of the wall with windows and doors facing the poultry yards. Chickens can exit to the yards via two-foot-by-two-foot doors integrated into the jack structure beneath the window, streamlining movement and control of forage activities. In the future, integrated grazing practices will be facilitated via easy loading of a chicken tractor backed against these doors. The center of the wall features a 3-way joint for the chicken room divider.



Structural Drawings of Brood Room Wall and Chicken Room Divider: The Brood room walls are drawn from the outside looking in, and feature upper sections that will seal to the underside of the hip-gable roof for heating and biosecurity. The divider wall will sit between the main facility divider wall and also has a segment that seals to the hip roof.



Structural Drawing of Main Facility Divider Wall: This wall sits in the center of the facility, and offers access to the chicken rooms via half-light doors for ease of observation per AWA guidelines. It features a section sealing to the roof as well as a 3-way joint for the chicken room divider wall.



Hip-Gable Roof Structural Plans: Due to the complex geometry involved in stick building a hip roof, these plans are presented differently. The upper right drawing shows the total roof surface area per quarter for calculating roofing tin needs. The upper right image is a line diagram of structural ridges and jacks that form the roof with their lengths, showing the unique four-ridge layout of a hip roof. The bottom drawing is a partial view from any side of the roof, showing a centered jack between two ridges. This illustrates a construction view of the roof with eaves, as well as the full lengths of jacks. The calculations for lumber lengths are included in the original plans to aid in any changes or re-calculations due to the complex geometry of hip roof designs.