Homesteading in a Modern Society

THEORETICAL QUESTION

Can a family of four be self-sufficent on five acres of land?

NARRATIVE OF THE THEORETICAL ASPECT

In today's society people have become disconnected from how and where they get their food. It is simpler for food to be processed and packaged at large plants, then have the food shipped across the county to grocery stores. This way of mass producing and distributing food results in food that is less nutritious, less fresh, and contains more chemicals and preservatives. Producing your own food leads to a healthier diet and lifestyle. The reason many people have turned away from the homesteading lifestyle is because of the amount of money needed to establish a homestead and the amount of labor needed to maintain it. If there was an affordable and simple solution to having a homestead, people may be drawn back to the homesteading lifestyle.

MAJOR PROJECT ELEMENTS

- Residential House
  - Provides sleeping and living spaces for the family
  - Sustainable design to lower energy needs and costs
  - Pantry to store one year's worth of food harvested from the homestead
- Livestock Barns
  - Stalls and pens for livestock
  - Storage spaces for feed and equipment
  - Milking stanchion
  - Sustainable design to lower energy needs and costs
- High tunnel / Garden Spaces
  - Greenhouse to increase the growing season
  - Raised garden beds to provide a year's worth of food
  - Irrigation system

GOALS OF THE THESIS PROJECT

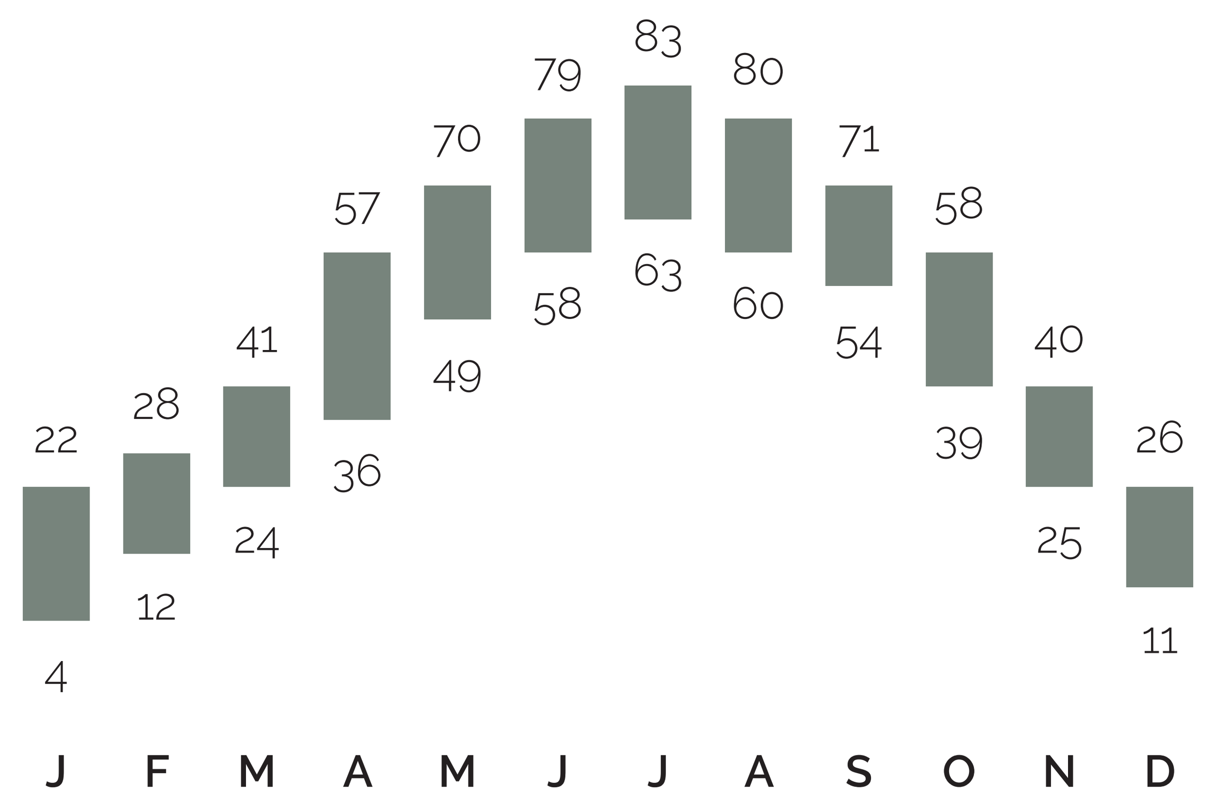
- Demonstrate that homesteading can be accomplished in a modern society.
- Understand how to efficiently and affordably run a homestead.
- Provide an alternative to the traditional way of providing for one's family.
- Understand how to create efficient and self-sufficient housing.
- Understand how to create a space suitable for growing food efficiently.

JUST ENOUGH ACRES
EST 2021
PARK RAPIDS, MN

THE RESEARCH

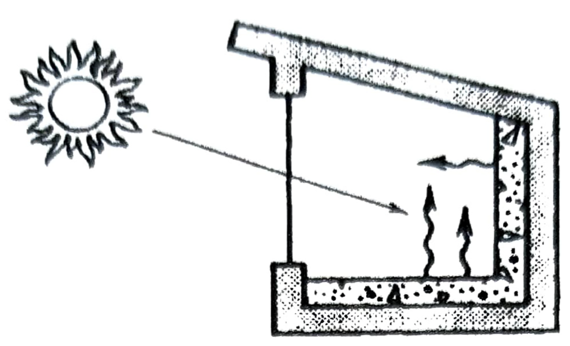
PASSIVE HEATING & COOLING

AVERAGE HIGH & LOW TEMPURATURE

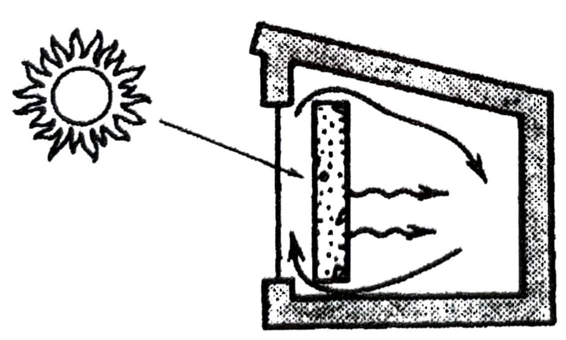


According to average monthly temperatures, the house will need to be heated between September and April and cooled between June and August.

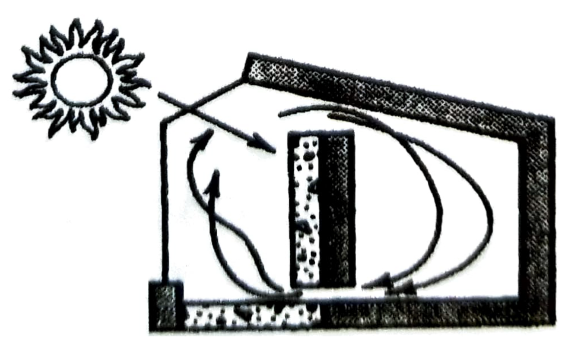
Passive Heating Strategies



Direct gain uses heat from the sun that comes directly in to heat a space. This is most commonly achieved by placing large windows on the south facade.

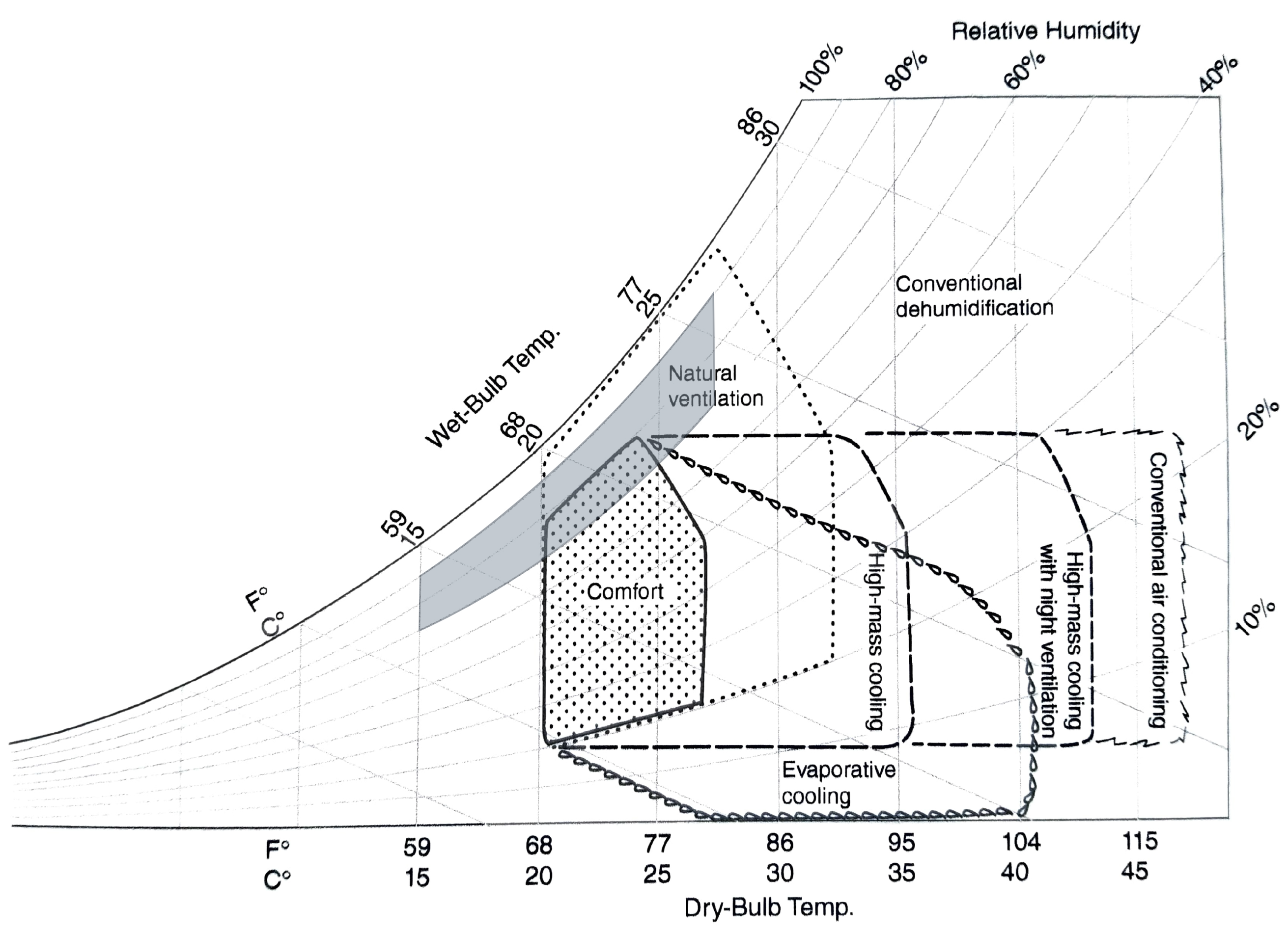


Isolated gain traps heat from the sun in an intermediate space. Sunlight enters a space, heat is trapped within the space, then distributed throughout the rest of the building



Thermal mass uses a large mass to capture heat during the day and radiate it into the space at night. Thermal masses can also be used during the summer to cool the space.

Passive Cooling Strategies



According to the Psychrometric Chart, cross ventialation will be the most effective strategy for cooling the house in the site's climate.

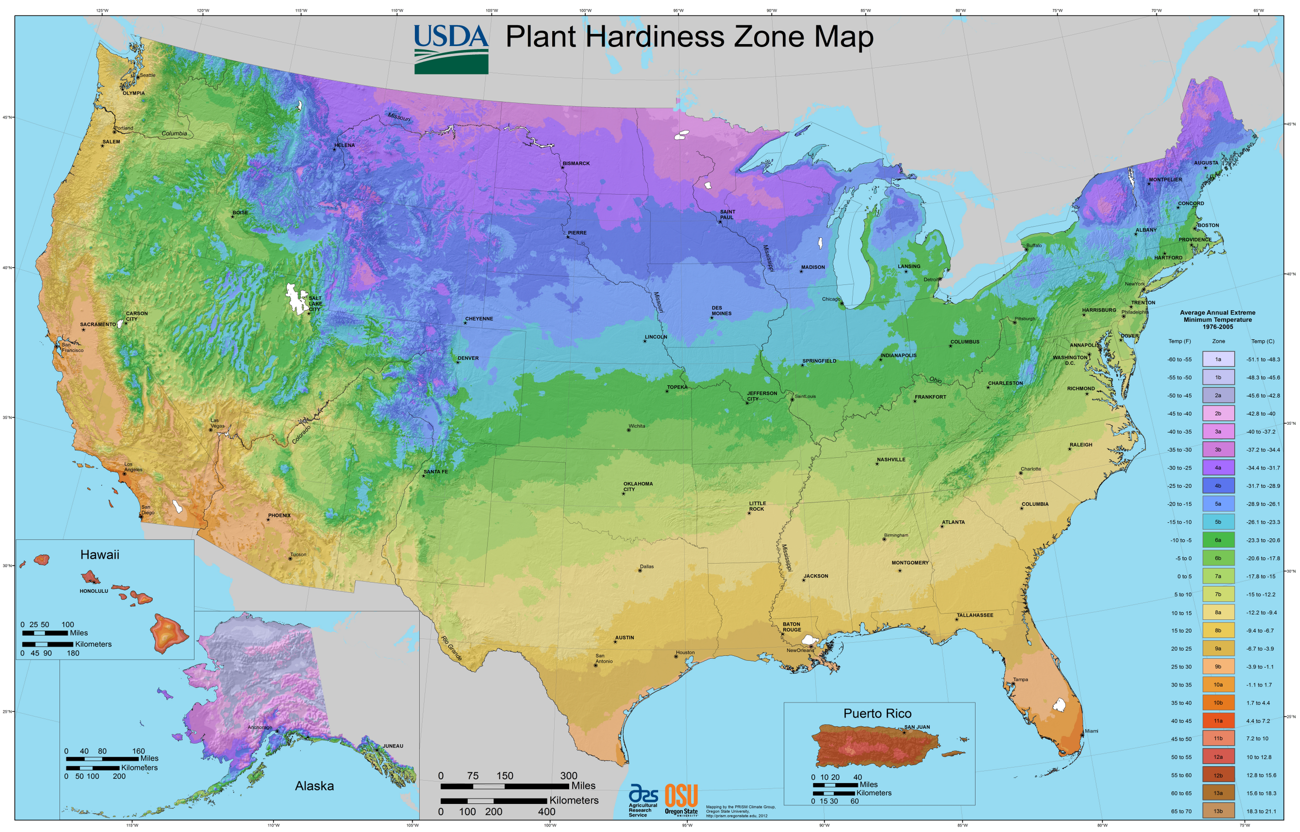
BOTANICAL

Square Foot Gardening

Square foot gardening uses raised beds divided into square foot sections to maximize the yield of a garden space. Unlike row planting, soil stays friable in SFG because you do not need to walk along rows to maintain crops. It also uses much less water and requires less weeding compared to row planting.

Plant Hardiness Zone

This site is located in growing zone 3a. The growing zone indicates which crops can be planted. Crops not within the growing zone can either not be planted or must be kept in a greenhouse. The growing zone will be listed on the back of the seed packet or on the label.



Greenhouses

Hoop House / High Tunnel

- Moderately extends the growing season
- Easy to build
- Requires an irrigation system

Conventional Greenhouse

- Use heaters and solar energy to extend the gowning season
- Requires skilled construction
- Requires an irrigation system

Cold Frame / Hot Bed

- Easy to build
- Protects plants from frost
- Does not need an irrigation system

LIVESTOCK

General Care

Most animals do not need to be kept indoors or in a heated space. In some cases, it may be detrimental to animals as it can affect their natural cycles. In most cases, a shelter that protects animals from wind, rain, and summer sun is all that is needed. Barns used to house animals indoors should be well ventilated. Poor ventilation can cause health issues such as pneumonia.

Livestock can either be kept in a pasture or hay fed. Pasture feeding is more sustainable, but may result in animals that produce less than other animals. Animals raised in a feedlot require much less space, but need to be provided with hay. No matter if livestock is kept in a pasture or feedlot, hay will need to be provided in winter when snow covers the ground.

Water should be provided to livestock at all times. Lack of clean water can result in many health risks year round. Lastly, animals are most likely to drink water that is kept at 50 degrees..

Dual Purpose

Dual Purpose Animals are animals that provide more than one resource (meat, eggs, milk, wool, hide) or skill (protection, herding, transportation). It is important to use dual purpose animals on a homestead with limited space because they will produce twice as much as other species to maximize the efficiency of the resources. Dual purpose animals are sometimes referred to as Heritage Animals because they were often used on farms and homesteads.

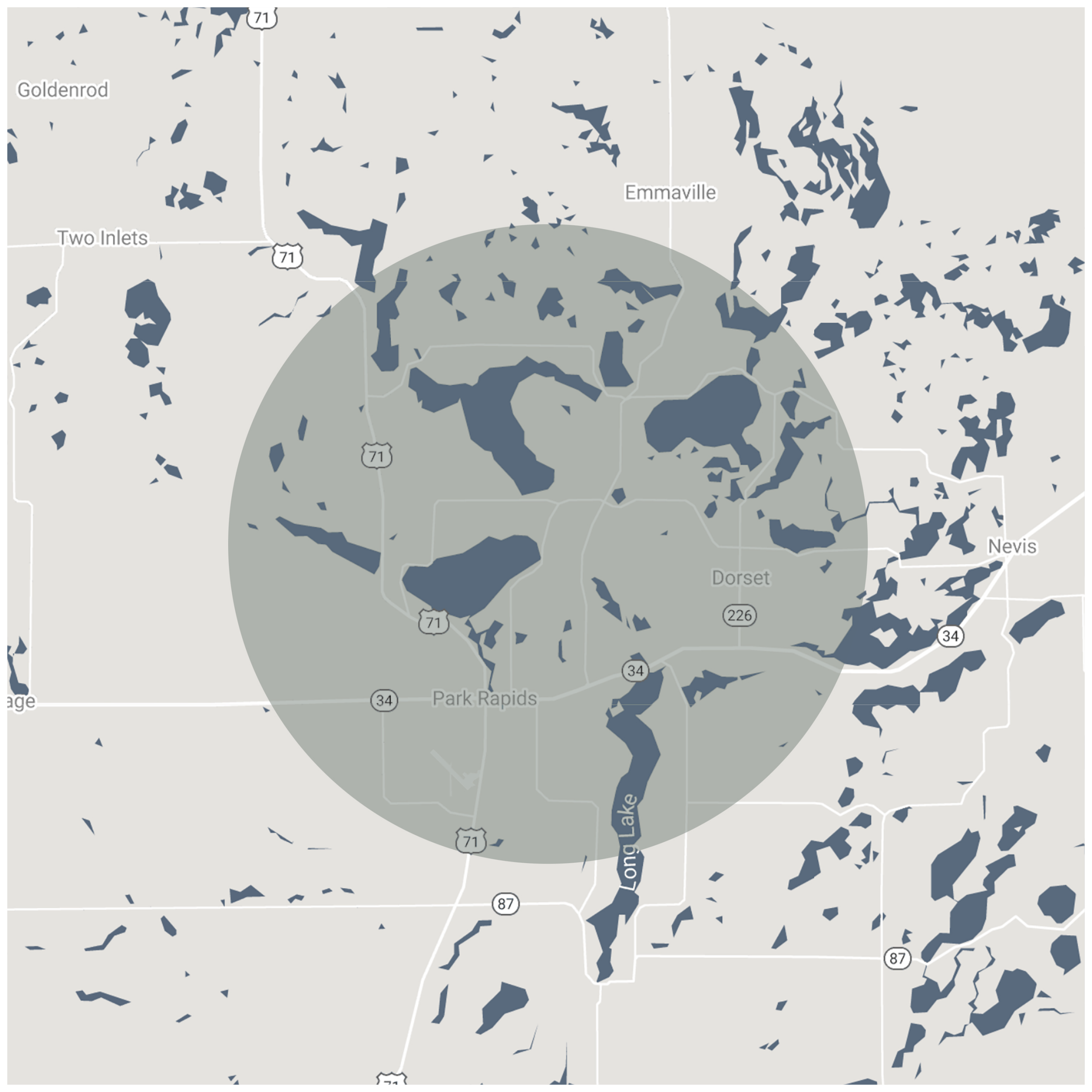
Rotational Grazing

Rotaional grazing centralizes basic needs, such as water and shelter, and controls where livestock can graze. By allowing certain pens to "rest" the pastures' yeild increases by reducing waste. Rotaional grazing also works as a natural pest control and increases its drought resistance.

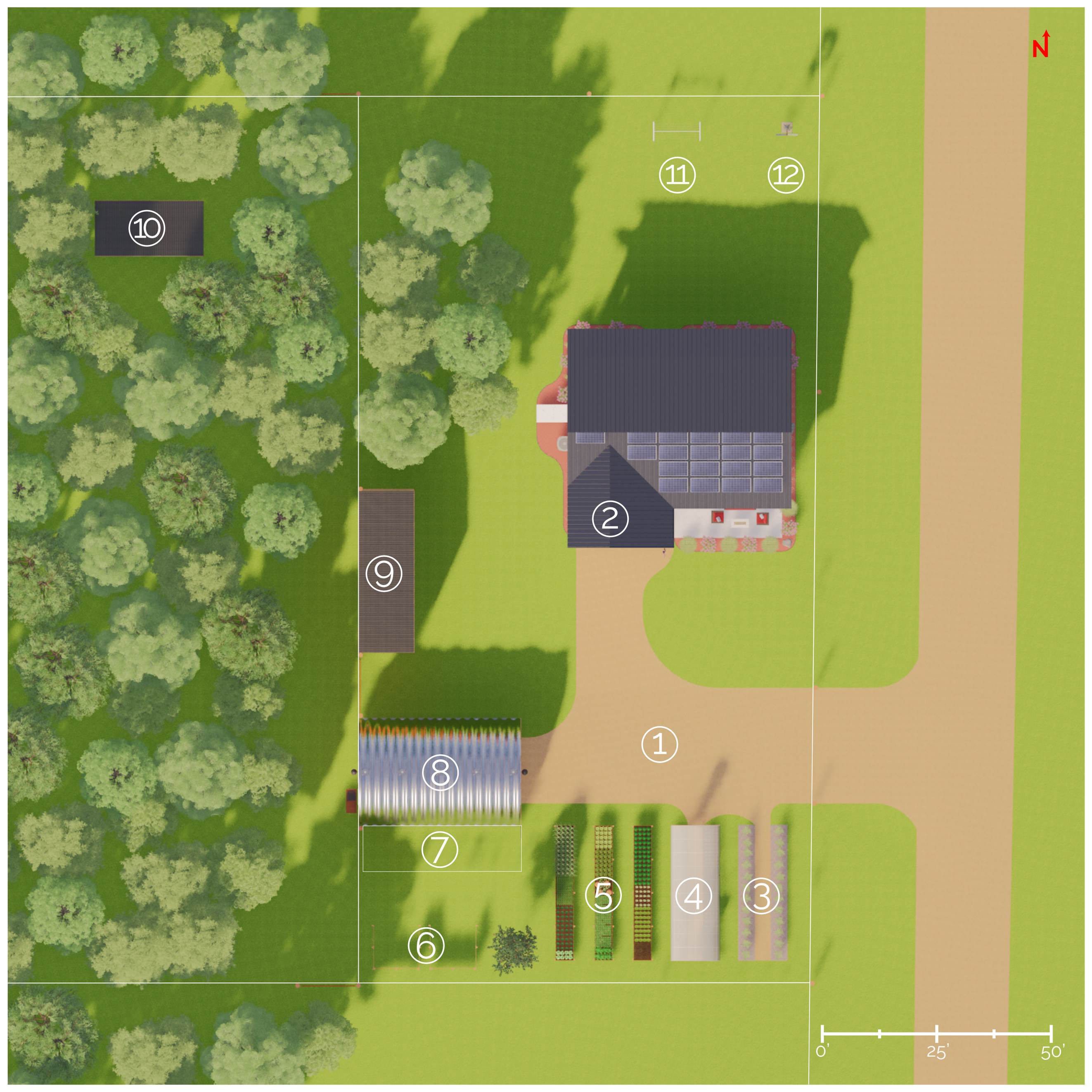
THE SITE

SITE INFORMATION

- 5.09 acres of land listed at $21,600
- Near the Heartland Trail (used for walking, biking, and horseback riding)
- 4 miles northeast of Park Rapids
- Half is covered in trees, half is field
- Growing zone 3



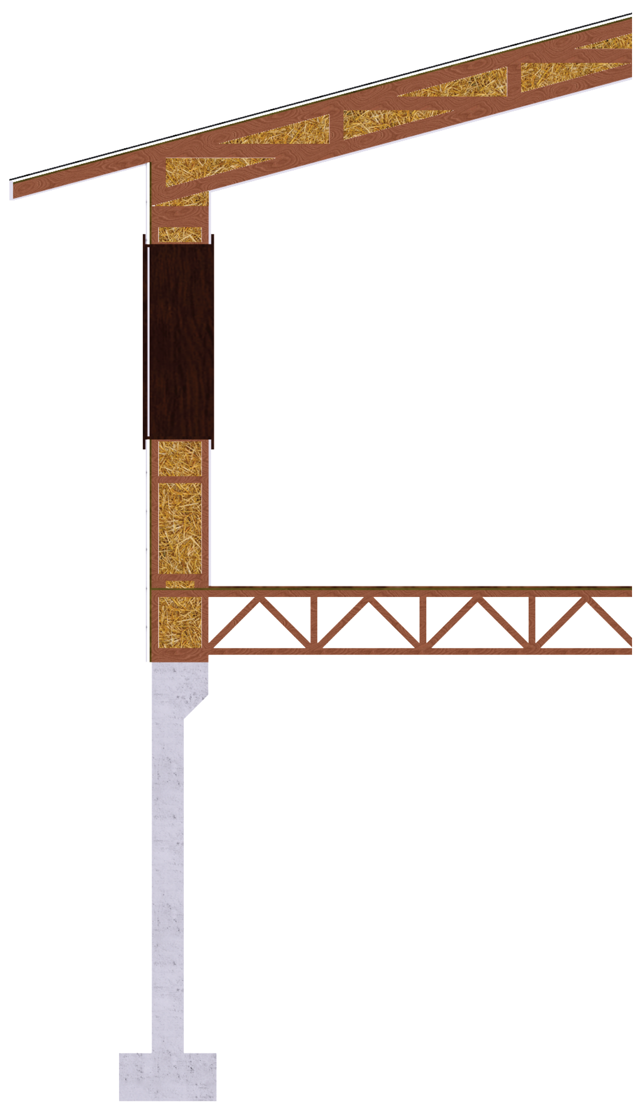
1. Sacrifice Pen
2. Rotation Pasture
3. Yard



1. Driveway
2. House
3. Berry Bushes
4. Hoop House
5. Raised Garden Beds
6. Compost Pits
7. Chicken Run
8. Barn
9. Hay & Storage Shed
10. Livestock Shelter
11. Cloths Line
12. Windmill

The House

BUCK & BEAM STRAWBALE CONSTRUCTION

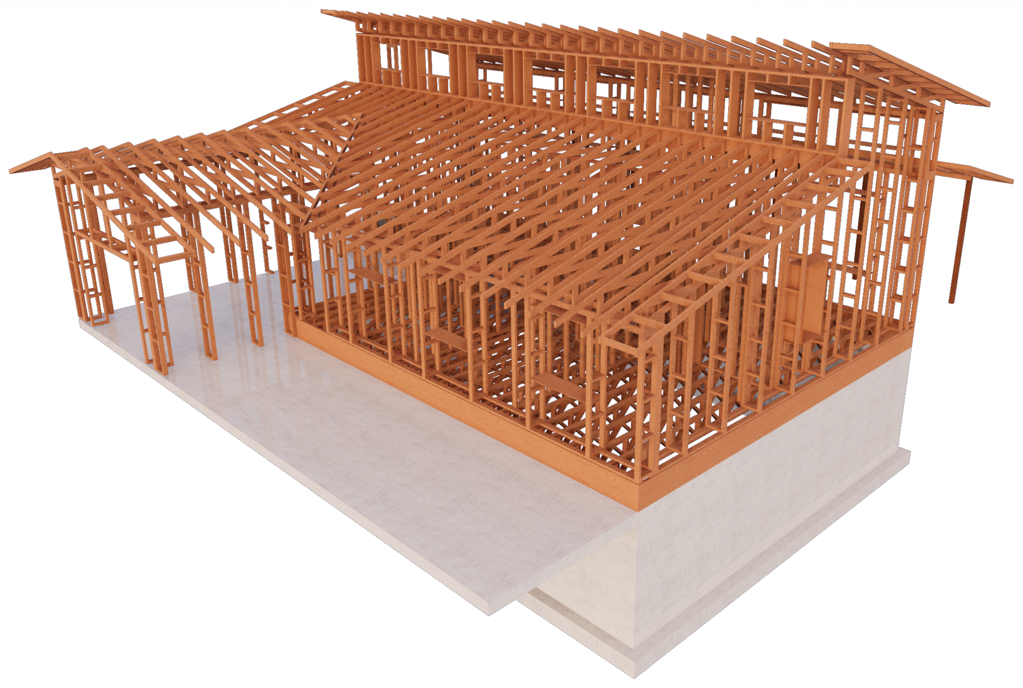


Wood framing supports the weight of the roof (opposed to the straw bales carrying the load)

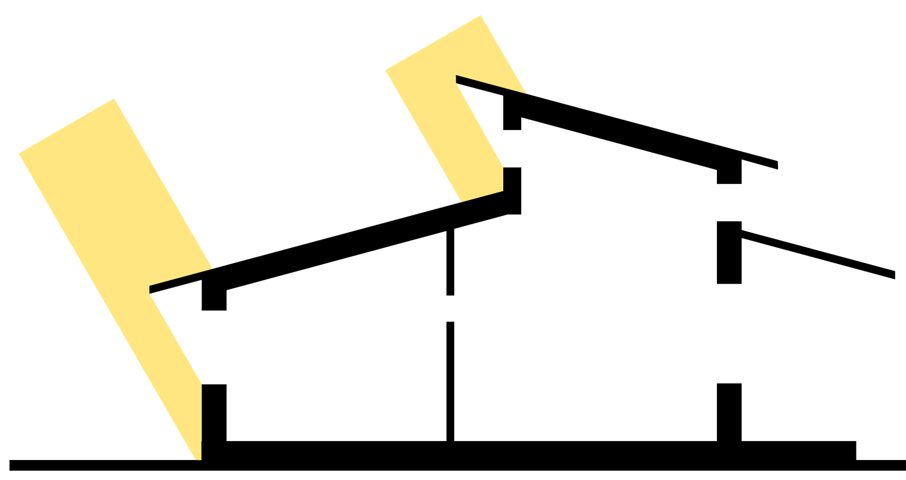
The wood framing is built first, then walls are infilled with straw bales

This method reduces settling issues

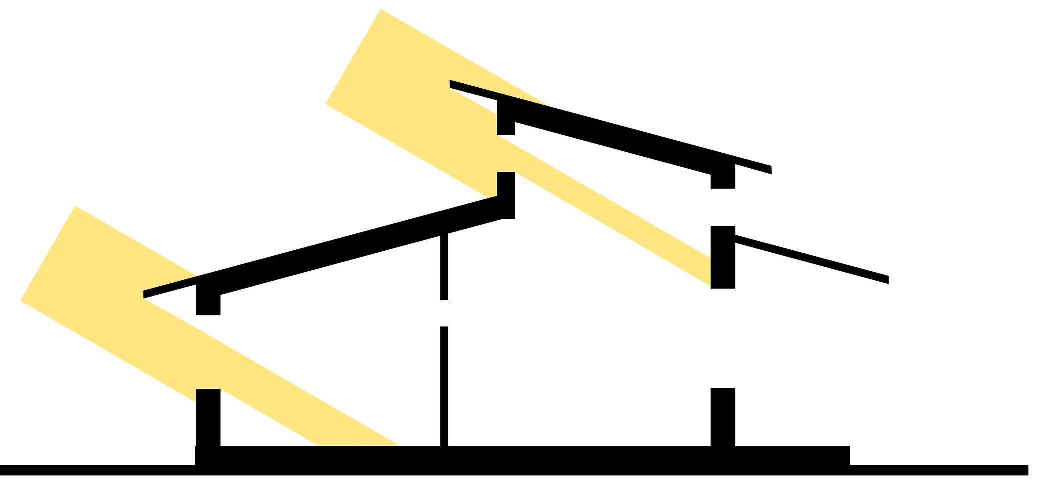
R-Value of 36



PASSIVE HEATING

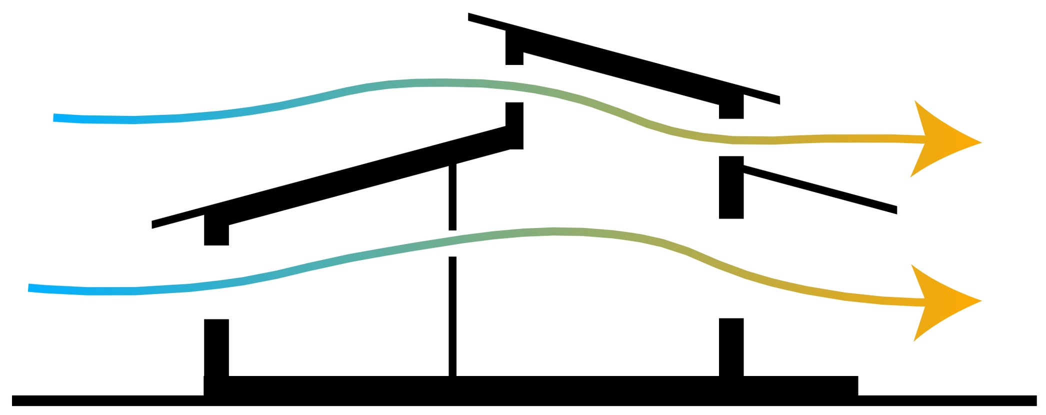


Summer Sun - Higher than 60˚



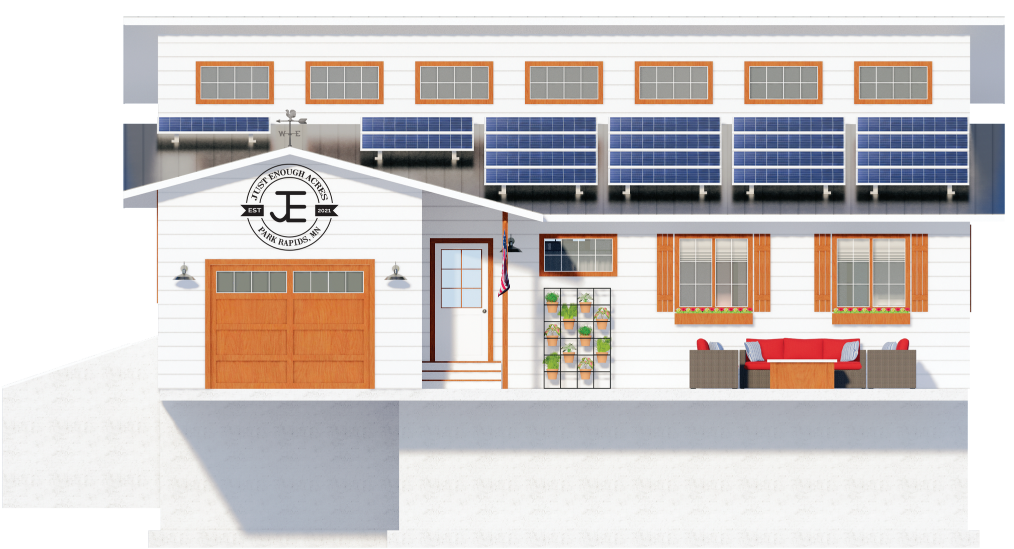
Winter Sun - Lower than 60˚

PASSIVE COOLING



Longitudinal Section

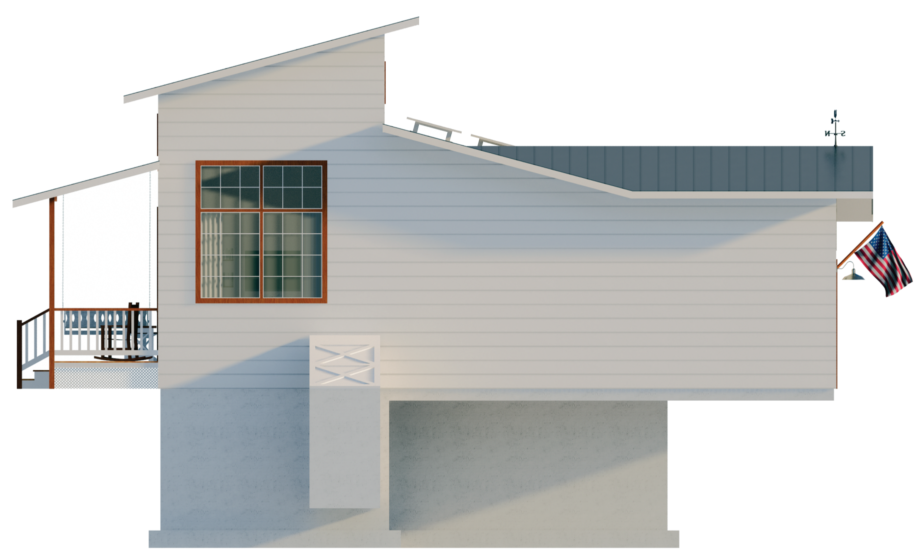
Transverse Section



South Elevation

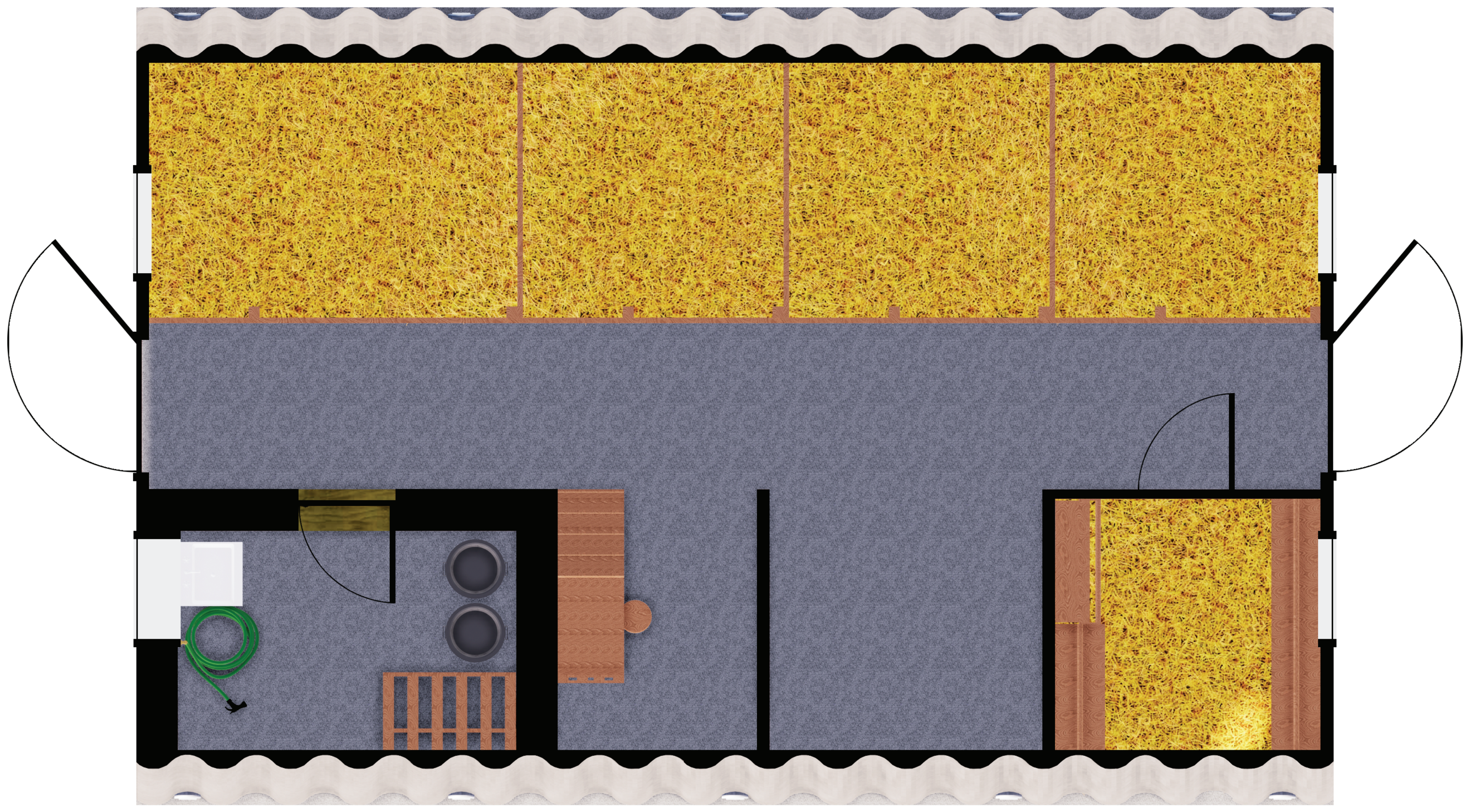
East Elevation

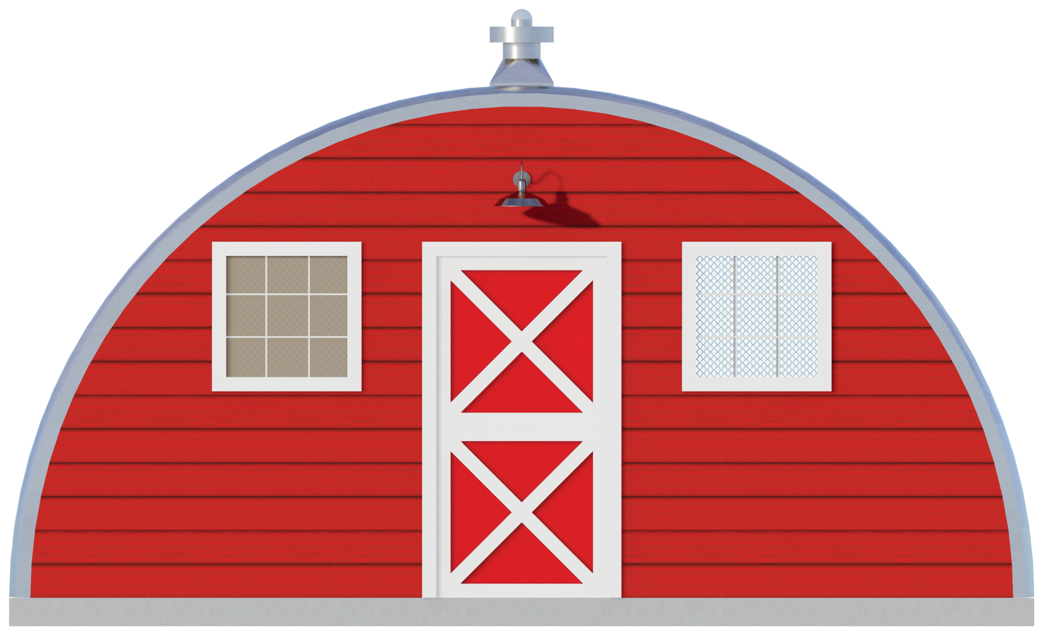
North Elevation



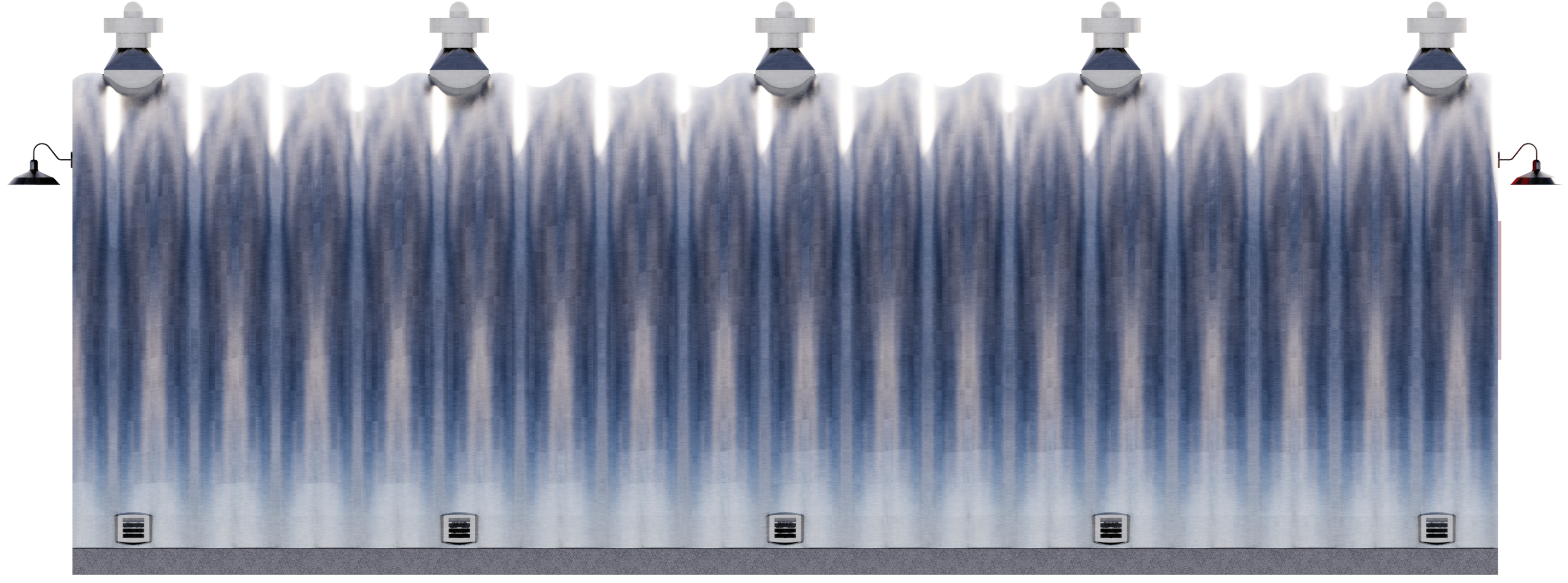
West Elevation

The Barn

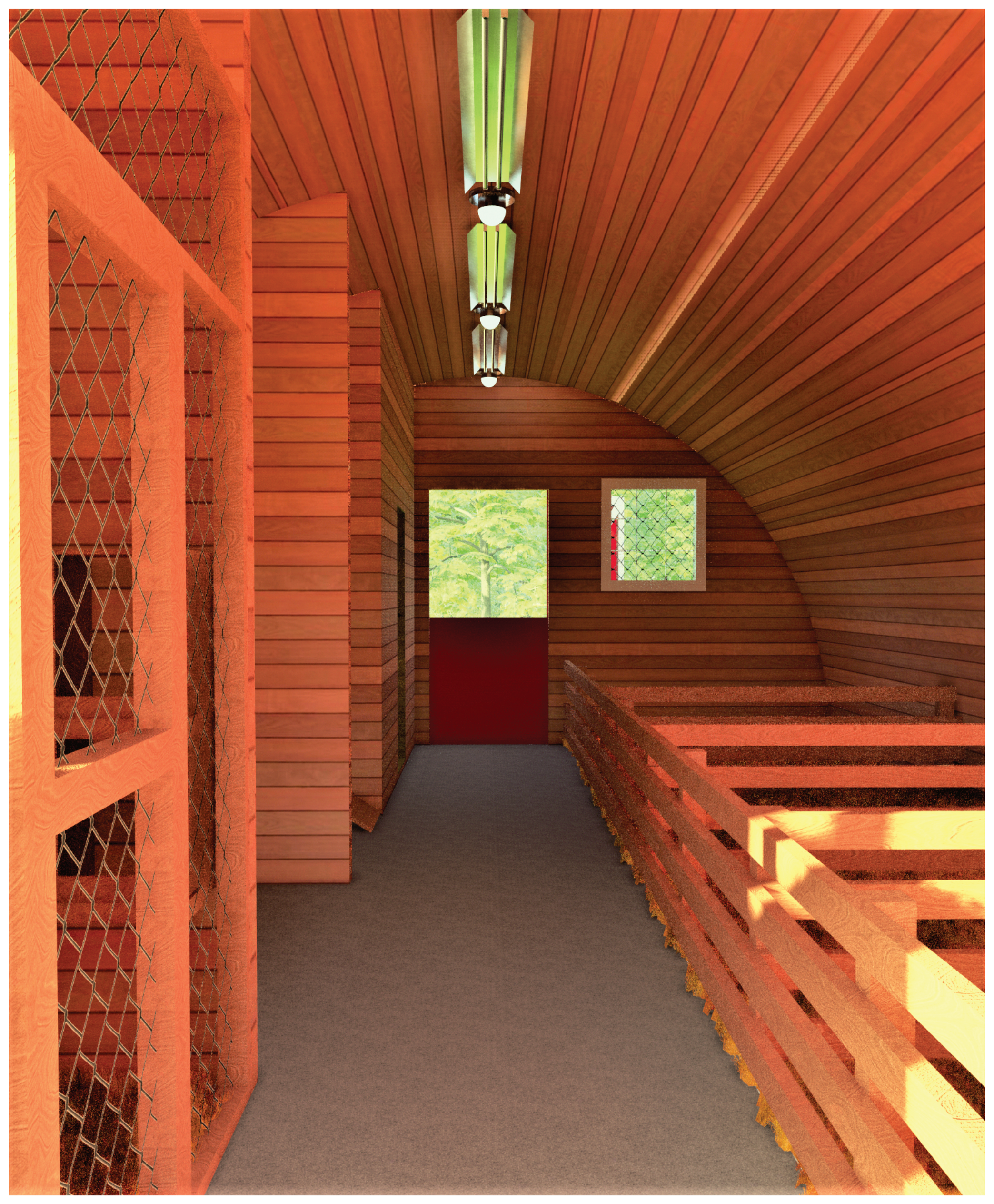


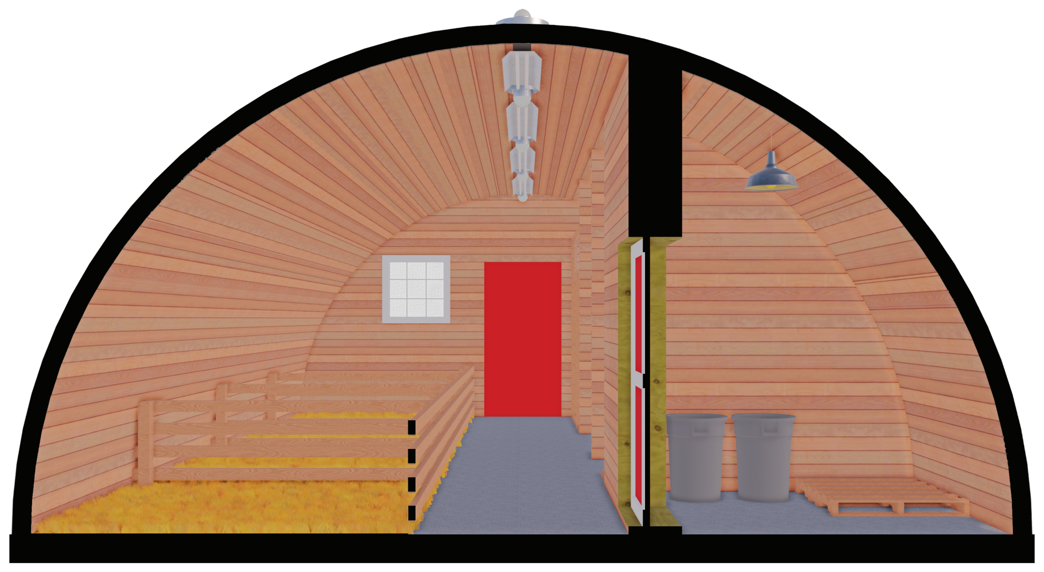


Front Elevation



Side Elevation



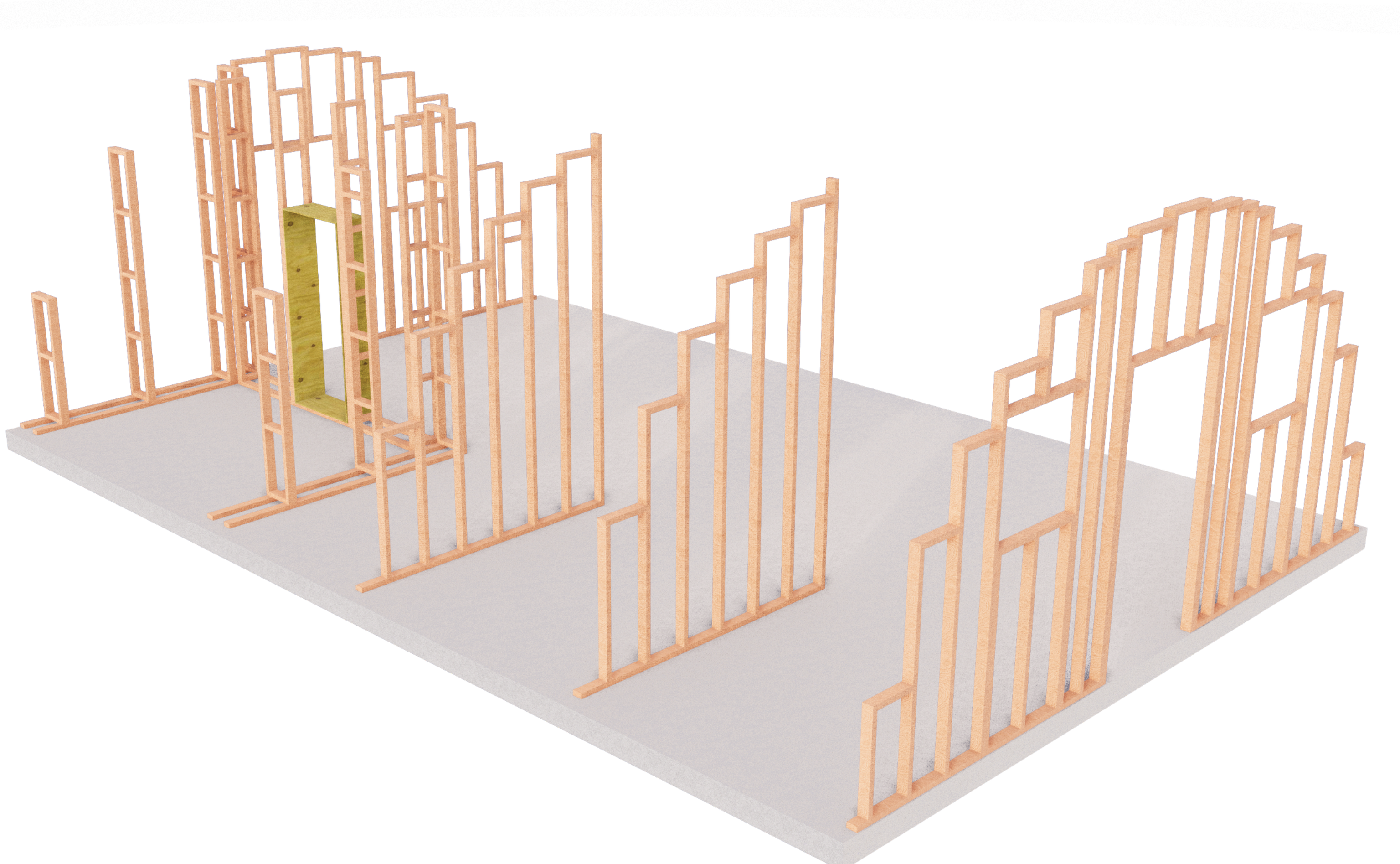


Longitudinal Section

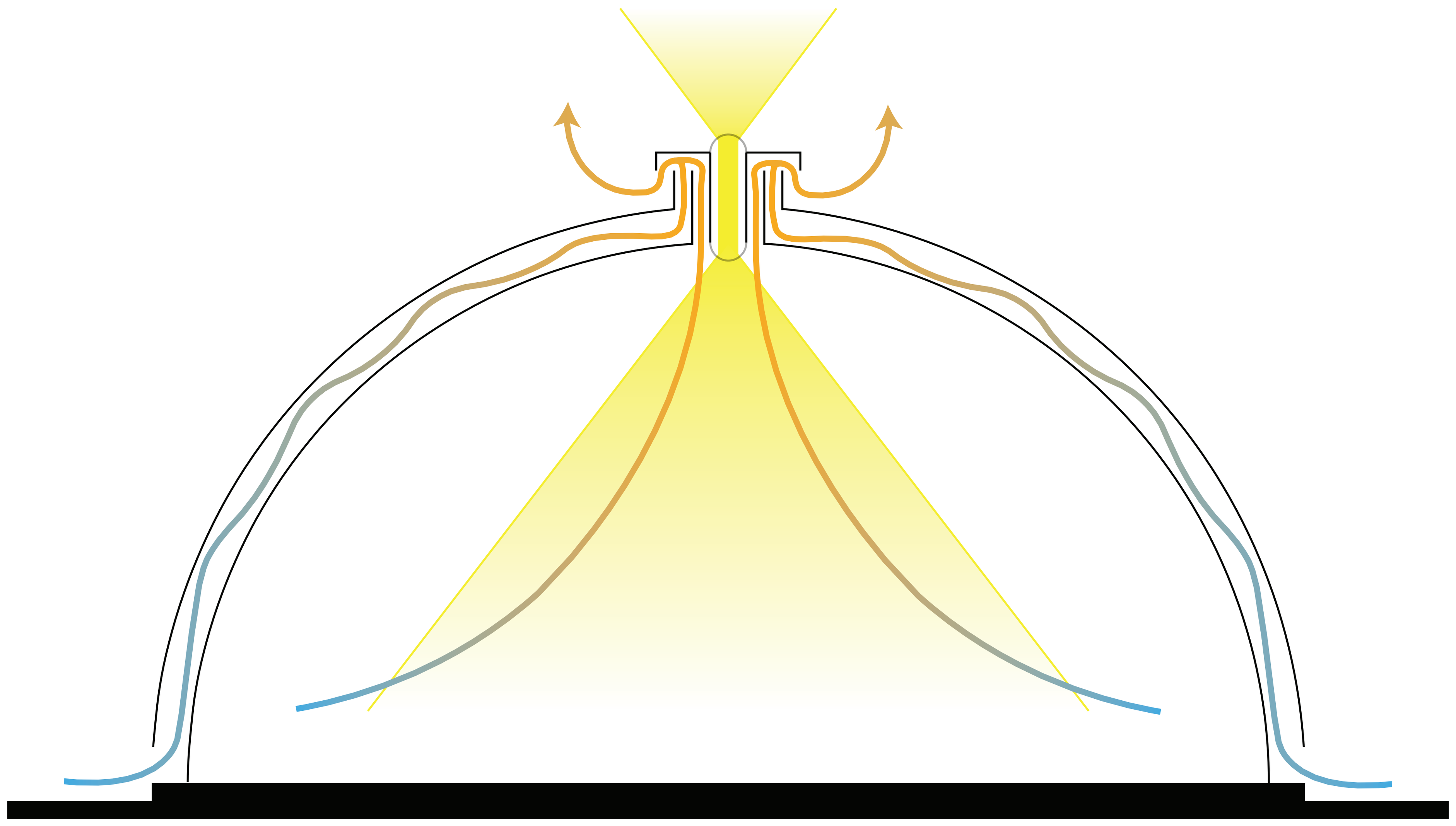
Transverse Section

STRUCTURE

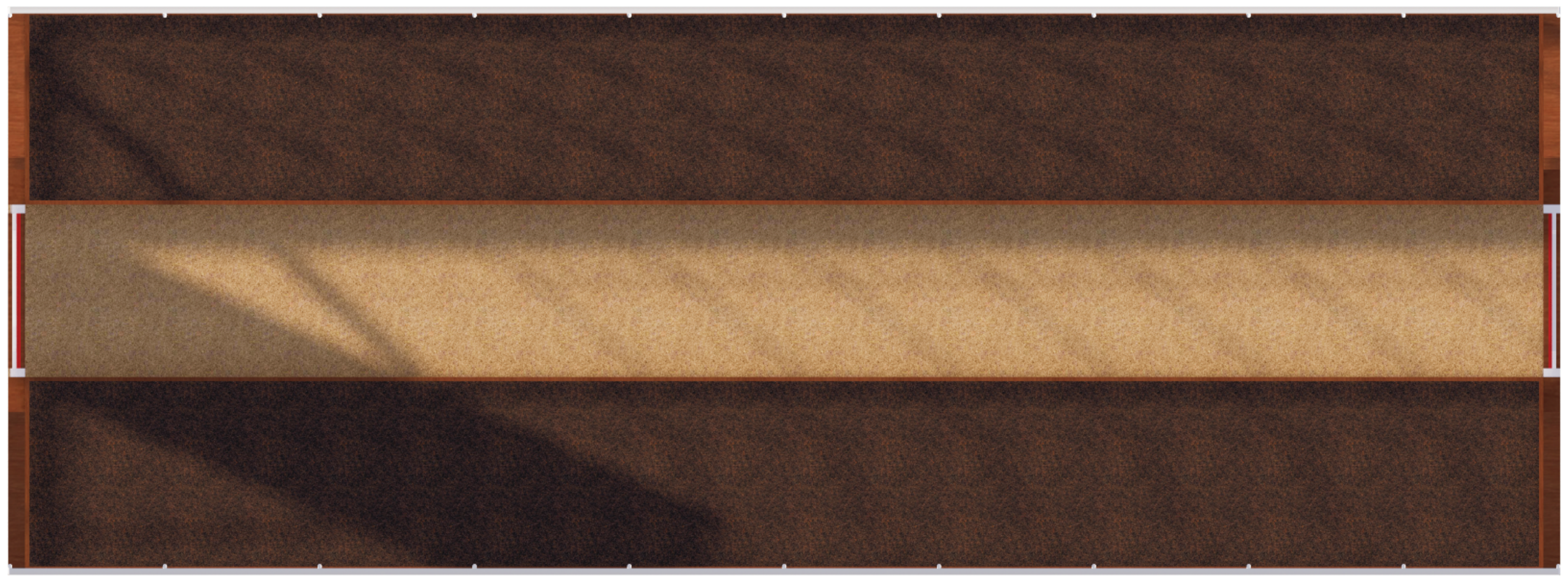
Quonset Hut - Double skin system to keep cool in summer months
Traditional Wood Framing - Used to construct the end walls
Buck & Beam Straw Bale Construction - Used to insulate the feed room

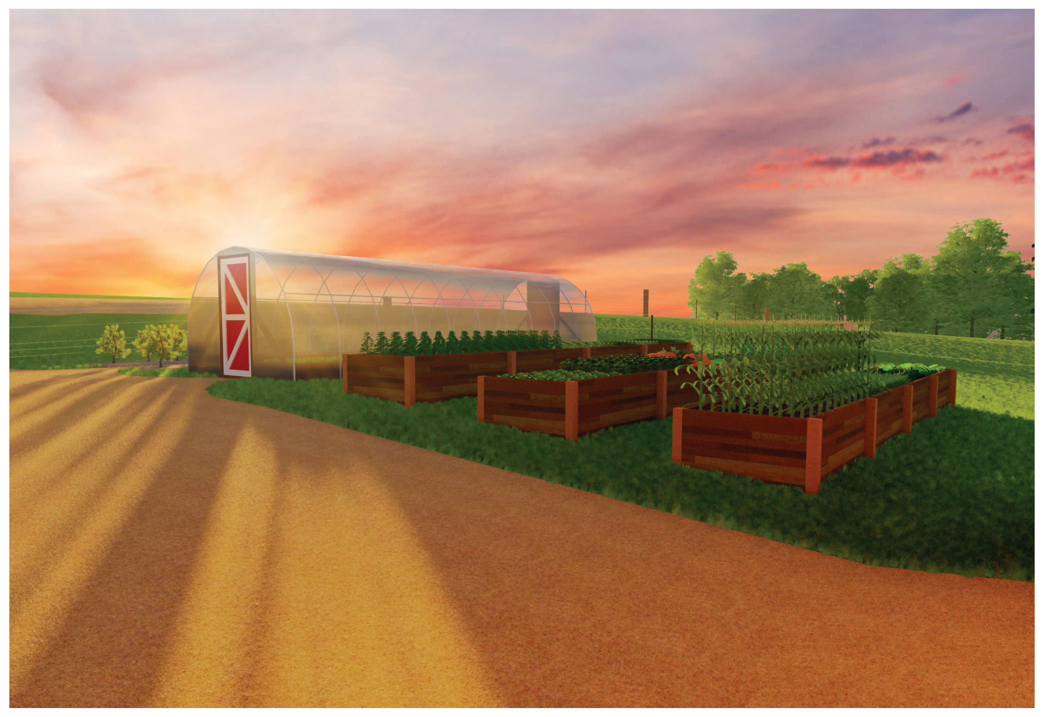


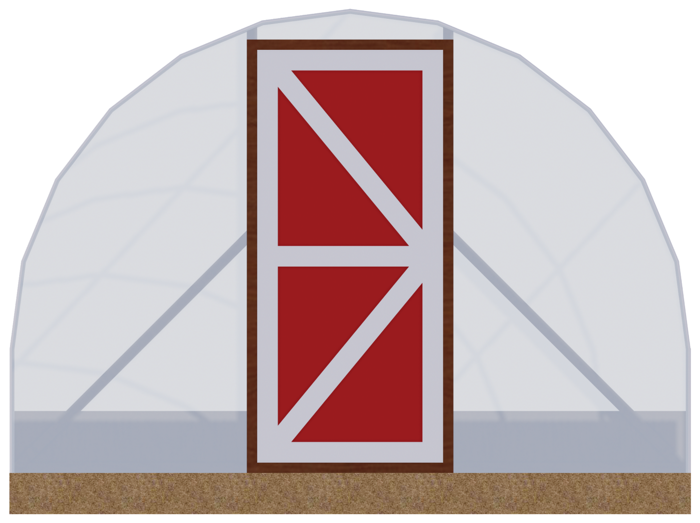
PASSIVE SYSTEMS



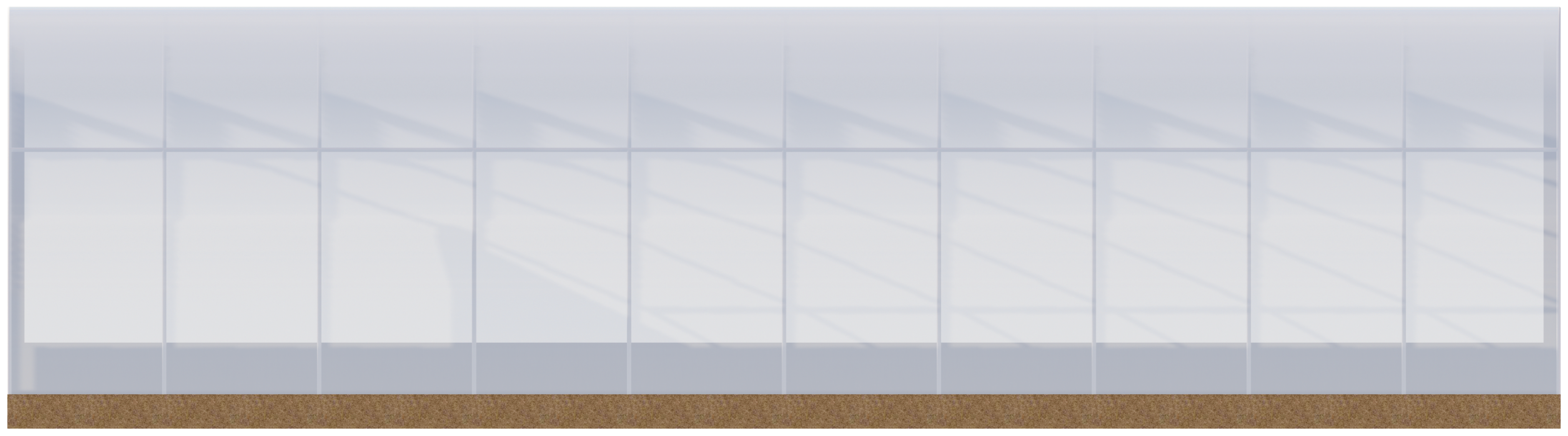
The Garden



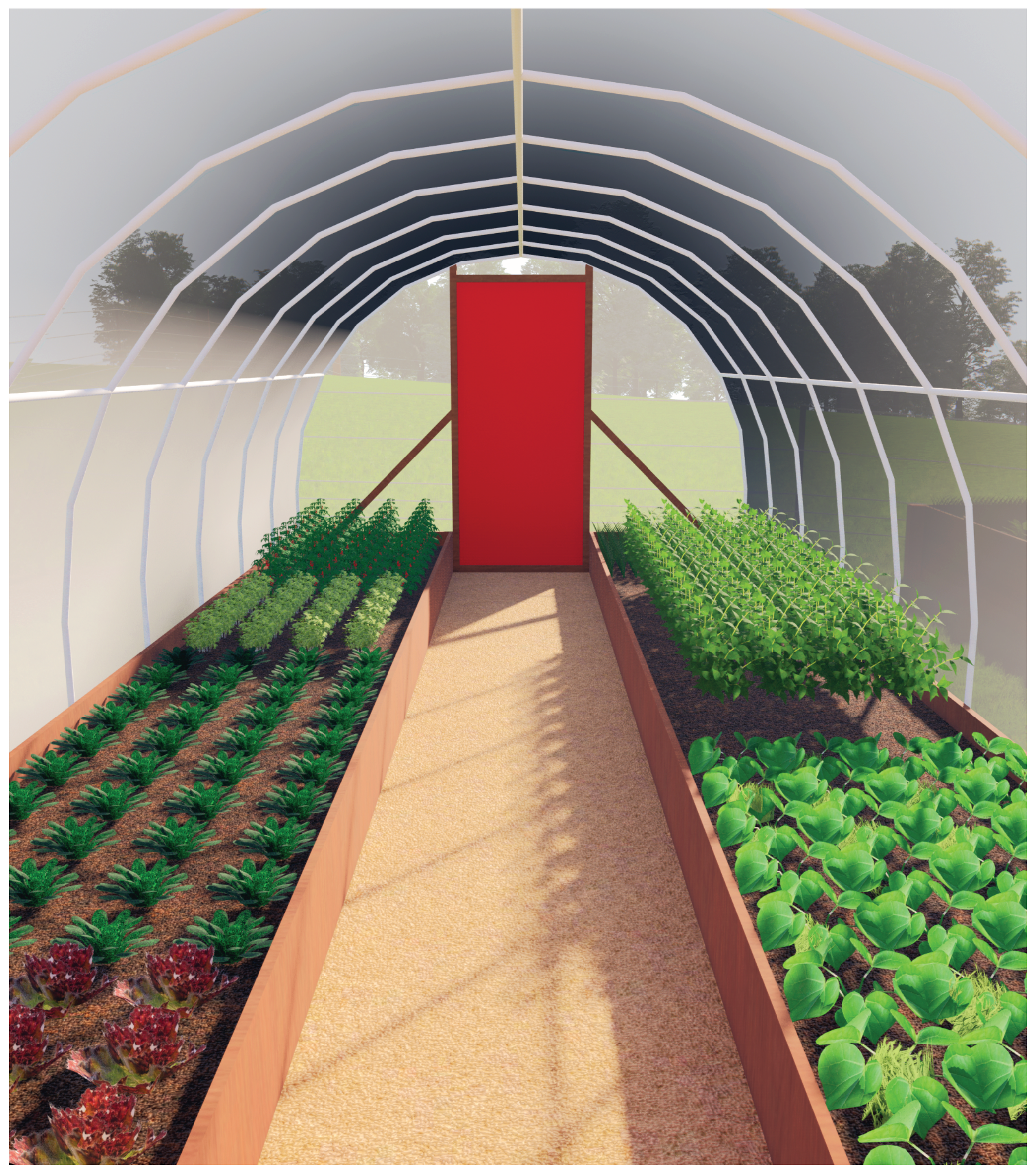


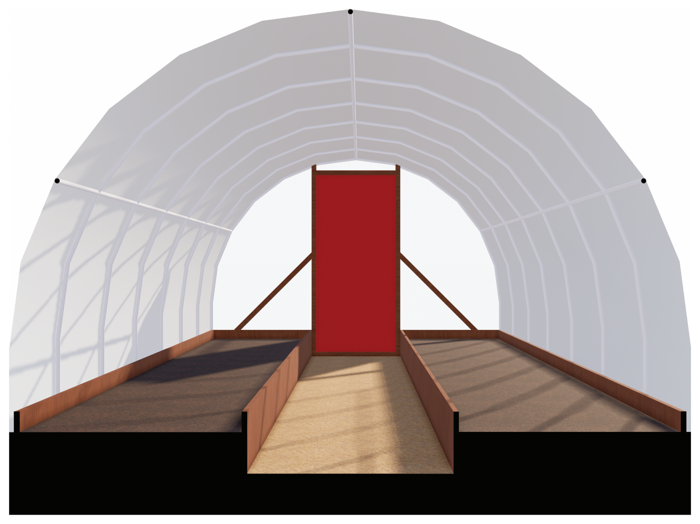


Front Elevation

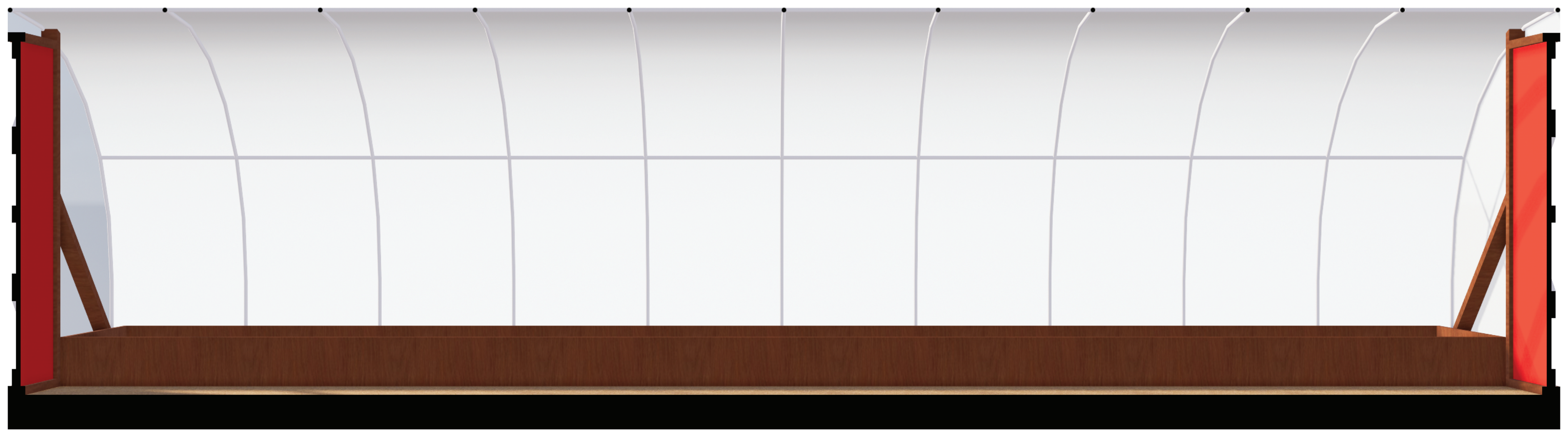


Side Elevation





Longitudinal Section



Transverse Section

STRUCTURE

GARDEN PLANNING

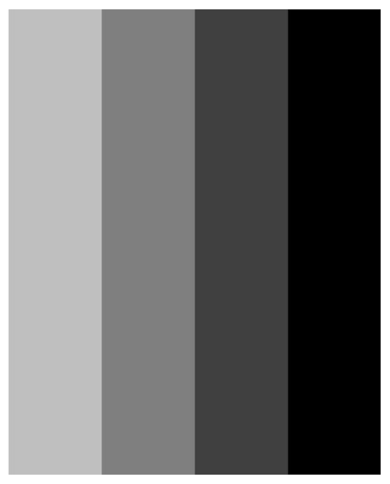
CROP	# OF PLANTS	AREA PER PLANT (sf)	AREA PER CROP (sf)
Asparagus	50	1	50
Basil	4	4	1
Bush Beans	198	9	22
Pole Beans	30	6	5
Beets	81	9	9
Broccoli	20	1	20
Cauliflower	20	1	20
Cucumber	15	0.5	30
Pickles	20	1	20
Carrots	96	16	6
Celery	8	4	2
Corn	80	1	80
Chives	9	9	1
Cilantro	5	5	1
Cabbage	24	1	24
Dill	20	1	20
Garlic	72	9	8
Leaf Lettuce	50	2	25

CROP	# OF PLANTS	AREA PER PLANT (sf)	AREA PER CROP (sf)
Melon*	9	0.5	18
Onions	64	4	16
Oregano	1	1	1
Peas	90	6	15
Pepper*	40	1	40
Potato	80	4	20
Pumpkin	4	1	4
Parsley	10	2	5
Rhubarb	4	0.5	8
Rosemary	1	1	1
Strawberries	20	1	20
Summer Squash	3	0.5	6
Winter Squash	10	0.5	20
Sweet Potato*	14	1	14
Thyme	4	4	1
Tomato*	50	1	50
Watermelon*	4	1	4

** should be planted in the high tunnel*

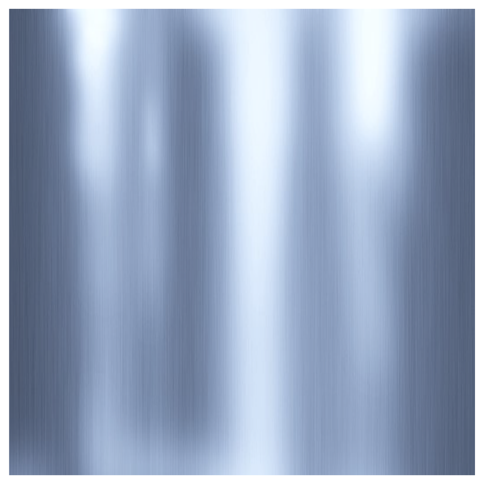
The garden will provide all the fruits and vegetables needed for a year for a family of four. It is a total of 600 square feet; 240 square feet in the high tunnel and 360 square feet in the raised garden beds. The chart above estimates how many plants of each crop should be planted and how much space each crop needs. The estimated total space needed to plant these crops is 587 square feet. As a rule of thumb, you should only plant as much food as you are able to eat within a year. For example, if you can 52 jars of peas, you will need to eat about 1 jar a week. The number of plants per crop can be adjusted to fit the diet of the residents.

Color & Material Palette

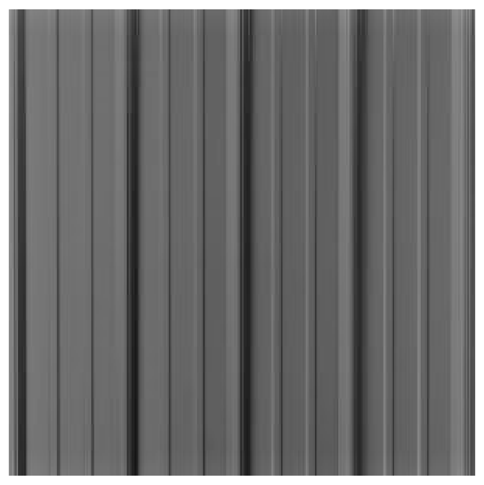


Color Scheme
Black, white, and greys are used throughout the house to tie everything together

Straw
Used to insulate the house and feed room



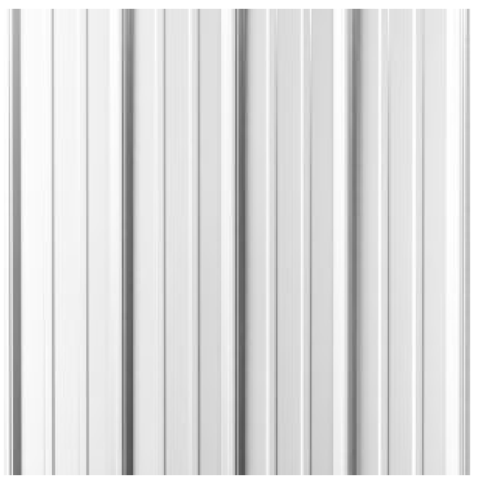
Corrugated Galvanized Steel
Used to sheath the quonset hut



Grey Steel Roofing
Used to roof the house

Stained wood
Used on trim and wood furniture

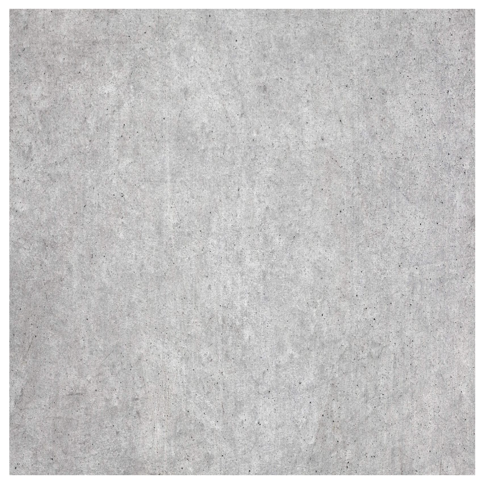
Red Painted Wood
Used to side the end walls of the barn



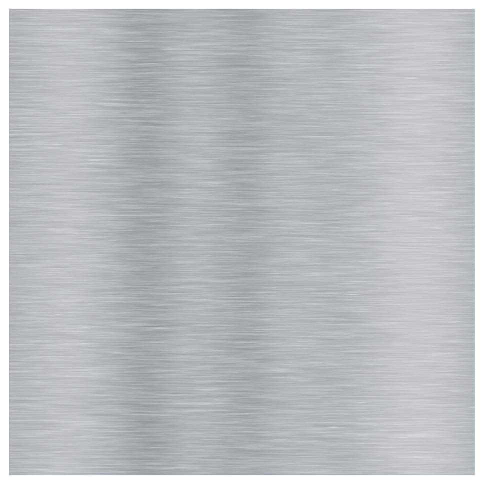
White Steel Siding
Used to side the house

White Hexagon Tile
Use in the mudroom, kitchen, and bathroom

Wood Planking
Used on the interior of the barn



Concrete
Used for the house foundation and other on grade slabs



Brushed Silver Metal
Used for fixtures in the mudroom, kitchen, and bathroom

Specifications

ELECTROBRAID FENCING

An Electrobraid fence should be used because it has a higher strength and uses less fence posts than wire fencing. This makes it ideal for pastures with cattle and wooded areas, and reduced to cost of fence posts.

LOW IMPEDANCE FENCE CHARGER

A low impedance fence charger is ideal for pastures with overgrown weeds, large animals such as cows and horses, and animals that have thick or wooly coats.

TWO-WAY SELF-CLOSING GATE LATCH

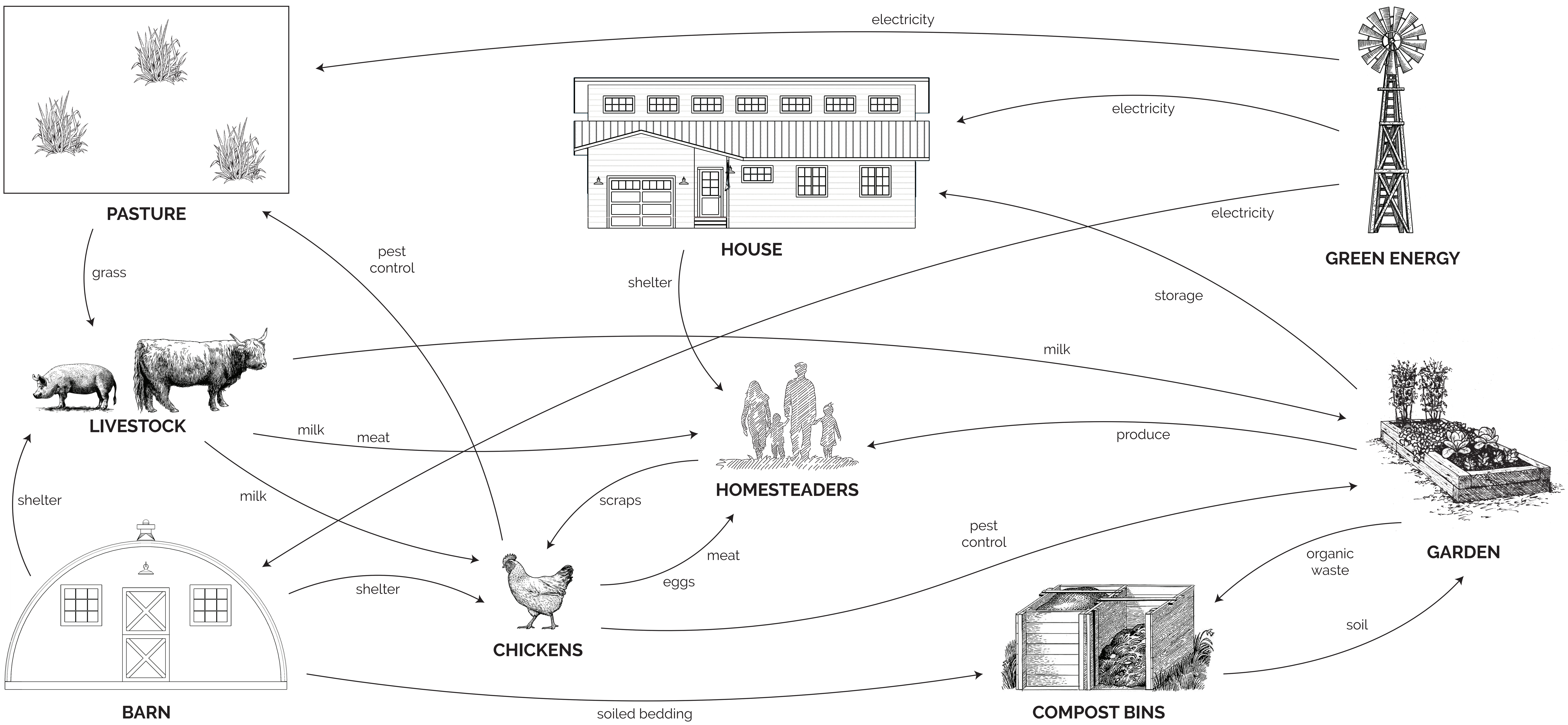
Two-way self-closing gate latches allow for gates to swing both directions and can be latched by simply swinging the gate shut. This makes opening and closing gates quick and easy while also ensuring that they are secure.

SLOW FEED HAY NET

Slow feed hay nets use small holes in the net to force livestock to eat slowly and prevent hay from being stepped on to minimize waste.

THE ANALYSIS

RESOURCE FLOWCHART

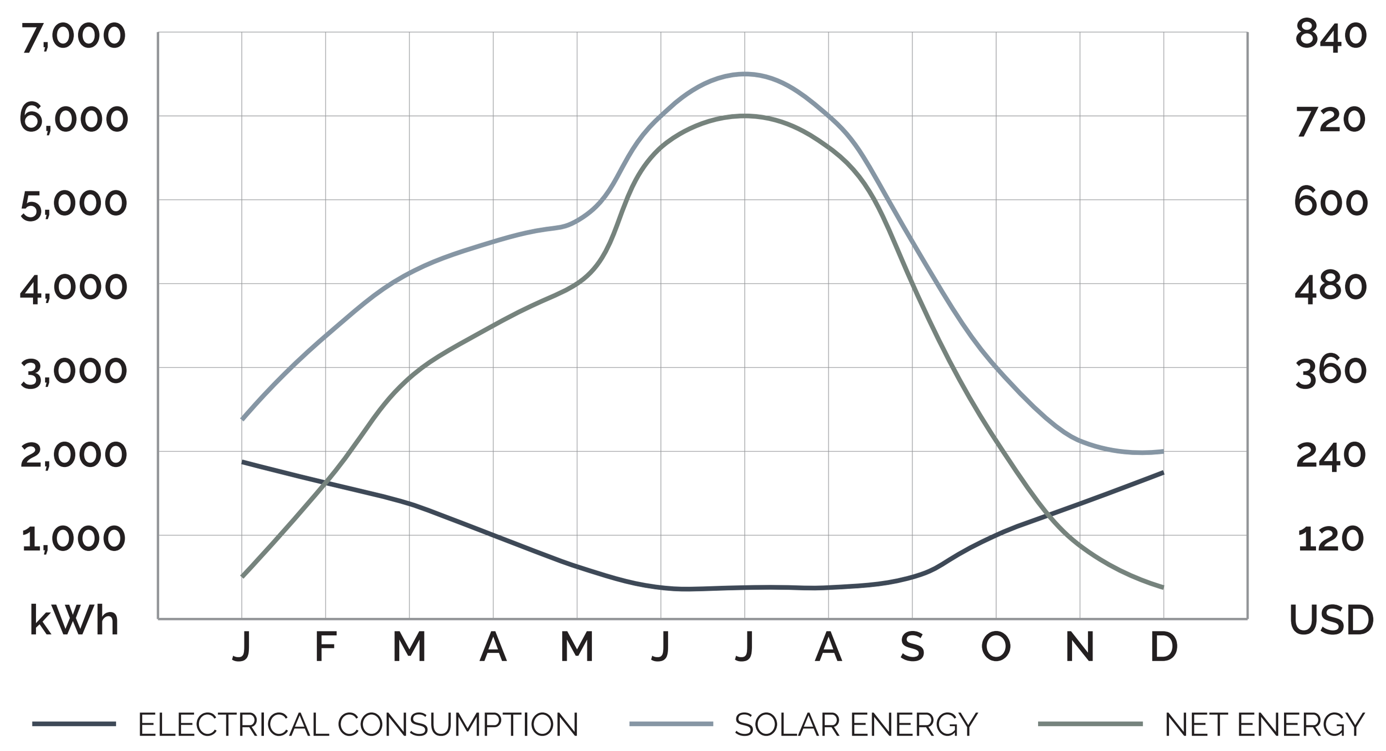


ENERGY CALCULATIONS

MONTH	ELECTRICITY CONSUMPTION	SOLAR ENERGY	NET ENERGY	BALANCE
January	-1,888 kWh	+2,341 kWh	+453 kWh	+$54.36
Febuary	-1,673 kWh	+3,331 kWh	+1,658 kWh	+$198.96
March	-1,356 kWh	+4,166 kWh	+2,810 kWh	+$337.20
Arpil	-1,015 kWh	+4,512 kWh	+3,497 kWh	+$419.64
May	-662 kWh	+4,702 kWh	+4,040 kWh	+$484.80
June	-411 kWh	+6,038 kWh	+5,627 kWh	+$675.24
July	-429 kWh	+6,468 kWh	+6,039 kWh	+$724.68
August	-409 kWh	+6,061 kWh	+5,652 kWh	+$678.24
September	-587 kWh	+4,531 kWh	+3,944 kWh	+$473.28
October	-982 kWh	+3,085 kWh	+2,103 kWh	+$252.36
November	-1,311 kWh	+2,150 kWh	+839 kWh	+$100.68
December	-1,733 kWh	+2,053 kWh	+320 kWh	+$38.40
YEARLY	-12,456 kWh	+49,438 kWh	+36,982 kWh	+$4,437.84

CHORE SCHEDULE

TASK	LOCATION	SEASON	REPETITION	DURATION
Feed Chickens	Barn	Year Round	Daily	2 min
Water Chickens	Barn	Year Round	Daily	2 min
Collect Eggs	Barn	Year Round	Daily	1 min
Milk Cow	Barn	Year Round	Bidaily	30 min
Fill Stock Tank	Barn	Winter	Daily	5 min
Feed Pigs	Barn	Year Round	Daily	4 min
Weed Garden	Garden	Summer	Weekly	90 min
Clean Stock Tank	Barn	Summer	Weekly	10 min
Clean Coop	Barn	Year Round	Biweekly	15 min
Hay	Sacrifice Pen	Winter	Biweekly	15 min
Hay	Sacrifice Pen	Summer	Monthly	15 min
Canning/Freezing	House	Fall	Yearly	na



TOTAL PRODUCTION

PRODUCT	SOURCE	YEARLY PRODUCTION	WEEKLY PRODUCTION
Eggs	Chickens (16-18)	3,500 eggs	48 eggs
Poultry	Meat Birds (25)	125 lbs	2 lbs
Milk	Cow (1 Highlander)	730 gal	14 gal
Beef	Cow (1 Highlander)	220 lbs	4 lbs
Pork	Pig (1)	175 lbs	3 lbs
Produce	Garden	587 lbs	11 lbs
Electricity	Solar Panel (342 sf)	49,438 kWh	950 kWh

EXPENSES

PRODUCT	COST
Hay	-$1,200
Pig Feed	-$750
Chicken Feed	-$400
Meat Bird (Chicks)	-$75
Straw	-$200
TOTAL	-$2,625

Summary

To prove the homestead's effectiveness; the cost of electricity used, solar energy produced, and the expected expense can be compared to find the net balance of the homestead. The analysis was broken down by month to ensure that the minimum solar energy production was greater than the maximum energy need. The expected electricity consumption was estimated by calculating the cost to heat and cool the house, and the cost of running household appliances. The electricity needed by the homestead was subtracted from the amount of electricity produced by the solar panels to estimate the surplus electricity by month. All unused energy can be used as income. Over the course of a year, the homestead produced a surplus of 36,982 kWh or $4,437.84. After subtracting the estimated expenses, the homestead has a yearly profit of $1,8 12 that can be invested back into the homestead.

To make the homestead more efficient, resources produced on the homestead can be used by the homesteaders or in other parts of the homestead. For example, milk produced by the cows can be used by the homesteaders for drinking and making cheeses, yogurt and other dairy products. Leftover milk and dairy byproducts can be used to fertilize the garden and supplement feed for the pigs and chickens. Some additional resources were needed to support the homestead such as hay, pig feed, chicken feed, and meat bird chicks. These expenses are paid for by the surplus electricity produced by the solar panels.

The site was designed so that the garden and barn are close to the house, reducing the amount of time and energy needed to complete chores. The chore schedule changes based on time of year and how often the chores must be done. For example, the stock tank must be filled daily but only during the winter months as an automatic waterer can be used during the summer. The homesteaders can also invest in a heated automatic waterer that can be used year round but is more expensive than a stock tank. Another way to reduce the amount of time spent doing chores is to allow a calf to nurse for half the day and separate the calf from the mother for the other half to reduce the number of milking times per day from 2 to 1.

"I had rather be on my farm than be emperor of the world."

- George Washington