PROGRAM
RESEARCH
5 c. flour = 2 loaves
15 slices per loaf

Yeast:
Sourdough bread

Tim Kraft
T Tim Kraft
- 14 / 3 / 1
- 4 / 3 / 2
- 4 / 2 / 2

2 cups
1 pint
4 cups

13687.5 cups

Milk
2

2 c. adult
4 c. children

Meat:
2 servings of 2 oz each including nuts, eggs

3 / 1 / 1 / 1 / 8

4 servings one should be v.i.c.
one green leaf

Bread
1 serving
2.4431
- 4.9312
- 4.321
- 4.321

- Tim
- Tim
- Tim
- Tim

Sever damage - lumbar

Heath

Great

15 acres, 1000 square'

50 x 1000 = 50,000

Tim

2.

4. Add Children

5.

A.

Bill
BUD SOURCES

DAIRY CATTLE (3)/YRS
- MILK
- YOGURT
- BUTTER

OUT PUT 2000 GALLONS/CONV/YEAR 10 PEOPLE
2 ACRES PASTURE 50% OF FEED
2 TONS GRAIN (CORN) 110 BUS/ACRE
SUPPLEMENTARY FEED: SILAGE 17 BUS/ACRE

GOATS (2)/YRS
- CHEESE
- MILK

EX Output 250 GALLOONS/GOAT/10 MOS
1/4 ACRE PASTURE
450 LB. GRAIN

BEEF CATTLE (5/YEAR)

1/2 BEEF/4 MOS./10 PEOPLE
1/2 x 12 MOS. x 30
2 ACRES GRAIN PER YEAR

HOGS (6/YEAR)

1/2 HOG/4 MOS./10 PEOPLE
1/2 ACRE PASTURE
LEGO + GRAIN

CHICKENS, LAYERS (120/YEAR)

12 LAYERS/6 EGGS/PAT
120 LAYERS = 60 EGGS/DAY
1 ACRE = 75% FEED/25 CHICKENS
5 ACRES + FEED

CHICKENS (520/YEAR)

$20/10 BIRDS/WK
2 $ ACRES CORN + FEED

SHEEP (6/YR)

FEW TIMES MUTTON + WOOL
2 ACRES PASTURE + FEED CORN + FEED

TURKEYS (6/YR)

2 HOLIDAY
FEED SLIGHTLY MORE THAN CHICKENS

RABBITS (START 1/4)

HAY/Table Scraps/Some Supplementary
**FISH SOURCES**

- **FISH**
  - 160 lb/year
  - 260 lb/year/acre
  - 160 lb bluegill
  - 40 lb bass

**FRESH WATER CLAMS**

- Cray fish

**VEGETABLES**

<table>
<thead>
<tr>
<th>FRUIT</th>
<th># PLANTS</th>
<th>ACRE</th>
<th>SOIL</th>
<th>TOTAL BU/ACRE</th>
<th>SOIL ASSOS</th>
<th>ACRE <strong>/Y</strong></th>
<th>TOTAL BU/ACRE</th>
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<tbody>
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<td>APPLES</td>
<td>20</td>
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<tr>
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<td>.25</td>
<td>100</td>
<td>3-10</td>
<td>1.0</td>
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</tbody>
</table>
**Bees** (29 Hives)

- 4 Hives / Small Group = 10
- 12 Hives Family
- 12 Hives Sell

**Pond 2A**

**Water Plant Cultivation** 2A
- Cattails
- Algae

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**Total Assigned Acres**

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Acres</th>
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<tr>
<td>Pasture</td>
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<tr>
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<tr>
<td>Fruit</td>
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<tr>
<td>Water (Aquaculture)</td>
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<td><strong>Total</strong></td>
<td><strong>56.0</strong></td>
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**Remainder**

- To be used for
  - Hardwoods 1" 30 yrs: 140.0
  - Fruit 2" 10 yrs: 20.0
  - Development (Houses, Barns): 217 - 160.0
  - Energy Equip: 57.0

This should not take this much but will also be able to use it a pasture.
### Shelter for Animals

<table>
<thead>
<tr>
<th>Animal</th>
<th>Quantity</th>
<th>Size in ft</th>
<th>Total</th>
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<tr>
<td>Cattle</td>
<td>(8+2?)</td>
<td>10</td>
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<tr>
<td>Goats</td>
<td>(2+?)</td>
<td>3'3'5&quot;</td>
<td>15</td>
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<tr>
<td>Hogs</td>
<td>(2+?)</td>
<td>9'4'</td>
<td>56</td>
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<tr>
<td>Chickens</td>
<td>(640+)</td>
<td>1'4'</td>
<td>2560</td>
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<tr>
<td>Sheep</td>
<td>(6+)</td>
<td>1'11'5&quot;</td>
<td>196</td>
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<tr>
<td>Turkeys</td>
<td>(6+)</td>
<td>1'11'5&quot;</td>
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<tr>
<td>Rabbits</td>
<td>(4+?)</td>
<td>1'11'5&quot;</td>
<td>825</td>
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<td>Total</td>
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</table>

### Shelter for Food (Storage)

- Vegetables
- Total Production

- [2150.2 m³/BU] or [1.2 m³ = 1BU]

### Other Notes
- Daily Use
- Security Feed
- Less
- Periodic
- Monthly Use
- Less
- Security Feed
- Daily
Some vegetables can be dried to reduce the figure.

![Image of a page with calculations and notes on vegetable yields and sizes](image-url)
1 BUSHEL = 32 QTS.

\[
3/5 \text{SERV} \times 30 \text{PEOPLE} \times 7 \text{DAYS/WK} \times 50 \text{WKS/YR} = 525 \text{KGS/YR = SERV} \times 1445 \text{QTS/YR} = 31500
\]

\[
31500 \times 80 \text{QTS/ACRE} \times \frac{1}{3} \text{qt} = 7875 \text{ QT}
\]

<table>
<thead>
<tr>
<th>FRUIT</th>
<th>BU PRODUCED</th>
<th>QTS</th>
<th>PEAKS UK</th>
<th>CANNED &amp; DRIED</th>
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<td>GRAPES</td>
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</tbody>
</table>

13,988 BU 7875 QT/YR

13,360 QT/ACRE AVAILABLE FOR SALE, WINE, METHANE, ANIMAL FOOD, WICED

7875

35,144 QTS/ACRE

8
HOME-EC
285-1322 Ms Simpson

100 grams 3 1/2-1 oz serving

BASIC 4
Protein
Grain
Milk + Cheese
Vegetables + Fruit

Pam Brummitt
Virginia Soukow

1:30 Pam Brummitt
HUMANIZING

ACTIVITIES

- Office - Business duties
- Watching TV
- Eating
- Cooking
- Dish washing
- Sleeping
- Bathing
- Pilots
- Clothes washing
- Drying
- Reading/studying
- Shop work
- Equipment sterilization
- Canning & storage
PUBLIC
    FOOD PREP   MEAL COOKING    CLEANING    BAKING    CANNING    STORAGE
    LOOKING    LOUNGING    TV, READING, MAPPING
    WORKING/FARMING    THE SHOP + ALL FARMING ACTIVITIES
    MILKING    LOGGING    (TREE PRUNING)    GARDENING

SEMI-PUBLIC
    STUDYING    SEMI QUIET AREA
    BUSINESS/OFFICES
    LAUNDRY    CLOTHES, EQUIPMENT
    STORAGE    FOOD (CANS, BAGS, MEATS, STAPLES)
    MECHANICAL SPACES    100%

PRIVATE
    BATHING    ET. AL.    PUBLIC FOR MEMBERS
    SLEEPING    FAMILY STYLE
    TOILETS    PUBLIC & PRIVATE
    MEDITATION/PRIVATE THINKING SPACE FOR EACH FAMILY
PERSONAL GOALS

- Low to medium technology self sufficiency
- To become more deeply involved with building details as a design element
- To look at all phases of land use as a whole system - that is everything either produces, uses, or uses energy. It should be possible to produce more than is used. Also by replacing the used energy into another usable form, it can be reused.

PHYSICAL CONTEXT

The site is in North Central Boone County at the Clinton County line. This is a heavy agricultural area, consisting of family farms. Mostly the land here is rotated between corn and beans. But there is some hog and cattle raising. This project would fit in well with land use patterns of the area.

Socially, some neighbors might be apprehensive about a commune in the area. But this can be overcome by keeping a high degree of openness and a good neighbor policy. These apprehensions could be over come.

Openness can be redefined as an open door for the neighbors. Visit them often and encourage them to visit you and see what you are about.

This can be further developed into a good neighbor policy by helping them when possible, following their advice or just by keeping the house and livestock under control. In good repair.

Economically, there would be little competition with the neighbors. Since most of the common crops would go towards feeding the livestock. So vegetable and fruit surpluses that might be sold would probably be consumed by the neighbors as there
is no major orchard or vegetable farms in the area. Although many farms have gardens, the trend seems to grow only enough for immediate consumption and small amounts of canning or freezing. Thus, with the farms and nearby urban markets, there would be a need for an on-site market. Any further surplus could be taken to larger urban markets like Indianapolis, Kokomo, or Lafayette, all less than a one-hour drive.

Budgets which start in the high range immediately as land is approximately no less than $100,000. For the 600 acres on site, this comes to $656,000. Farm land for farm machinery and equipment comes to another $200,000-$300,000 according to averages taken by the USDA in 1973 and updated to today's prices. Other expenditures for initial feed, livestock, and other supplies can run as high as $30,000-$50,000. So far the site has no buildings or other improvements and the cost is already close to $140,000. For the sake of rough numbers and estimated housing cost of $200,000 and additional buildings cost of $100,000 ($200,000/2) will bring the budget to about $1,000,000. This seems reason enough to approach this problem as one of growth by stages and taking advantage of used equipment and existing houses when possible.

So in an effort to avoid this $1,000,000 budget, it should be called AUSTERE.
Acting as my own client, there are two major goals I have as my client. The first is to be come as close to self-sufficient as possible to avoid the ever rising cost of living. Secondly, to provide a clean and natural home for the family that is not dependent on resources that are being used up. It is my belief that a major change is coming in the entire structure of civilization, probably for the worse. Therefore, I'm trying to design a place to take care of mine as a base for as long as one can. That I as an architect can operate from to aid people through this change. Specifically, this project must be totally self-sufficient in food and energy to keep the people and take care of those that live there. Also, it must generate enough revenue to pay taxes, pay off any loans and provide those things that cannot be produced on site. Renewable energy sources like wind, water power, sun in the form of photovoltaic cells, and home made methane gas. Vegetable gardens and orchards must be developed along with row crops.

To maintain order, a system of government must be devised which encourages participation but discourages schism causing factionalism. Also, a system of accepting members must be established where a period of semi-partial membership is used to examine the motives & compatibility with existing members. Although blind obedience & constant conformity will be discouraged, compatibility & acceptance. Assertiveness must be achieved as a means for constant growth, both personally & communally.
Eventually 4 & 6 families will be accepted to membership. Initially, they should be willing to pump money into the project before having a family. But children will not preclude membership for anyone, perhaps situation members should be able to devote much of their time to making the project work before they actually occupy the site. The work should be divided according to the desire & skills of members. Whenever possible, large jobs should be worked on simultaneously by all members to promote unity and test for compatibility. Specific work patterns & schedules depend on the season & membership. In other communes, work tends to be divided in more stereotyped roles, men doing men's work & women doing women's work. As this is usually the choice of those communes, then it is logical to assume this one will also fall into that pattern. It should not be locked there though.

Spatial Needs

1. Farming, Food Production & Storage
   - Vegetables
   - Animals
   - Trees
   - Fruits
   - Fish
   - Grain

Energy - Energy Production & Storage
   - Sun
   - Wind
   - Water
   - Methane
   - Wood
   - Alcohol Grain
HUMANIZING - HUMAN PRODUCTION & STORAGE

MED PEOPLE
WOMEN

FARMING
ROW CROPS

EQUIP
- TRACTOR
- TRUCK OR WAGON
- CULTIVATOR
- PLOW
- DISK
- PLANter
- HARVESTER
- BALER
- MOVER

FOOD CROPS - VEG/FRUIT/NUTS/
ANIMALS - MEAT/FISH/DAIRY

ENERGIZING

EQUIPMENT
- WAGON OR TRUCK
- WIND MILL (S)
- WATER WHEEL (S)
- VOLTAIC PHOTO CELLS
- LOGGING EQUIPMENT (HORSES?)
- TURBINES
- METHANE DIGESTOR
- WOOD
- DISTILLERY

STORAGE
- $1.40
- LOFT
- BINS
- SOUTHER

HUMANIZING

EQUIPMENT
- PEOPLE
- PONDS
- MILLERS

STORAGE
- BUILDINGS
- SHEED
- SOME PRESTATION
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<th>Crop</th>
<th>Land</th>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrots</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- **Land:** Acres
- **Plow:** FT
- **Disc:** FT
- **Plant:** FT
- **Cult:** FT
- **Harvester:** FT
- **Bale:** FT
- **Mower:** FT
- **Tractor:** FT
- **Yield:** BU

**Note:**
- **Avg. Based On Soil Type:**
  - 70% 9400 BU
  - 120  BU
  - 960  BU
  - 680  BU
  - 40 T
  - 680  T
<table>
<thead>
<tr>
<th>CROP</th>
<th>LAND</th>
<th>TREES</th>
<th>BUSHES</th>
<th>YIELD</th>
<th># PLANTS</th>
<th>ANNUAL YIELD</th>
<th>ANNUAL NEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>.5</td>
<td>25</td>
<td>.5</td>
<td>8 Bu.</td>
<td>24</td>
<td>19.2 Bu.</td>
<td></td>
</tr>
<tr>
<td>Peaches</td>
<td>.75</td>
<td>20</td>
<td>.5</td>
<td>8 Bu.</td>
<td>10.4</td>
<td>12 Bu.</td>
<td></td>
</tr>
<tr>
<td>Pears</td>
<td>.5</td>
<td>26</td>
<td>3.0 Bu.</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plums</td>
<td>.8</td>
<td>20</td>
<td>4.0 Bu.</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cherries</td>
<td>.5</td>
<td>26</td>
<td>2.5 Bu.</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pomegranates</td>
<td>.5</td>
<td>26</td>
<td>2.0 Bu.</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raspberries</td>
<td>.25</td>
<td>10</td>
<td>1.0 Bu.</td>
<td>138</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blueberries</td>
<td>.25</td>
<td>10</td>
<td>1.0 Bu.</td>
<td>138</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strawberries</td>
<td>.25</td>
<td>10</td>
<td>1.0 Bu.</td>
<td>138</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blackberries</td>
<td>.25</td>
<td>10</td>
<td>1.0 Bu.</td>
<td>138</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cranberries</td>
<td>.25</td>
<td>10</td>
<td>1.0 Bu.</td>
<td>138</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grapes</td>
<td>.25</td>
<td>10</td>
<td>1.0 Bu.</td>
<td>138</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4.50 A</strong></td>
<td><strong>105.2 Bu.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Acre = 43,560 ft²
1/2 A = 21,780 ft²
1/4 A = 10,890 ft²
3/4 A = 32,670 ft²

35' Between Trees = 908 #/tree
25' = 540 #/1/2 A
20' = 434 #/1/4 A
10' = 217 #/3/4 A

<table>
<thead>
<tr>
<th>CROP</th>
<th>PASTURE LAND</th>
<th># ANIMALS</th>
<th>CORN</th>
<th>BALE</th>
<th>OTHER FEED</th>
<th>OTHER FEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy Cattle</td>
<td>4 A</td>
<td>3</td>
<td>403 Bu.</td>
<td>1.7</td>
<td>17 Bu.</td>
<td></td>
</tr>
<tr>
<td>Beef</td>
<td>10 A</td>
<td>5</td>
<td>257 Bu.</td>
<td>2.5</td>
<td>43 Bu.</td>
<td></td>
</tr>
<tr>
<td>Hogs</td>
<td>1 A</td>
<td>2</td>
<td>200 Bu.</td>
<td>2.0</td>
<td>21.0</td>
<td></td>
</tr>
<tr>
<td>Chickens (Layered)</td>
<td>-</td>
<td>120</td>
<td>260 Bu.</td>
<td>-</td>
<td>86.0</td>
<td></td>
</tr>
<tr>
<td>Chickens (Fattening)</td>
<td>-</td>
<td>320</td>
<td>520 Bu.</td>
<td>-</td>
<td>86.0</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>12 A</td>
<td>9</td>
<td>275 Bu.</td>
<td>6.0</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>Goats (Ewes)</td>
<td>.5 A</td>
<td>2</td>
<td>120 Bu.</td>
<td>1.0</td>
<td>.200</td>
<td></td>
</tr>
<tr>
<td>Turkeys</td>
<td>-</td>
<td>4</td>
<td>(Weight)</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Rabbits</td>
<td>-</td>
<td>4</td>
<td>(Weight)</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

See Farming, row 1270, for total acreages.
<table>
<thead>
<tr>
<th>Farming Crop</th>
<th>Land Use</th>
<th>Trees Spread</th>
<th># Plants/Year for Twenty Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walnuts</td>
<td>1 A</td>
<td>30'</td>
<td>60</td>
</tr>
<tr>
<td>Oak</td>
<td>1 A</td>
<td>30'</td>
<td>60</td>
</tr>
<tr>
<td>Hickory</td>
<td>1 A</td>
<td>30'</td>
<td>60</td>
</tr>
<tr>
<td>Maple</td>
<td>1 A</td>
<td>30'</td>
<td>60</td>
</tr>
<tr>
<td>Poplar</td>
<td>1 A</td>
<td>30'</td>
<td>60</td>
</tr>
<tr>
<td>Ash</td>
<td>1 A</td>
<td>30'</td>
<td>60</td>
</tr>
<tr>
<td>Beech</td>
<td>1 A</td>
<td>30'</td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td>7 A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

30' between trees = 700#/tree

<table>
<thead>
<tr>
<th>Farming Crop</th>
<th>Land Use</th>
<th>Hives</th>
<th>Output per frame</th>
<th>Usable Frame/ Hive</th>
<th>Yield per Year</th>
<th>Total Annual Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beech</td>
<td>Min.</td>
<td>24</td>
<td>4.16</td>
<td>15</td>
<td>90#</td>
<td>180#</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Farming Crop</th>
<th>Pond Yield</th>
<th>Pond Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bass</td>
<td>≥ 40#</td>
<td>Available</td>
</tr>
<tr>
<td>Bluegill</td>
<td>≥ 160#</td>
<td></td>
</tr>
<tr>
<td>Catfish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh water clams</td>
<td>≥ 100#</td>
<td></td>
</tr>
<tr>
<td>Algae</td>
<td></td>
<td>As allowed to grow</td>
</tr>
</tbody>
</table>

- These as available in sufficient quantity so as to allow a constant population. The population would be allowed to increase with the increased forest area. Population size would be managed in association with appropriate state agencies. Areas would be planted to provide winter food. This would consist of a 5-10 row strip field several 100 feet long. It would be repeated in several locations.
FARMING

TOTAL ASSIGNED ACREAGE

PASTURE 29.5 A
GRAINS - ROW CROPS 80.5 A
VEGETABLES 3.0 A
FRUIT 4.0 A
WATER (AQUACULTURE) 4.0 A
EXISTING FOREST 211.0 A
PLANTED FOREST 7.0 A

TOTAL ACREAGE 339.0 A
TOTAL ASSIGNED ACREAGE 217.0 ACRES FUTURE DEVELOPMENT

FUTURE DEVELOPMENT

PLANTED FOREST (HARDWOOD) 140 A
FRUIT 10 A/yr / 20 yrs 20 A

160 ACRES

217
160

57.0 ACRES

EXISTING FARMS & HOMES APPROX 120.0 ACRES
37.0 ACRES

TOTAL ACREAGE FOR FARM BUILDING, HOME, & ENERGY EQUIPMENT, & RECREATIONAL AREAS 37.0 ACRES
FARMING
SHELTER
VEGETABLES 324 ft SHELF SPACE  DRYING PEA9
FRUIT COOL DRY AREA
MEAT 50 QTS. 6 ft SHELF SPACE  SMOKED HOUSE 10 lb
GRAIN WHEAT 120 BU OATS 600 BU CORN 3900 BU SB 320064
FISH POUND 1000/200 lbs/YEAR
HAY 50 T
MILK 6-8 gal/day

NEEDS FOR FOOD TYPES

DAILY FOOD NEEDS BASED ON 4 FOOD GROUPS
MILK
- 2 CUPS ADULTS
- 4 CUPS CHILDREN

MEAT (MUS, EGG, SOYBEANS INCLUDED)
- 2-20 oz SERVINGS EACH

FRUITS & VEGETABLES
- 4-20 oz SERVINGS
  1 SHOULD BE VITAMIN C
  1 SHOULD BE GREEN LEAF

BREAD & GRAIN
- 4-20 oz SERVINGS

IDEAL COMMUNE POPULATION: 24-6 FAMILIES 4 EACH
12 ADULTS 50% > BUT FOR PLANNING, 30 PEOPLE WILL BE
12 CHILDREN 50% USED.

DAILY NEEDS
MILK MEAT FV BREAD
6.8 gal. 8 lbs 8 QTS 15 lbs
YEARDLY NEEDS
MILK MEAT FV BREAD
2190 gal. 2920 lb. 2920 QTS 5478 lb
Milk Storage & Processing
- Stalls
- Sterilizer
- Sinks
- Pasteurizer
- Cool Storage

Meat Storage & Processing
- Butcher Area (washable)
- Canned
- Smoked → Smoke House
- Pickled
- Salted → Smoke House or Small Shed → Salt Barrel
- Leather shop (to work it & tan it) → General shop

Fey Storage & Processing
- Canning Area
- Drying Racks
- Shelves (cool dry) → 2,920 qts
- Pegs for dried Fey & Nuts → 20-30 pegs
- Sterilizer

Bread & Grain Storage & Processing
- Storage as per harvest but at least 2427 qts or 107 bushels wheat (yearly grain demand in wheat)
- Mill
- Baking Area
- Store Over
- Bread Storage → 12 loaves/day → 24 bake every other day

All human food must go through the kitchen which will be covered in humanizing section
ENERGIZING

KEEPING WITH THE SELF-SUFFICIENCY OF THE PROJECT ENERGY AUTONOMY WILL ALSO BE SOUGHT. THE ENTIRE SYSTEM WILL RESEMBLE BE PATTERNS AFTER THE SYSTEM FLOW CHART. ONE SYSTEM THAT IS NOT DETAILED IS PASSIVE COLLECTION, IT WILL ALSO BE USED. MORE SPECIFIC CLIMATIC DATA WILL BE LISTED IN THE SITE ANALYSIS.

INPUTS

THE MAJOR PARTS OF THE SYSTEM ARE: SUN, WIND, WATER, PLANTS & ANIMALS. THE CHART SHOWS HOW THESE RELATE TO HUMAN NEEDS & HOW THESE PARTS ARE RECYCLED. THE SIZES OF ALL THE SYSTEMS WILL BE DEVELOPED IN ASSOCIATION WITH SPECIFIC SITE SELECTION.
Activities listed below are divided into Public/Semi-Public & Private as a tool for Spatial Organization.

Necessity for Public Area Exposure

PUBLIC ACTIVITIES
- Food Prep & Clean-Up
- Cooking, Meals
- Baking
- Canning
- Sterilizing
- Cleaning Dishes & Jars
- Storage for Dishes
- **Often used staples, salt, ketchup, sugar, flour**
- Storage for refrigerated goods, milk, meat leftovers
- Eating
- Meeting
- Working outside
- Store spaces → separate project
- Lounge/Tv spaces

SEMI-PUBLIC
- Storage food/cans, dried, smoked, freezer
- Study/Business Office/Library
- Laundry - Clothes
- Slaughter House
- Milking
- Sterilizing
- Shop & Food Storage
- Mechanical Spaces 10%
- Source/To Rea (living/family room)

PRIVATE
- Bathing → Public for residence
- Sleeping → Family
- Toilets → Public & Private
- Meditation/Private space for each family
PUBLIC

FOOD PREP & CLEAN UP - PREPARATION OF FOOD FOR MEALS, SHOULDBE SEPARATE FROM BAKING, CANNING ACTIVITIES SO THAT MEALS DON'T INTERRUPT STOCKPILING EFFORTS.

KITCHEN FOR 20-23 PEOPLE TO WORK

LIGHTING IS NEEDED FOR LIGHTING

TASK LIGHTING & NATURAL OVERALL LIGHTING

EQUIPMENT

CABINETS - WHERE EVER POSSIBLE
SINK - DOUBLE SINK W/ DOUBLE SIDE BOARD
STOVE - EIGHT BURNER GAS INDUSTRIAL OR GRIDDLE
OVEN - LARGE DOUBLE OVENS THAT COME WITH ABOVE STOVE
REFRIGERATOR - ENERGY EFFICIENT DOUBLE DOOR INDUSTRIAL

(IT WOULD BE BEST TO ELIMINATE THIS EVENTUALLY BUT IS NEEDED FOR THE TRANSITION PERIOD.)

ENVIRONMENT

LIGHTING

BASICALLY TASK LITTED BY NATURAL TASK (WINDOW AT SINK)
OVER ALL NATURAL LIGHT FOR GENERAL ILLUMINATION

VENTILATION

NATURAL SHOULD NOT ADD TO HEAT LOAD
SHOULD COOL IN BUILDING IN SUMMER

HEAT IS GENERATED BY COOKING SHOULD BE DISPERSED THROUGH THE HOUSE WHEN NECESSARY

MOVEMENT

FROM RECEIVING & FOOD PREP TO FOOD PREP & CLEAN UP TO COOKING AND SERVING

R & FP SHOULD HAVE EASY ACCESS TO STORAGE
FP & C SHOULD HAVE ACCESS TO BOTH OF THE ABOVE AND BE EASILY REACHED WITH DIRTY DISHES.

C & S ACCESS TO FP & C AND DINING ROOM
PEAK PERIODS WILL OCCUR BEFORE MEALS & AFTER THEM

IMPORTANCE - IN SOME RESPECTS THIS IS THE MAJOR SPACE AS ALMOST ALL GOODS PRODUCED COME THROUGH HERE.
BAKING & CANNING 75#

This area produces food items that won't be consumed at the next meal. Requirements are similar but more specialized. Reason:
there can be sharing of resources with kitchen as long as they don't interfere with meal production.

Room for 3-4 people to work.

- Stone - 4 large burners gas, if possible
- Baking ovens - wood, fuel possible here & double size (2 loaves)
- Sink - double sink for jar & baking utensil washing
- Sterilizer for jars (can be pan on stove) could be used w/milk room
- Drying racks for jars - pegs on wall or drain board is sufficient.

Cabinets for storage

Shelves for bread to rise (2 loaves) near heat

A table w/chair is needed for preparing food for canning

Environmental

Lighting same as kitchen

Ventilation same as kitchen

Movement

To storage areas, stove, milk room, fire wood, to outdoors for produce

Importance

This area shares the kitchen's role of importance because canning is the primary food storage method.

In the overall scheme of the human areas, these spaces must take a slight second to the dining/meeting area. The importance of the D/M area will be discussed when it is analyzed.
DINING/METEING 600-700+ 

The area with tables and chairs can double as a study area for children & the main party area seating capacity for 32 (guest) 

Equipment Required: 
4 tables - 8 chairs each (extra chairs can be available) 

Environment: 
Lighting - Natural & Low Level Artificial 
Ventilation 

Required due to heat of bodies 
Natural - A screen porch setting would be nice in the summer 

Movement: 
People coming in to eat should not cross paths with people coming from kitchen (which should be adjacent). An entrance to the exterior should be near. 
A wash up area should also be in the area. 
Peaks would occur at mealtimes & meetings 
Minor peaks would occur during study periods. 

Importance: 
Although this space takes second place behind the kitchen in the scope of the entire project, it is the prime human space. A family grows closer around the dinner table. It’s where the children learn to communicate, also symbolic roles of leadership are reinforced here. All the problems & day experiences are discussed here. It is a major learning place for all.
OUTSIDE WORK
SHOP 300 $  
STORAGE 400 $  

SHOP  
- THE SHOP IS TO BE DESIGNED TO BE ABLE TO HOUSE FOR THE REPAIR OR CONSTRUCTION ITEMS. THIS IS HELD TO PRACTICAL LIMITS THOUGH, 2-5 PEOPLE MAX  

EQUIPMENT
WORK BENCHES  
VICE  
SHELL  
FIRE PIT  
DRILL PRESS  
ACETYLENE TORCH  
WELDER  
TOOL RACKS (HAND TOOLS FOR SHOP ONLY)  
SAW MILL (LATER ON WHEN FOREST MATURES)  

ENVIRONMENTAL
LIGHTING  
NATURAL GENERAL & TASK LIGHTING ASSIST ARTIFICIAL TASK LIGHTING & NIGHT GENERAL  
VENTILATION  
MUCH IN SUMMER  
LESS IN WINTER EXCEPT FOR PAINTING ETC  

MOVEMENT  
PEOPLE WILL COME FROM ANY WHERE ON THE SITE TO FIX WHAT THE VE THEY'VE BROKEN. THIS INCLUDES THE BARN & THE HOUSE. LOCATION SHOULD BE SOMEWHERE CLOSE TO BOTH BUT IN THE MIDDLE.  

IMPORTANCE  
ONE OF THE MAJOR GOALS OF THIS PROJECT IS TO
OBTAIN S.S. THEREFORE ANYTHING THAT CAN BE MADE OR REPAIRED AIDS IN THE ACHIEVEMENT OF THAT GOAL. THIS IS IMPORTANT BECAUSE EACH TIME IT IS USED SAVES THE COMMUNITY MONEY. IN THE OVERALL SCHEME IF THINGS CAN BE REPAIRED IT CAN REDUCE DOWN TIME & KEEP THINGS RUNNING SMOOTHLY.

STORAGE

ALL TOOLS FOR HOUSE, GARDEN, FOREST & FISH POND MAINTENANCE ARE KEPT HERE: FROM PAINT BRUSHES, TO RAKES, TOTROWELS TO CHAINSAWS TO FISHING POLES 102.2 PEOPLE AT MOST.

EQUIPMENT REQUIRED

SHELVES
RACKS
CABINETS

ENVIRONMENTAL REQUIREMENTS

LIGHTING

NATURAL 99% OF LIGHTING EQU.

ARTIFICIAL NIGHTTIME GENERAL MOVEMENT

FROM OUTSIDE, TO OUTSIDE, SHOULD HAVE SHOP ACCESS PEAK PERIODS OCCUR AT STARTING & STOPPING TIMES RE WORK

IMPORTANCE

THIS PLACE SHOULD ALSO BE CENTRALLY LOCATED AND HAVE EASY ACCESS TO PERMIT PEOPLE TO QUICKLY GET ANY TOOL THEY NEED.
SEMI-PUBLIC

STOREAGE, FOOD 750 $ 

THIS CAN BE A ROOT CELLAR TYPE SITUATION IN THAT ITS SOLE PURPOSE IS TO STORE FOOD IN A COOL DARK AREA. THE ONLY OTHER SIMILAR FACILITY IS THE SMOKE HOUSE. 1 OR 2 PEOPLE AT THE MOST - MUST BE RODENT FREE, INSECT FREE.

EQUIPMENT

SHELVES 40 LINEAR FEET
PEGS FOR SACKS OF DRY STORED ITEMS (FRUIT, NUTS)
FRESEER WILL EVENTUALLY BE DISCARDED AFTER OTHER MEAT STORING PROCESSES HAVE BEEN PERFECTED
RITS FOR OTHER DRY STORAGE (POTATOES, ONIONS)

ENVIRONMENT

LIGHTING

NATURAL & ARTIFICIAL LIGHTING BOTH MINIMAL, FOR ITEM RECOGNITION ONLY

MOVEMENT

EXCLUSIVELY TO & FROM KITCHEN/CANNING AREA

IMPORTANCE

THE SMALL SPACE IS VERY IMPORTANT FOR FOOD BUT A D OF LESSER IMPORTANCE FOR PEOPLE.

OVERALL THIS IS A TEMPORARY STORING PLACE FOR FOOD ITEMS

SMOKE HOUSE 60 $ 

IT IS FOR THE CURING & SMOKING OF MEAT. MEAT IS EITHER SMOKE FROM A REMOTE FIRE OR SALT. FOR 2 PEOPLE

EQUIPMENT

FIRE BOX FOR SMOKE (BURN GREEN HICKORY, APPLE WOOD)
RAPERS OR HOOPS TO HANG MEAT FROM

ENVIRONMENTAL

LIGHTING - NATURAL

VENTILATION - NATURAL - LIMITED

MOVEMENT FROM HOUSE OR SLAUGHTER AREA.
SMOKEHOUSE
PEAK USE WHEN AN ANIMAL IS SLAUGHTERED
THIS IS IMPORTANT AS IT IS A GOOD WAY TO CURE MEAT WITHOUT THE EFFORT OF CANNING

STUDY/BUSINESS/LIBRARY

TO BE INCLUDED IN DINING ROOM BY ADDING SHELVES & LOCKABLE CABINETS

LAUNDRY, CLOTHES $100

SPACE TO WASH & DRY CLOTHES OPEN AIR SUMMER
2 TO 3 PEOPLE

EQUIPMENT (SEWING MACHINE)
SINKS 1 DOUBLE SINK/DEEP
WASHER (2?) AGAIN WILL PROBABLY BE PHASED OUT
LINES FOR DRYING CLOTHES
CABINETS FOR SOAP(ETC)

ENVIRONMENTAL REQ.
LIGHTING NATURAL
VENTILATION TO KEEP HUMIDITY DOWN

MOVEMENT
TO & FROM BEDROOMS, BATHROOMS

IMPORTANT
CLOTHES MUST BE KEPT CLEAN FOR HYGIENIC AS WELL AS PUBLIC RELATIONS
SLAUGHTER HOUSE 120#
EASILY CLEANED SPACE FOR THE PURPOSE OF KILLING
& BUTCHERING ANIMALS
2 PEOPLE
EQUIPMENT
MEAT HOOKS IN CEILING
SINK & HOSE & FLOOR DRAIN - EASILY CLEAN
CONCRETE FLOOR
PLY BOARD FOR INSTRUMENTS & SHELVES
BUTCHER BLOCK
VARIOUS PANS & JARS FOR SAVING PIECES (INTESTINES, TONGUE ETC)
ENVIRONMENT
LIGHTING
NATURAL / HIGHLIGHT LEVELS SHOULD BE MAINTAINED
ARTIFICIAL TO AID IN CUTTING THE WRONG ARM OR FINGER
VENTILATION
NATURAL TO ALLOW FOR COMPLETE DRYING AFTER EACH USE.
MOVEMENT
FROM FIELD OR BARN TO SMOKE HOUSE OR HOUSE
NO REAL PEAKS EXCEPT WHEN MOVING FRESHLY
SLAUGHTERED MEAT.

THIS IS IMPORTANT AS A MEANS TO AN END. PEOPLE
MUST EAT MEAT TO BALANCE THEIR DIET. THIS CAN BE DONE ON A
FARM. THIS IS HEEDED BEFORE THE MEAT IS PLACED ON THE TABLE.
Milk Room
Can possibly be combined with Slaughte room
as sanitary conditions must be kept similar.
3 People, 3 Cows

Equipment
Stools - 3
Stalls - 3
Buckets - 3
Milk Can - 2

Sink - Cows must be cleaned before milking
Sterilizer - can be done in the Kit/CAN/Bak/area

Homogen.
Pasteurizer
Cold Storage
Refrig in the

This is also important for dietetic reasons. The peak periods occur morning & evening at milking time

Mechanical Spaces as derived, later in process
PRIVATE

BATHING

WOMEN 180 ft
MEN 177 ft

SPACES FOR THE DAILY CLEANING MALE & FEMALE ROOMS

20 PEOPLE MAX LOAD

EQUIPMENT

2 GANG SHOWERS 4 HEADS EACH 36 ft/room
4 SINKS/ROOM
3 W.C. 54 ft

TOILETS WOMEN 3

TOILETS MEN 2 + 2 URINALS 30 + 15 ft = 57

TRASH RECEPTECEES

BENCHES IN DRYING AREA 2 PEOPLE MAY

SHELVES FOR SHAVING EQUIP. TOOTHPASTES ETC.

THOSE ITEMS SHOULD BE PROVIDED BY COMMUNITY

SOAP

TOOTHPASTE

SHAMPOO

ETC.

ENVIRONMENT

LIGHTING NATURAL SHOULD BE SUFFICIENT FOR DAY TIME

ARTIFICIAL SHOULD BE AVAILABLE FOR NIGHTS

VENTILATION

MAX AMOUNTS TO DRY AREA AND PROHIBIT FUNGUS GROWTH

NATURAL WOULD BE SUFFICIENT "WHEN IT IS ABOVE FREEZE"

MOVEMENT

PEOPLE COME HERE FROM ALL THROUGH THE HOUSE

PRIMARY FROM BEDROOMS, DINING, & WORKS. THOUGH

THE PRIME TIMES CORRESPOND WITH GETTING UP IN

THE MORNING, AFTER MEALS, AFTER 4 DAYS WORK.

IMPORTANCE OF THIS SPACE IS OBVIOUS BUT ITS

OVERALL ROLE IS MORE OBSCURE. THE BY-PRODUCT

(I.E. FEES, URINE, SOAPY WATER) MUST BE SAVED

& RE-USED
SLEEPING IDEALLY A COUPLE HAS TWO KIDS
ADULTS WILL SLEEP AS COUPLES
KIDS WILL SLEEP IN ROOMS ADJOINING ROOMS
TO THEIR PARENTS. THIS IS AN EFFORT TO ESCAPE THE
LACK OF PRIVACY FOUND IN DORMITORY ARRANGEMENTS

EQUIPMENT
ADULTS 144 $ x 6 = 864 $ ALL ADULTS
2 DRESSERS W/MIRROR 9 $
2 CLOSETS (1514) 12 $
1 QUEEN SIZE BED 30 $
CHILDREN (PAIRS) 144 $ = 864 $ ALL KIDS
2 DRESSERS 9 $
2 CLOSETS 12 $
2 BEDS (BUNKBEDS) 36 $ (18 $)
CLOSETS SEE ABOVE
CHILDRENS ROOMS SHOULD BE EXPANDABLE
IN THE EVENT OF MORE THAN 2 CHILDREN
1 EXTRA SUITE SHOULD BE PROVIDED FOR GUESTS 288 $

ENVIRONMENTAL
LIGHTING & VENTILATION NATURAL IS SUFFICIENT
EXCEPT FOR MINOR AMOUNTS OF ARTIFICIAL
LIGHTING FOR NIGHT TIME USE

MOTION PATTERN ARE PRIMARILY FROM & TO THE
BATHROOM. PEAKS OCCUR AT BEDTIME & EARLY MORNINIG

THIS IMPORTANCE OF THIS ACTIVITY IS OBVIOUS &
ITS ROLE IN THE OVERALL SCHEME IS THESE SPACES
ARE GOOD INSULATORS FOR THE PUBLIC SPACES FROM
COLD & WINDS
PRIVATE SPACE IS A MAJOR PROBLEM. WHILE A SENSE OF COMMUNITY MUST BE MAINTAINED EACH INDIVIDUAL MUST HAVE SOME PRIVATE SPACE. SINCE A ROOM FOR EACH PERSON IS EXCESSIVE, A SMALL SPACE FOR EACH FAMILY WOULD SEEM TO BE BEST. IT COULD DOUBLE AS A PORCH IN THE WARMER MONTHS.

PRIVATE SPACE $0/
2 PEOPLE MAX
EQUIPMENT &
2 EASY CHAIRS
SMALL TABLE WITH LAMP
ENVIRONMENT
LIGHTING: MOSTLY NATURAL. SOURCE ARTIFICIAL IF DESIRED
VENTILATION: NATURAL

MOVEMENT
FROM BEDROOMS TO FAMILY SUITE NO PREDICTABLE PEAKS OF ACTIVITY FOR THIS AREA.

IMPORTANCE
THIS SPACE SHOULD BE THE ONLY LIMITED ACCESS & LIMITED NOISE SPACE thus providing a quiet place for personal thought. Its role in the whole project is that it should help keep tensions down. Another use is that if more bedroom space is needed, it could take up this study thus encouraging people not to have more than two kids. It should not become a living room for each family to hide in.
LOUNGE 250$+

For relaxing conversation, reading, or TV watching. All people should be able to see the tube if they want to. A small alcove should be set aside for children's play. It should have toy storage.

Equipment:
assorted chairs, couches, & tables
TV & stereo shelves (record & magazine storage)

ENVIRONMENT
Lighting:
natural during day
artificial at night

Ventilation:
assisted natural

Movement:
People can come from any where to here. Peak periods would be in the evening when the work is done.

Importance:
Provides an area for relaxation after a day's work.

CHILDREN'S PLAY AREA 200$
Same as lounge but no TV or stereo & less furniture.

A199
SPACES
PUBLIC
- KITCHEN/CANNING
- DINING/MEETING
- SHOP/STORAGE (STOOL)
- LOUNGE/PLAY AREA

SEMI-PUBLIC
- FOOD STORAGE
- SMOKE HOUSE
- SLAUGHTER "HOUSE" (ROOM)/MILK ROOM

PRIVATE
- BATHING/TOILET
- BEDROOMS
- PRIVATE STUDY

STUDIES
- MOVEMENT
- RESOURCE SHARING
- ENVIRONMENTAL
  - HEAT PRODUCING
  - HEAT LOSING
- RELATIONSHIP BY LOGICAL GROUPING
<table>
<thead>
<tr>
<th>Activity Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
</tr>
<tr>
<td>K/C</td>
</tr>
<tr>
<td>M/D</td>
</tr>
<tr>
<td>S1/0</td>
</tr>
<tr>
<td>S1/M</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### Site Conclusions

<table>
<thead>
<tr>
<th>Type</th>
<th>Time (Days)</th>
<th>Rate (Rate)</th>
<th>Total (Rate * Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEG 10A</td>
<td>20</td>
<td>.55</td>
<td>1320</td>
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<tr>
<td>FR TR 29A</td>
<td>25</td>
<td>.25</td>
<td>12</td>
</tr>
<tr>
<td>PAST 12A</td>
<td>3.5</td>
<td>508</td>
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<tr>
<td>CROPS 14SA</td>
<td>20</td>
<td></td>
<td>2040</td>
</tr>
<tr>
<td>POND 2A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOREST 284A</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Work Estimate

<table>
<thead>
<tr>
<th>Animals</th>
<th>Man Days/Head</th>
<th>Total (Man Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAIRY</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>BEEF</td>
<td>5</td>
<td>22.5</td>
</tr>
<tr>
<td>Hogs</td>
<td>2</td>
<td>2.4</td>
</tr>
<tr>
<td>CHICKENS</td>
<td>120</td>
<td>2.6</td>
</tr>
<tr>
<td>LAYERS</td>
<td>320</td>
<td>150</td>
</tr>
<tr>
<td>FRYERS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHEEP</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>GOATS</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>TURKEYS</td>
<td>2</td>
<td>1.8</td>
</tr>
<tr>
<td>RABBITS</td>
<td>4</td>
<td>1.2</td>
</tr>
</tbody>
</table>

**Total Man Days:** 2285.9

380 Man Days/Family
ENERGY INFORMATION
ENERGY SYSTEMS

1. PHOTOVOLTAIC CELLS
   a) ELECTRICITY
   b) HEAT
   ✓ RULES OF THUMB
   lighting & appliances
   space heating

2. METHANE DIGESTOR
   a) METHANE
   b) FERTILIZER
   c) ELECTRICITY
   ✓ RULES OF THUMB
   cooking & space heating
   greenhouses & fields
   for barns & lighting

3. GREEN HOUSES
   a) HEAT
   b) methane digestor fuel
   ✓ RULES OF THUMB
   space heating

4. WIND POWER
   a) WATER
   b) ELECTRICITY
   ✓ RULES OF THUMB
   all uses
   barns
ENERGIZING

SUN - SOMEWHAT SEASONAL
PASSIVE - YES
FLAT PLATE - HOT WATER - LIMITED USE
PHOTO VOLTAIC - MAIN THRUST OF ENERGY COLLECTION

WIND - SEASONAL EFFECTIVENESS
WATERPUMP
ELECTRICITY
MECHANICAL ENERGY - LIMITED USE

WATER - GOOD SEASONAL SOURCE PROBABLY NOT WORTH A LARGE INVESTMENT THOUGH
ELECTRIC
MECHANICAL

METHANE DIGESTOR
TURNS WASTE PRODUCTS INTO CH4 & CO2 & FERTILIZER
However the 31 lbs. dry weight, in practice, would be naturally damp droppings plus perhaps urine and in this state would weigh at least 3 x 31 or 93 lbs., so that 100 lbs. (or 12 U.S. gals. - 45 liters) of water would have to be added.

These calculations may appear to be complicated but once established need not be repeated. In practice your 4 ft. diameter, 12 ft. long tank would have a loading of one high-sided wheelbarrow of 2 cu. ft. (0.06 cu. m.), perhaps a little more, which would be tipped into a mixing basin and about 10 to 15 U.S. gals. (37 to 76 liters) of water added until the slurry reached the consistency of cream. This would most likely finish at between 12% to 14% dry solids slurry. The outlet from the basin to the digester inlet could be an inch or two above the bottom so that sand and grit would settle out and not be loaded into the digester.

The gas yield that can be expected can be estimated quickly by a simple rule of thumb. Whatever the digester capacity in cubic feet or cubic meters, you can expect that same amount in cubic feet, or meters, of methane gas. In this case the capacity is 149 cu. ft. Thus you could expect 149 cu. ft. of gas per day. This is assuming that regular loadings are made and the temperature inside maintained at 95°F (35°C).

On my farm the twin digesters with a total capacity of 6,000 cu. ft. produced 8,000 cu. ft. of gas per day with peaks of up to 12,000 cu. ft. In general the greater the digester the greater the overall efficiency.

Temperature

For the digesting methane bacteria to work at the greatest efficiency a temperature of 95°F (35°C) is best. Gas production can proceed in three ranges of temperature as different sets of acid-producing and methane bacteria thrive in each of these different ranges:

1) Thermophilic or heat-loving bacteria in the range of 120°F to 140°F (55°C to 60°C).

Digesters are only very rarely operated at this high temperature because a) most materials will digest well in the middle or mesophilic range, b) thermophilic bacteria are easily killed by changes in temperature, c) the sludge effluent is of poor fertilizer quality and is smelly, and d) it is uneconomical to maintain such a high temperature, especially in cold climates.

2) Mesophilic or middle range of 55°F (13°C) to 105°F (40°C).

These bacteria are easier to maintain in a well-buffered state and can remain active through slight temperature changes, especially if those changes occur slowly. At the low end very little activity is discernible. For instance, at 60°F (15.5°C) the rate is about half that at 95°F (35°C). However, at this low temperature, activity continues and might be of interest to those who do not intend to heat their digesters.

At temperatures around 50°F (10°C) to 45°F (7°C) and below activity almost ceases and this range of bacterial fermentation becomes dormant until temperature rises past these figures again. A example a digester can be constructed for seasonal use and manure slurry loaded during the season until activity ceases in winter and again res in spring. Seeding with bacteria would not be required.

Operation at 105°F (40°C) is not recommended. Production becomes sporadic as great outbursts of gas for a few hours while little is produced for the rest of the day. If the temperature should rise to 106°F per day for instance, it would certainly not be 10°F at night. This could very easily kill the bacteria.

3) Psychrophilic or low range of 32°F (0°C) to 70°F (21°C). Very few bacteria thrive in this range.

Since the object of a methane plant is to decompose raw wastes and produce gas, it follows that the advantages of bacteria have to be understood. Part of the design and operation of a methane plant should be directed toward generating the most active bacteria and to keep them in as near a condition as can be done.

Having determined that the best temperature range is 60°F (15.5°C) to 105°F (40°C), and that 95°F (35°C) is the best temperature of all, the problem rests itself to two facets:

1) Insulation. This problem is complicated by the relatively large size of the digester itself, by rain, weather and the fact that certain porous mate might not be suitable.

One solution would be to insulate the digester if you can find a material that is suitable.

Styrofoam (sometimes called expanded polystyrene) is an extremely good insulator and also has the property of being a closed cell material. This makes it far safer than open cell materials which might allow a leak of gas from the digester walls or the formation of an explosive mixture of gas and air.

Another possibility might be to surround the digester with another structure, such as a greenhouse, to maintain the temperature at 95°F (35°C). This might be found still more advantageous at large stables where four or more digesters would lay side by side.

Packing a half-buried digester in a massive compost heap might be another solution in certain climates. In the tropics, little or no insulation may be required. If the digester temperature drops to 60°F (21°C), a drop in activity might not warrant the expense of heating. In considering insulation and or heating fact should be borne in mind: Bacteria will not stand up to violent (15°F) changes in a short time.
Any cylinder longer and thinner or shorter would not be suitable for a digester. An existing cylinder for use as a digester requires that the cylinder should have a drum removal door at each end of the more easily installed on flat surfaces than others. A note of caution: It is dangerous to use tinfoil in tanks that have contained products such as gasoline, solvents, etc. A authority should be consulted before thinking of any such cylinder.

Try the four most important points in this digester:

- A loading rate of .22 lbs. per cu. ft. per day total weight manure can be maintained with a reasonable certainty of not overloading on time should be 35 to 40 days. Thus, the last 35 to 40 times the amount of a daily dry total that is 14% solids, i.e., the consistency temperature should be maintained at 95°-F.

Displacement-type, continuously-operated must be cylindrical in design (or partly with a concrete base, for instance) and be of length to surface area (height times or size is dependent only on the dry weights of the solids to be loaded continuously. Deinterethe interrelationship of the factors at workment digester I will cite four examples.

No. 1: Three 50 U.S. gallon oil drum capacities of each drum is approximately (220 liters) but since a small space must be of the digester contents for the gas, 55 liters) is the working capacity. Thus the digester capacity is 165 U.S. gals. (603 liters)

8 ft. by 22 cu. ft. (.623 cu. meters)

Loading is to be .22 lbs. per cu. ft. per day (3.4 meter per day) the dry weight manure is 2.8 lbs. or 4.8 lbs. (2.2 kg.). Natural damp would weigh three times this or 15 lbs. (6.7 loading would have a capacity of 165/35 U.S. gals. (17 liters).

Simply, one would weigh off 15 lbs. (6.7 container of at least 6 U.S. gals. capacity manure and/or water until the container held 3 U.S. gals. (17 liters).

Operation is maintained at 95°F (35°C) the should be at least 5 cu. ft. per pound of raw (0.31 cu. meters per kg.) or a total of 25 cu. ft. per day (720 cu. ft.) gas per day.

No. 2: Large scale, 100 ft. long. 25 ft. in

$25 \times 25 \times 7584 \times 100 \text{ cu. ft.} = 49,000 \text{ cu. ft.}$
or 366,000 U.S. gals. working space. ($7.62 \times 7.62 \times 0.7584 \times 30.48 \text{ cu. m.} = 1,389 \text{ cu. meters.}$)

At a loading rate of .22 lbs. per cu. ft. per day (3.4 kg. per cu. m. per day) dry weight droppings would be 5½ tons (5 tonnes). The gas yield could be expected to be 5 cu. ft. per pound raw matter (0.31 cu. m. per kg.) or over 50,000 cu. ft. (1,524 cu. m.) daily. In a digester of this capacity the efficiency of the whole process could be expected to produce a gas yield of twice this amount in peak production and to average at least 20% to 70% more than the basic volume quoted. This is due in part to the greater depth of the vertical surge action, and in part to the generally greater efficiency of larger units.

The total daily slurry loading would be $1/35 \times 366,000$ U.S. gals. or about 10,500 U.S. gals. (38,000 liters) composed of just under 14% solids with the remaining 86% consisting of water and/or urine to bring it to cream consistency.

There is no technical reason why digesters of this large capacity should not be built and no doubt the time will come when such digesters are in common use.

Example No. 3: A power plant that might be operated on a livestock farm of, say, 3,000 hogs, or 300 cattle, or 30,000 layers. Three digesters constructed side by side, with the loading being spread equally, or between two should one of the units be out of operation.

Capacity of each unit is 124 sq. ft. cross section to 50 ft. long. The cross-section could be roofed by a half cylinder bolted down to a concrete or cinder concrete base, or a complete cylinder of 14 ft. diameter. (Using the formula of a diameter squared x .7854 x 50 ft. = 7,700 cu. ft. = 57,500 U.S. gals [218 cu. m].)

The loading of each digester would be at least .22 lbs. per cu. ft. per day (3.4 kg. per cu. m. per day) dry weight, or 7,700 x .22 lbs. = 1,694 lbs. (770 kg.). This figure would be a reasonable estimation from all the droppings on such a farm, assuming the livestock are fed an average amount. Total figure 3 x 1,694 lbs = 5,082 lbs. dry weight (2,310 kg.). Total gas yield 25,000 cu. ft. per day (720 cu. m.) could be expected with peaks to twice this amount and an average 20% to 70% higher.

Assuming a gas yield of 30,000 cu. ft. (850 cu. m.) per day one third that amount (10,000 cu. ft. or 283 cu. m.) could be used to fuel a 20 BHP engine continuously. In practice it would be advisable to use a higher BHP engine such as 24 or 30 BHP heavy duty engine and operate it at 20 BHP to increase endurance and lower maintenance costs. The heating generated would be enough to replace heat losses from the digester even in cold winter climates, provided the digesters were well insulated thermally, and the daily quota warmed before loading.

The advantage of a methane plant designed along
that the daily influx of a relatively large volume of raw slurry at near-freezing temperatures would drop the general temperature of the digester in only a few days. This happened on my farm once causing a problem that was compounded when far too much cold water was added to the slurry, reducing the solids content to below 5%.

When the engine was running, so much surplus heat was generated that it did not matter if the raw slurry was near freezing when it was loaded, provided it was not diluted beyond the normal 12% solids content. Thus, even in winter raw slurry was not heated as long as the massive heating of the engine continued. Many think of South African winters as warm, but from May to late August frosts of 15°F (−9.4°C) were frequent at night. In fact, on my farm 8 miles south of Johannesburg, situated on land at an altitude of 5,500 ft. above sea level, there was frost nearly every night during the winter.

It has been estimated that one third of the energy heat value of the gas generated in a digester would be sufficient, with thorough insulation, to maintain the temperature at 95°F (35°C) in cold climates. I was using 3/4 of the gas generated to fuel my engine. Thus, the heating was more than enough despite the fact that the digester roof itself was hardly insulated and the raw slurry was near freezing. I imagine the same conditions would exist where most plants would be put into operation in winter.

In extremely cold climates good insulation is the first essential, and the second is that the raw slurry temperature should be raised to 95°F (35°C) or higher so that the general temperature of the digester is maintained at the optimum despite heat losses through the sides and roof of the digester.

1) One method of preserving heat, employed in sewage works, is to use warm supernatant as the liquid mixed with the raw material to form a slurry.

A tank outside the digester is built to receive the raw material which is then reduced to a slurry by recirculating liquid taken from the outlet end of a digester at a point about halfway between top and bottom where it is thinnest. The second advantage of this method is that the raw material is thoroughly seeded with bacteria when pumped into the inlet end. The disadvantage is that the digester contents tend to thicken and become too dry over a period of time. Also, the outside mixing tank means that oxygen has access to the methane bacteria when the mixing is vigorous, as it has to be. Smells are obnoxious.

Alternative systems are discussed under Digester Operation. In nearly all cases some form of raw slurry heating is essential to efficient methane plant operation.

Digester Size. Those planning to build their own methane plants should be aware of the full scope of such an undertaking. A significantly productive plant is no backyard, weekend project. The size of a methane plant in relation to the quantity of manure loaded is 35 or 40 to 1. For instance, Santa Barbara with a population of 78,000 has a sewage plant with digester each of 700,000 U.S. gallons or about 100,000 cu. ft. capacity (2,750 cu. meters). Yet this plant is too small for the city and a new plant is being built. The important point is that methane plants, even highly efficient ones, have to be large to handle the vast volumes of raw materials for the amount of gas required.

From what is known about methane digestion at the present time the requirements pertaining to digester size are as follows:

1) A digester must have a capacity 35 times (preferably 40) that of the slurry mixed to the right consistency for daily loading.

2) The digester must be insulated and the colder the climate the better the insulation required.

3) A digester of displacement design allows the operator far better control of the continuous operatic aspect.

Should a more efficient method of fermenting be devised in the future, the original digester would not be rendered obsolete, but could be loaded at a higher rate to give better results. Oxidation (rusting) is not possible since there is only a trace of oxygen inside the digester. The outside must be covered with some form of insulation and therefore keeps dry. A steeled roofed design should have a long life even without coating or painting.

A displacement digester can consist of a complex cylinder, or of simply the roof half of the cylinder bolted down to a concrete base thus affording a much greater capacity than with the lower half of the complex cylinder (see drawings of both versions).

The proportion of length to diameter (or surface area of a cross section) are important to keep within certain bounds:

1. 1) If the digester is too long and thin the fresh slurry loaded will not be seeded properly with active methane bacteria so as to start the fermentation process speedily. One essential feature in the design of an efficient digester is that the raw slurry loading should come into contact with the previous loadings which, in turn, should be in the active stages of decomposition leading to the final stage of methane fermentation.

2) If too short or wide the physical and biological succession would be foreshortened. If taken to extremes the action would be no better than that of a vertical digester without the benefits of slow digestion over distance.

The proportions of width and depth for diameters to length is not critical. A ratio of 1 diameter to 5 length is optimal. The ratio of 1 to 8 in length or 1:3 in length each would be the outside extremes.
PRACTICAL BUILDING OF METHANE POWER PLANTS

FOR RURAL ENERGY INDEPENDENCE

L. John Fry

STANDARD PRINTING

SANTA BARBARA, CALIFORNIA

1974
PATTERN
LANGUAGE
PATTERN LANGUAGE
TOWNS
1. INDEPENDANT REGIONS
2. AGRI. VALLEYS
3. COUNTRY TOWNS
4. THE CONTR. SIDE
5. IDENTIFIABLE NEIGHBORHOOD
6. NEIGHBORHOOD BOUNDARY
7. ACCESS TO WATER
8. LIFE CYCLE
9. MEN & WOMEN
10. PROMENADE
11. DEGREES OF PUBLICNESS
12. CLUSTER
13. HOUSING HILL
14. NETWORK OF PATHS & LAKES
15. MAIN GATEWAYS
16. HIGH PLACES
17. POOLS & STREAMS
18. COMMON LAND
19. GRAVESITES
20. STILL WATER
21. ANIMALS
22. THE FAMILY
23. HOUSE FOR A SMALL FAMILY
24. TEENAGE SOCIETY
25. CHILDREN'S HOME
26. SLEEPING IN PUBLIC
99. Main Building
   More prominent than rest
   \rightarrow Kitchen

100. Pedestrian Streets
     From room to room should be outdoors

105. South-facing outdoors
     Open spaces to South & South-West

106. Positive outdoor space
     Each space should have its own identity

107. Wings of Light
     Wings not to exceed 25' width

109. Long Thin House
     Tall or long

110. Visible Main Entrance

112. Entrance Transition
     The entry should complete
     the physical environment
     travel of person approaching the door

114. Hierarchy of Open Space
     Every open space should have a smaller "back space"
     and a larger open space in "front"

117. Sheltering Roof
     Low edges (0-6"
     Entirely visible
118 ROOF GARDENS
   ALL ROOF SYSTEMS SHOULD
   HAVE GARDEN SPACES
   AT VARIOUS STORIES &
   MAKE THEM ACCESSIBLE
   TO "LIVE-IN" SPACES

119 COVERED ARCADES
   SHOULD CONNECT BUILDINGS

120 PATHS & GOALS

121 PATH SHAPE
   NARROW AT ENDS - WIDE IN MIDDLE
   TO MAKE A PLACE TO STAY
   NOT JUST A PLACE TO WALK
   THROUGH

 - 125 STAIR SEATS

126 SOMETHING ROUGHLY IN THE
   MIDDLE OF A SPACE

127 INTAMACY GRADIENT

 - 128 INDOOR SUNLIGHT
   BEDROOMS SE
   PORCHES SW

129 COMMON AREAS AT THE HEART

 - 130 ENTRANCE ROOM
   LIGHT FILLED ROOM THAT
   STRADDLES INDOOR & OUTDOOR
   SPACES

 - 132 SHORT PASSAGES
   MAKE THEM LIKE ROOMS
   & GIVE THEM PLENTY OF WIND
133. STAIRCASE AS A STAGE
People coming down should become part of the action before they reach the bottom & the people in the room should be enticed to sit on the stairs

134. ZEN VEN
Place windows with veils at places of transition

135. TAPESTRY OF LIGHT & DARK

136. COUPLES' REALM
Private from children

137. CHILDREN'S REALM
Continuous play space from bedrooms (at the back) to outdoor room near street where kids can play outdoors when it rains - path should pass kitchen & bathrooms

138. SLEEPING TO THE EAST
Sleeping rooms should have east orientation

139. FARM HOUSE KITCHEN
Major space - gathering place

140. PRIVATE TERRACE ON THE STREET
Terrace should let people look out but not in
141. A ROOM OF ONE'S OWN
PLACE AT FAR ENDS OF
INTIMACY GRADIENT
ESPECIALLY ADULT

142. SEQUENCE OF SITTING SPACES
FORMAL - ENCLOSED
INFORMAL - OPEN

BED CLUSTER
CHILDREN'S BEDS SHOULD
NOT BE TOO ISOLATED

144. BATHING ROOM
BESIDE COUPLES REALM W/ PRIVATE
OUTSIDE ACCESS IF POSSIBLE
TUB BIG ENOUGH FOR TWO TOTALLY
ENRESHED

145. BULK STORAGE 15% - 20% SPL. AREA

146. TEENAGERS COTTAGE
PRIVATE ENTRANCE
EXPRESSION OF COMING INDEPENDENT

148. OPEN STAIRS

149. LIGHT ON TWO SIDES OF
EVERY ROOM

160. BUILDING EDGE DEVELOP IT

161. SUNNY PLACE

163. OUTDOOR "ROOM" FOR KIDS

166. GALLERY SURROUND OUTSIDE BALCONIES

167. SIX-FOOT BALCONY AT LEAST
RECESS IT INTO BUILDING IF
POSSIBLE
168 CONNECTION TO THE EARTH
    MAKE IT IN DEFINATE
175 GREEN HOUSE MAKE IT PART OF THE HOUSE
- 179 ALCOVES
    A PLACE FOR GATHERINGS OF LESS THAN FOUR IN ROOMS FOR MANY MORE
- 180 WINDOW PLACE "WINDOW SEAT"
- 181 THE FIRE
    IN A PUBLIC SPACE
    ADJUST IT TO KNIT TOGETHER THE SOCIAL SPACES
    PLACE A WINDOW NEAR IT
- 182 PLACE LIGHT OVER TABLE EATING ATMOSPHERE
- 184 COOKING LAYOUT
    PLACE THE STOVE, SITIK, TRFF.
    FOOD STORAGE SO THAT
    1. NO 2 ARE MORE THAN 10' APART
    2. ONE IS 12' ABOVE
    3. NO SECTION IS LESS THAN 1'
- 185 SITTING CIRCLE
    PROTECT FROM MOVEMENT PATH
    PLACE CHAIRS & CUSHIONS LOOSELY AND HAVE A FEW TO MANY
187 MARRIAGE BED
    IN SPECIAL SPACE
188 BED ALCOVE
189 DRESSING ROOM
190 CEILING HGT. VARIETY
  Lg. gatherings  10-12'
  sm. gatherings  7-9'
  Alcoves        6-7'
193 HALF OPEN WALLS balance walls
194 INTERIOR WINDOWS to separate dead spaces
196 CORNER DOORS
197 THICK WALLS
198 CLOSETS BETWEEN ROOMS
199 SUNNY COUNTERS - KITCHEN
200 OPEN SHELVES 1/day
201 WAIST HIGH SHELVES
  202 BUILT IN SEATS BE CAREFUL
203 CHILDREN CAVES
204 SECRET PLACE
233 FLOOR SURFACE
  PUBLIC  → HARD WLS
  PRIVATE  SOFT WLS
254 ROOFS OF LIGHT
REFERENCES

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