

Silkworm Rearing Houses Design & Construction



S.B. Dandin & Satish Verma

SILKWORM REARING HOUSES

- DESIGN & CONSTRUCTION

S. B. Dandin
Satish Verma



CENTRAL SERICULTURAL RESEARCH & TRAINING INSTITUTE

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Preface

Silkworm rearing and cocoon production are high value activities in many parts of India, specially in the States of Karnataka, Andhra Pradesh, Tamilnadu, West Bengal, Jammu & Kashmir. In past few years, the production of silk per unit area has increased many folds due to modernization of sericulture in India. As we all are aware that, rearing of mulberry silkworm is fully domesticated in order to provide optimal environmental conditions such as temperature, relative humidity, illumination and ventilation to silkworms for their good growth and production of silk rich cocoons. An exclusive house for silkworm rearing is considered as main key after quality mulberry leaves for a successful cocoon crop.

In India, the design and construction of silkworm rearing houses vary from place to place and region to region. Most of the time, the rearing houses are designed based on the local needs, expertise and materials of construction. Very little science and engineering are involved in the design of the rearing houses as a result of which the farmers are not able to create and maintain optimal environmental conditions most of the time during rearing. Hence, need for a book containing the design and construction details of the rearing house has been felt from some time from sericulturists, engineers and farmers. It is hoped that this book will fulfil the requirement of the silkworm rearing house planners and sericulture farmers.

Authors

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1. Introduction

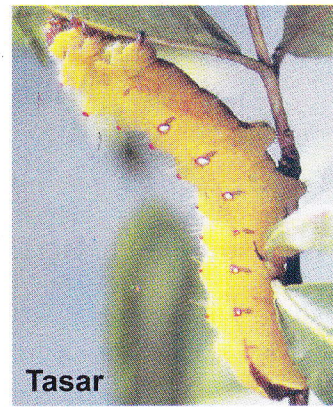
Silk is named in legend, fable and folklore. The word spells luxury and class. The superiority of silk as textile fibre has been recognized from time immemorial and even today no other fabric can match its lustre and elegance. Mankind has always lived for silk. It is the yarn of life, extended by a caterpillar called silkworm into a continuous filament.

There are five types of natural silk mulberry, tasar, oak tasar, eri and muga, each of which is produced by a distinct species of silkworms feeding on specific host plant . India is the second largest producer of mulberry silk after China in the world. Over 95 % of silk produced in world is mulberry silk. In global textile parlance, the term silk refers to mulberry silk. India has the unique distinction of producing all the five types of silk. India has largest production of tasar silk, eri silk and monopoly in golden muga silk in world. The mulberry silk is produced mainly in the States of Karnataka, Andhra Pradesh, West Bengal, Tamilnadu, Jammu & Kashmir, Uttar Pradesh, and Uttranchal.

The rearing of the mulberry silkworms is fully domesticated. A silkworm rearing house is the place where the silkworms are reared to produce the cocoons. It is an essential and fundamental



Mulberry



Tasar



Oak Tasar



Muga

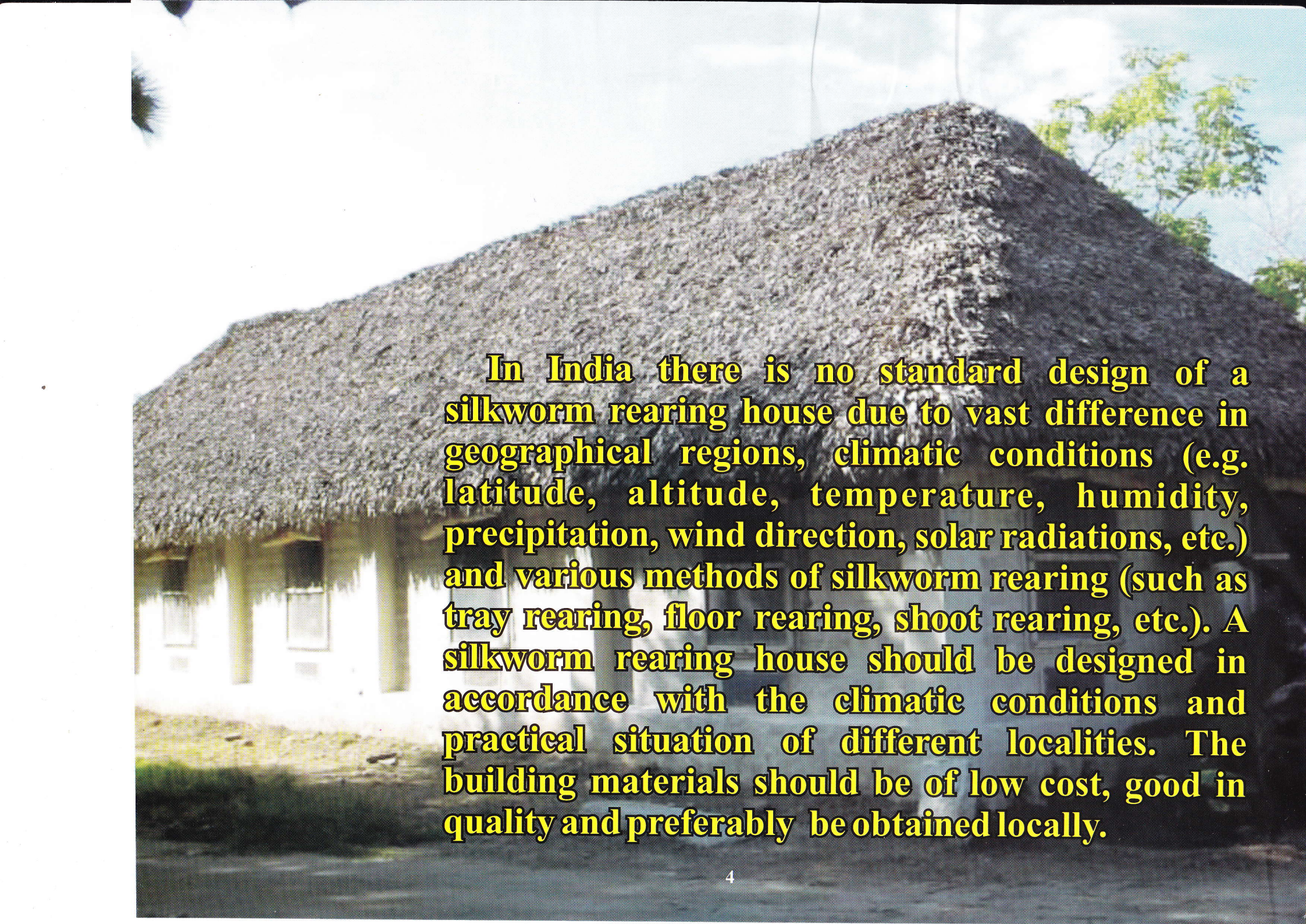


Eri

component for production of cocoons of mulberry silk. The cocoon yield and quality of the silk are adversely affected when silkworms are not reared under optimal environmental conditions i.e. temperature, relative humidity, ventilation, illumination, hygiene, etc. The rearing house must be rationally designed in order to keep the micro-climatic and environmental conditions suitable for rapid and healthy growth of the silkworms. It should, therefore, have facilities for creating, controlling and monitoring of environmental parameters such as temperature, relative humidity, ventilation, illumination, etc. The rearing house should also provide sufficient space and healthy environment for the workers attending the silkworm rearing.



A good rearing house provides healthy environment to silk worms



In India there is no standard design of a silkworm rearing house due to vast difference in geographical regions, climatic conditions (e.g. latitude, altitude, temperature, humidity, precipitation, wind direction, solar radiations, etc.) and various methods of silkworm rearing (such as tray rearing, floor rearing, shoot rearing, etc.). A silkworm rearing house should be designed in accordance with the climatic conditions and practical situation of different localities. The building materials should be of low cost, good in quality and preferably be obtained locally.

2. Environmental Conditions and Rearing Bed Area Requirement of Silkworms

The environment plays an important role in expression of genetic characters by the silkworms. The environmental factors mainly temperature, relative humidity, light, ventilation, etc. during the rearing have a direct influence on the growth of silkworm and production of silk besides mulberry leaf quality.

Temperature and relative humidity: A rearing house should provide optimal environmental conditions along with adequate rearing bed space for good growth of the silkworms. The optimum rearing temperature and relative humidity during different stages of young and late age silkworms are as follows :

	Temperature	Relative Humidity
I instar	27-28 °C	85-90 %
II instar	27-28 °C	85-90 %
III instar	26-27 °C	75-80 %
IV instar	25-26 °C	70-75 %
V instar	25-26 °C	70-75 %

When the temperature and relative humidity inside the rearing house are below optimum conditions, they are artificially raised through charcoal or electric heaters and running humidifiers. When the rearing room temperature and relative humidity are above the optimum conditions, arrangements for natural cooling through good ventilation or forced cooling through wet curtains on windows, air coolers or air-conditioners should be made; besides covering the roof with mats made of coconut fronds, grass. etc.

Light or illumination : Young Silkworms prefer dark or dim light (15-30 lux) . Light intensity influences the distribution of the larvae in the rearing bed. Silkworms are crowded in dark place in the rearing bed compared to area under light.

Ventilation : A silkworm rearing house should be well ventilated. Poor ventilation leads to humidity built up and accumulation of gases like carbon monoxide, carbon dioxide, ammonia, etc. which adversely affect the growth of silkworms and make them susceptible to diseases.

Rearing Bed Area requirement for silkworms : The rearing bed area required for different races of the silkworms during different stages of growth is given below for 100 Dfls (2 Boxes) resulting approximately 40,000 larvae.

Rearing bed Area Required for silkworms during different stages

Instar	Multi x Bivoltine			Bivoltine x Bivoltine		
	Bed area at Beginning (sqm/sqft)	Bed area at End (sqm/sqft)	No. of larvae per sqm/sqft	Bed area at Beginning (sqm/sqft)	Bed area at End (sqm/sqft)	No. of larvae per sqm/sqft
First	0.50/5	1.50/15	27,000/2,700	0.45/4.5	1.75/17.5	23,000/2,300
Second	1.50/15	4.50/45	9,000/900	1.75/17.5	5.25/52.5	7,500/750
Third	4.50/45	9.00/90	4,500/450	5.25/52.5	12.00/120	3,500/350
Fourth	9.00/90	24.00/240	1,650/165	12.00/120	33.00/330	1,200/120
Fifth	24.00/240	50.00/500	800/80	33.00/330	70.00/700	575/58

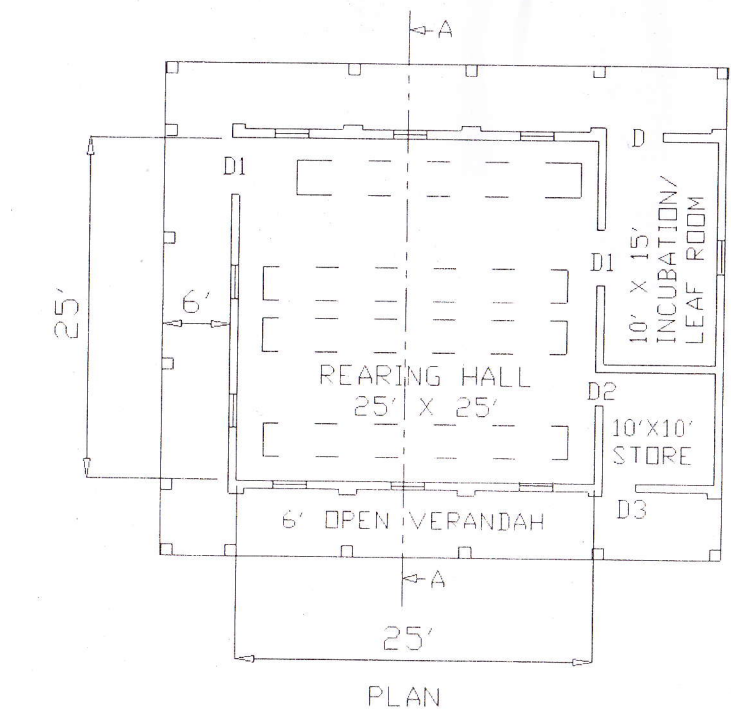
1 sqm = 10 sqft

3. Young Age Silkworm Rearing House

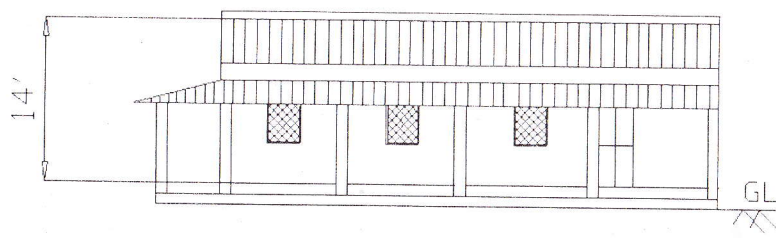
The Young age silkworm rearing houses are often called as Chawki Rearing Centre (CRC). Adequate care in terms of temperature, relative humidity and hygienic conditions should be provided to young silkworms for their good and healthy growth. Since, the young silkworm rearing is becoming popular these days in general and specially for Bivoltine races, a separate rearing space is a must. A CRC for brushing 5000-6000 dfis per batch consists of a rearing hall of 30' x 30', leaf storage room of 10' x 20' and ante room of 10' x 10' size. Adequate ventilation in the rearing hall is recommended. A continuous water channel inside the rearing hall along the walls helps in keeping the ants away from silkworms and also maintaining the humidity. The windows should be fitted with wire mesh to avoid entry of uzi fly. The ceiling should be kept at 9-10' from floor. In case of more roof height a false ceiling at 8'-9' from floor helps in reducing the volume of air in the rearing hall so that required temperature and humidity can be maintained conveniently.

Salient features of a young age silkworm rearing house

- 30' x 30' rearing hall for 6000 dfis
- 5' covered veranda around rearing hall
- 10' x 20' leaf storage room
- 10' x 10' ante room
- Cement flooring for easy cleaning
- assured water supply
- 5'x10'x2 ½' disinfection tank
- wall height maximum 10'
- 3'x4' windows fitted with wire mesh and wooden shutters
- asbestos sheet roof
- all doors should be double door - wire mesh & panel door
- 2"-4" water channel all around rearing hall
- adequate lights for working during night
- walls should be white washed



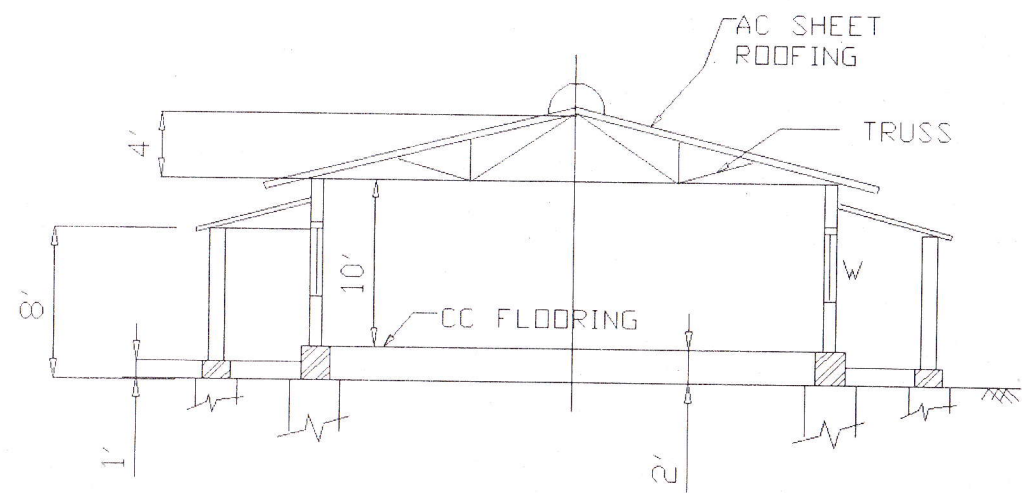
PLAN



ELEVATION



- D - 5'X7' -- WOODEN PANELLED SHUTTER
- D1 - 5'X7' -- WOODEN PANELLED SHUTTER
FLY PROOF WIRE MESH SHUTTER
- D2 - 3'X7' -- WOODEN PANELLED SHUTTER WITH
FLY PROOF WIRE MESH SHUTTER
- D3 - 3'X7' -- WOODEN PANELLED SHUTTER



SECTION-AA

**PLAN OF 5000-6000 DFL/BATCH CAPACITY
YOUNG AGE REARING HOUSE/CHAWKI REARING CENTRE**



An overall view of Chawki Rearing Centre (Young age silkworm rearing house)



Inside view of young age silkworm rearing house



Water channel in rearing hall



Veranda around rearing hall



Windows in rearing hall should be fixed with uzi proof mesh



Disinfestation tank for washing trays, nets and other rearing equipments and materials

4. Late Age Silkworm Rearing Houses

We have seen in the earlier chapters that silkworms need specific environmental conditions for their healthy and robust growth and production of good quality cocoons. The design of a silkworm rearing house for a particular place depends upon the climatic conditions, rearing capacity, construction materials available, farmer's resources, and local expertise available for construction of houses.

Guidelines for construction of silkworm rearing houses

1. The silkworm rearing house should be located on an elevated place to avoid moisture migration from floor to rearing house, provide good cross ventilation, facilitate drainage of the water at the time of cleaning and disinfection.
2. The rearing house should be north facing i.e. the windows face north and south. This will avoid direct entry of the sunlight into the rearing house.
3. Ventilators should be provided above and below the windows for air circulation inside the rearing house.
4. The rearing house should have cement flooring for maintaining hygiene.
5. The rearing bed area should be 650sft/100 dfls for cross breeds and 700sft /100 dfls for bivoltine races.

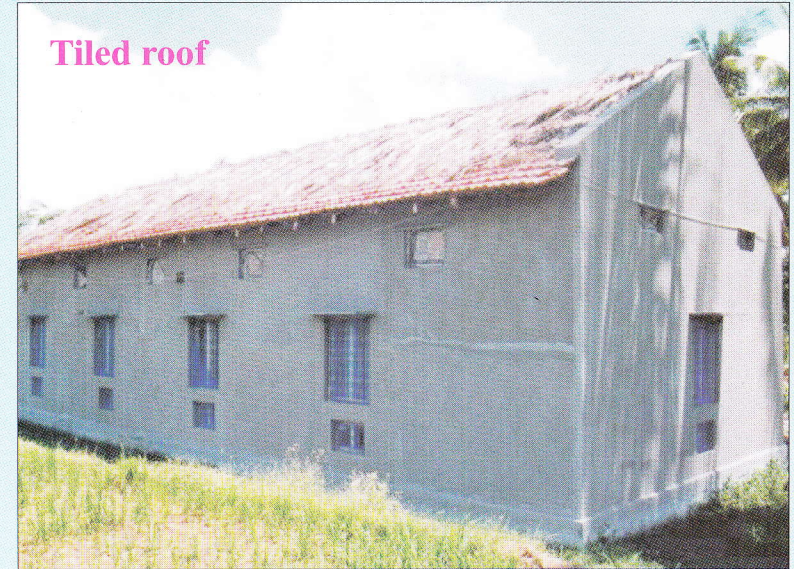
6. A 10-15 cm deep channel inside all around the rearing hall should be provided to avoid entry of ants into the rearing area and also to drain out water at the time of cleaning and disinfection. During summer, the water in channel helps in increasing the humidity and cooling the air entering in through the lower ventilators.
7. The roof of the house should be of either Asbestos sheets or RCC to avoid entry of the Uzi-fly. In hot regions, coconut fronds or straw should be placed over the roof to avoid heat radiations during day time. A false ceiling of plywood or thermocol sheet is also effective in reducing the solar radiation from roof.
8. The minimum width of a rearing house for late age rearing should be 5.5 m (18'). The length of the rearing house can be calculated as follows :

Number of tiers in stand	Length of rearing House in feet (L)
For 4 tier shoot rearing stand	$0.20 \times \text{no. of dfls} + 10$
For 5 tier shoot rearing stand	$0.16 \times \text{no. of dfls} + 10$

Here, L (in feet) is total internal length of the rearing house which includes 5' width for anteroom, 2½' on each side of the rearing bed.



Thatch roof



Tiled roof



Asbestos sheet roof



RCC roof

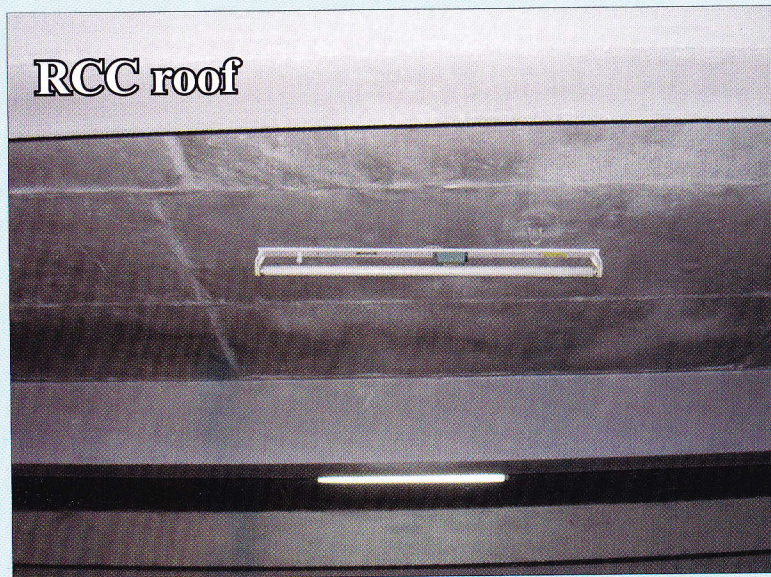
Different type of roofing materials for late age silkworm rearing houses (outside view)



Thatch roof



Aluminium sheet roof

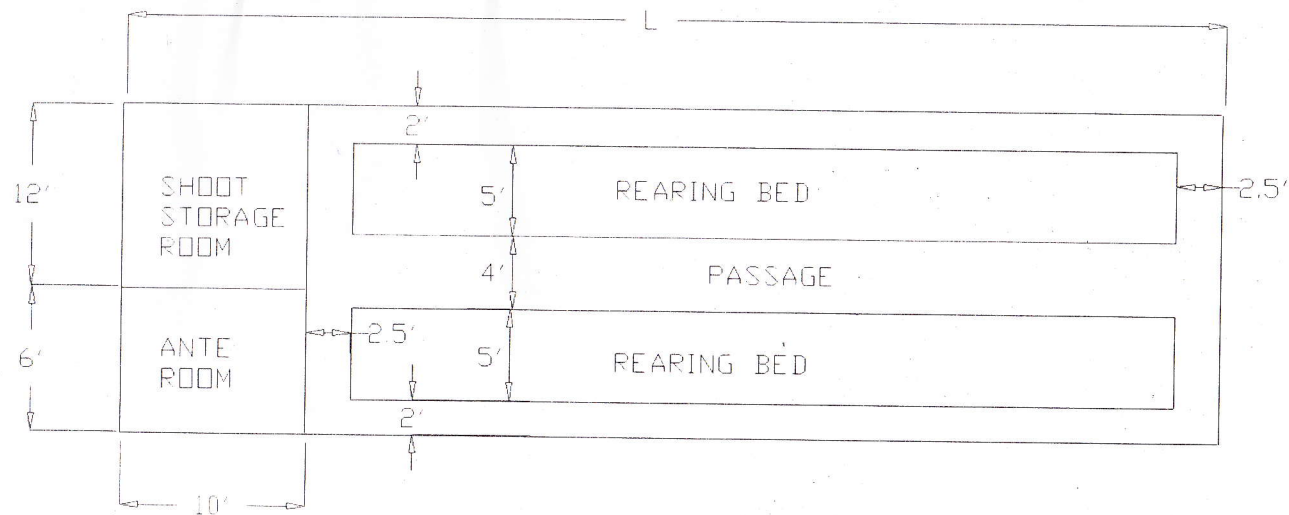


RCC roof



Asbestos sheet roof

Different type of roofing materials for late age silkworm rearing houses (inside view)

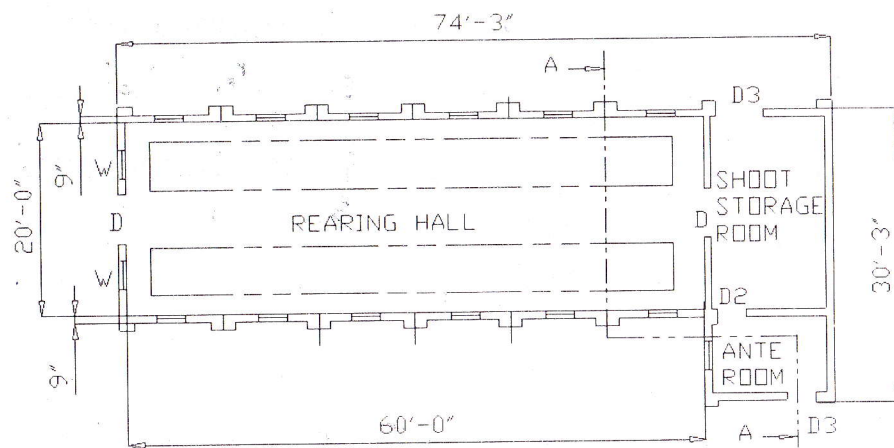


9. The wall height in a rearing house should be minimum 10' on the sides and 14' at the centre. The most common wall height on sides is 12' and 16' at the centre to accommodate 4 and 5 tier rearing racks and facilitate good ventilation during summer and rainy season besides increasing the rearing capacity in favorable season.
10. The young age rearing room should be located in the eastern part of the rearing house so that morning sun rays will warm the room.
11. An ante-room should be provided for washing hands and disinfecting legs before entering into the rearing area.
12. All the doors and windows should be fitted with wire mesh to avoid entry of uzi-fly into the rearing house.

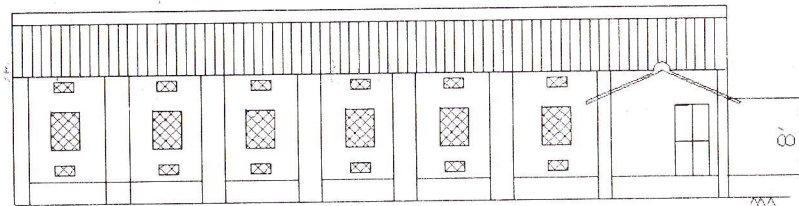


Windows and ventilators should be fitted with mesh to protect silkworms from uzi fly. An Ante room helps in restricting entry of uzi fly to the rearing hall

13. Water facility should be provided in a rearing house for cleaning/washing and disinfection and also for humidification purpose.
14. The rearing house should have adequate lighting arrangements for working during night.
15. Electrical points in the rearing house should be provided for using heaters, humidifiers, coolers and lighting the building for workers during night hours.
16. The fancy works in the rearing house should be avoided to minimize the cost.
17. RCC structures should be avoided for rearing houses as walled structures are sufficient.
18. Provisions must be made for exhaust fans for evacuating humidity from rearing house during rainy days.
19. Make arrangements to ward off rats, lizards and snakes and avoid entry into the rearing house.
20. Grow shade trees around the rearing house to protect the walls and the roof from afternoon sun .



PLAN

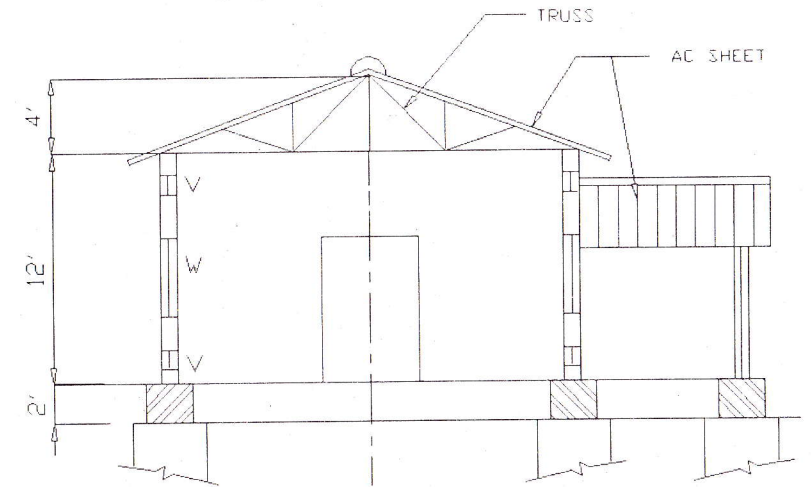


ELEVATION

REARING HALL -- 60' X 20'
 SHOOT ROOM -- 12' X 20'
 ANTE ROOM -- 12' X 8'
 HEIGHT OF SIDE WALL -- 12'-0"
 HEIGHT OF CENTRE -- 16'-0"



- D -- 5'x7' -- WOODEN PANELLED SHUTTERS WITH FLY PROOF WIRE MESH SHUTTERS
- D1 -- 5'x7' -- FLY PROOF WIRE MESH SHUTTERS
- D2 -- 3'x7' -- FLY PROOF WIRE MESH SHUTTERS
- D3 -- 3'x7' -- WOODEN PANELLED SHUTTERS
- W -- 3'x4' -- WIRE MESH FIXED WINDOW
- V -- 2'x15' -- WIRE MESH FIXED VENTILATOR



SECTION - AA

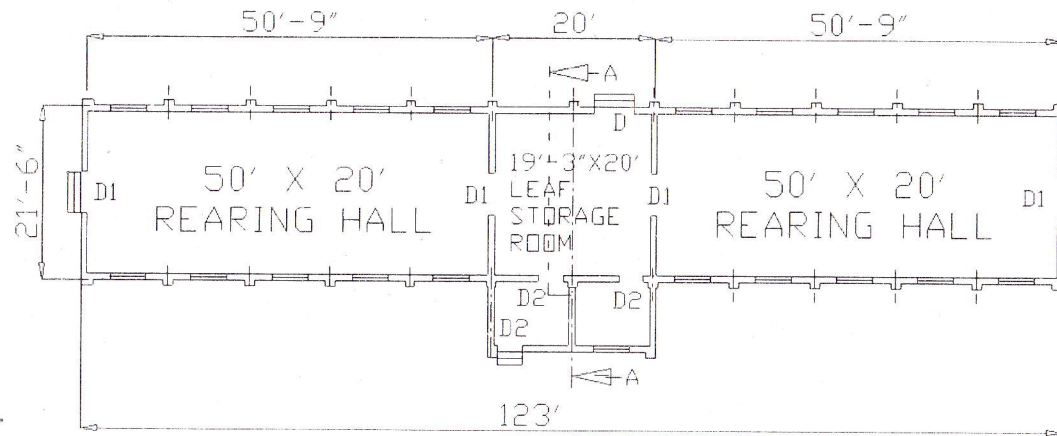
300 dfl capacity silkworm rearing house (2 acre model)



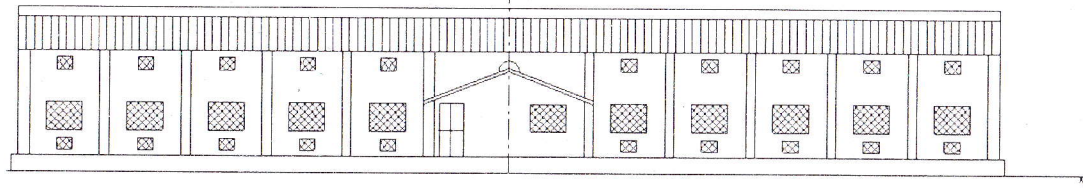
300 dfl capacity late age silkworm rearing house



Inside view of the 300 dfl late age silkworm rearing house

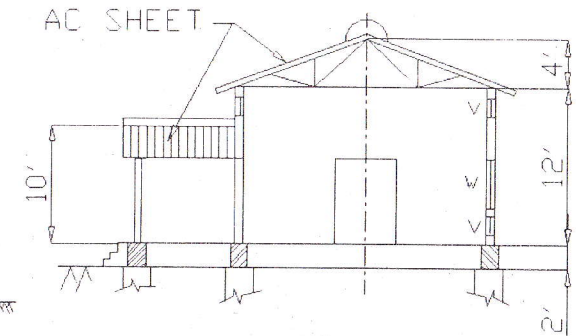


PLAN



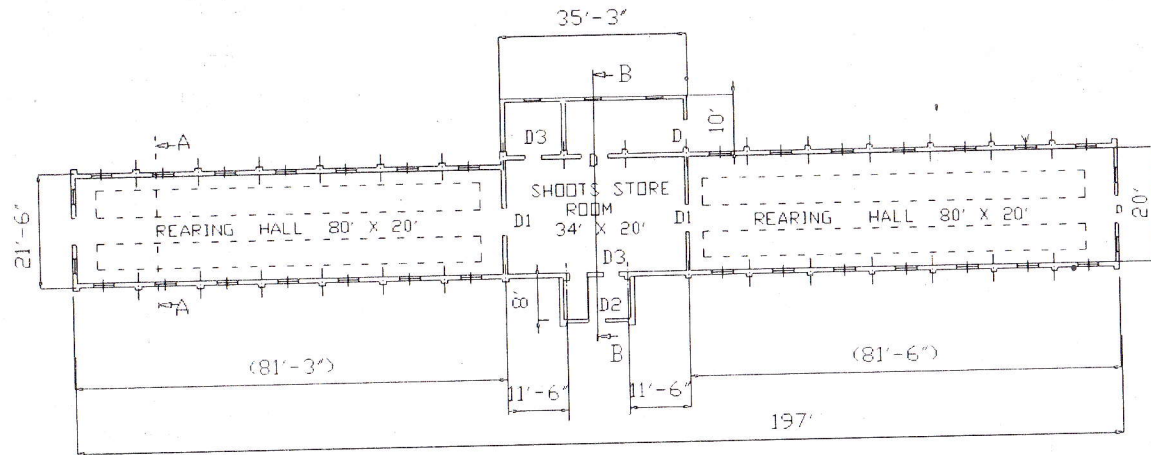
ELEVATION

- D- 5'-0" X 7'-0"-WOODEN PANELLED SHUTTER
- D1-5'-0" X 7'-0"-WOODEN PANELLED SHUTTERS WITH FLY PROOF WIRE MESH SHUTTERS
- D2-3'-0" X 7'-0"- WOODEN PANELLED SHUTTERS
- W -4'-6" X 4'-0"-WIRE MESH FIXED WINDOW
- V- 2'-0" X 1'-6"-WIRE MESH FIXED VENTILATORS

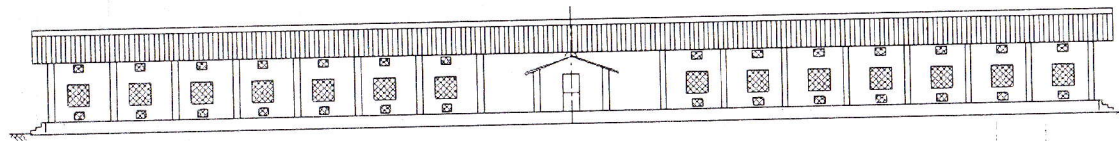


SECTION-AA

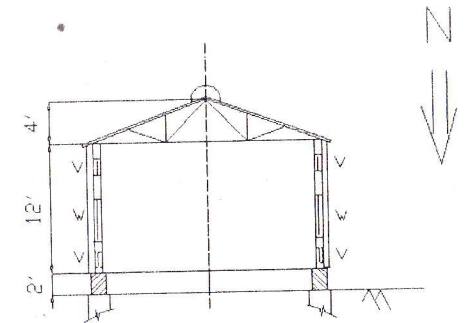
600 dfl capacity silkworm rearing house (5 acre model)



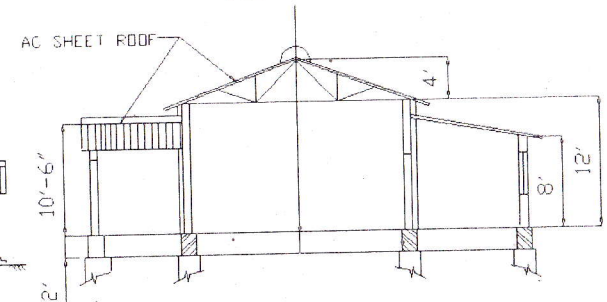
PLAN



ELEVATION



SECTION-AA



SECTION- BB

- | | | | | | |
|----|-----------------|------------------------------------|----|-----------------|-----------------------------------|
| D | - 5'-0" X 7'-0" | ----- WOODEN PANELED SHUTTERS | W | - 4'-6" X 4'-0" | ----- WIRE MESH FIXED WINDOWS |
| D1 | - 5'-0" X 7'-0" | ----- FLY PROOF WIRE MESH SHUTTERS | W1 | - 3'-0" X 4'-0" | ----- WIRE MESH FIXED WINDOWS |
| D2 | - 3'-0" X 7'-0" | ----- WOODEN PANELED SHUTTERS | V | - 2'-0" X 1'-6" | ----- WIRE MESH FIXED VENTILATORS |
| D3 | - 3'-0" X 7'-0" | ----- FLY PROOF WIRE MESH SHUTTERS | | | |

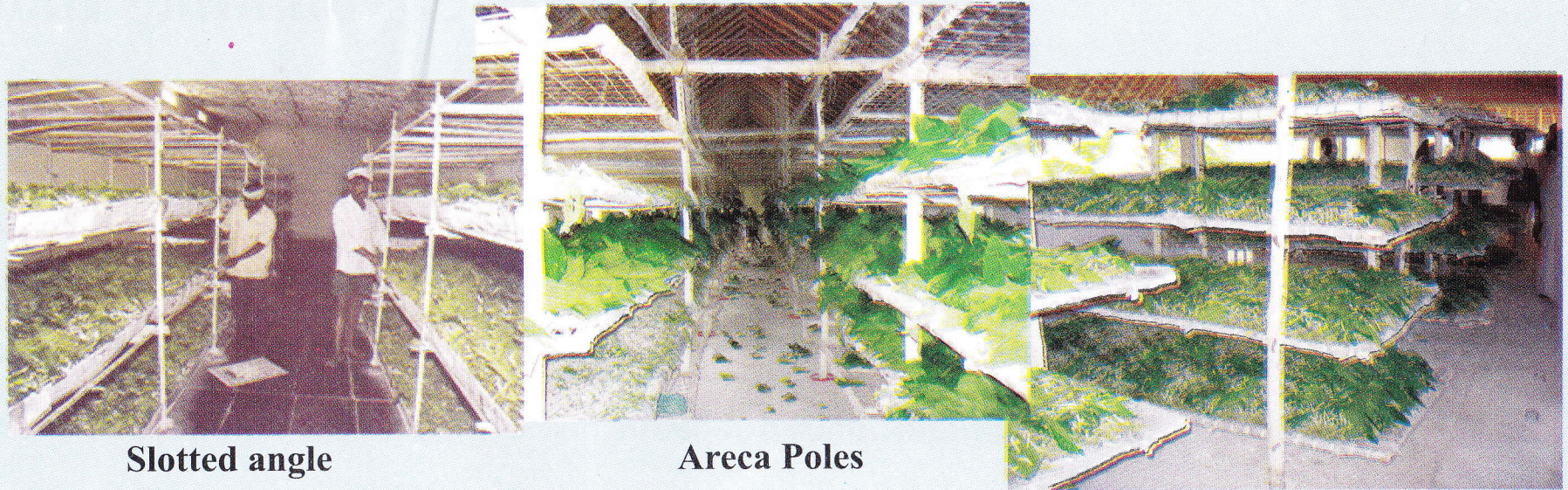
1000 dfl capacity silkworm rearing house (8 acre model)



1000 dfls capacity late age silkworm rearing house



Inside view of large scale silkworm rearing house



Slotted angle

Areca Poles

Casuarina poles (TN Model)

Sized Silver oak

Sized coconut wood



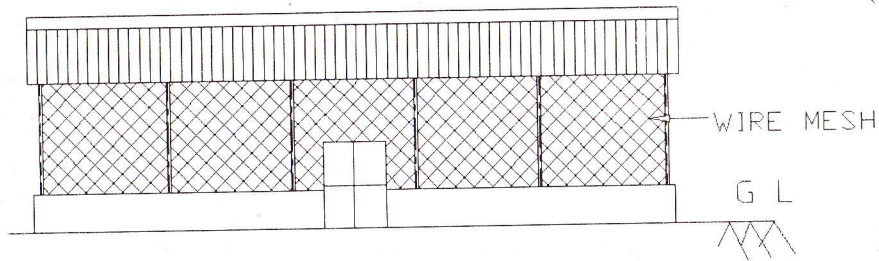
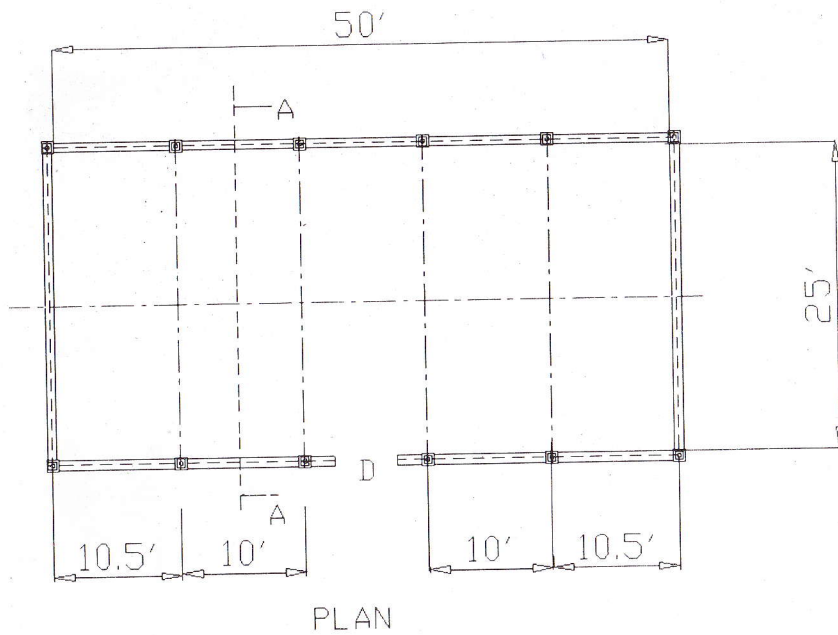
**Casuarina poles
(Karnataka Model)**

Different types of rearing stands and materials used for late age silkworm rearing houses

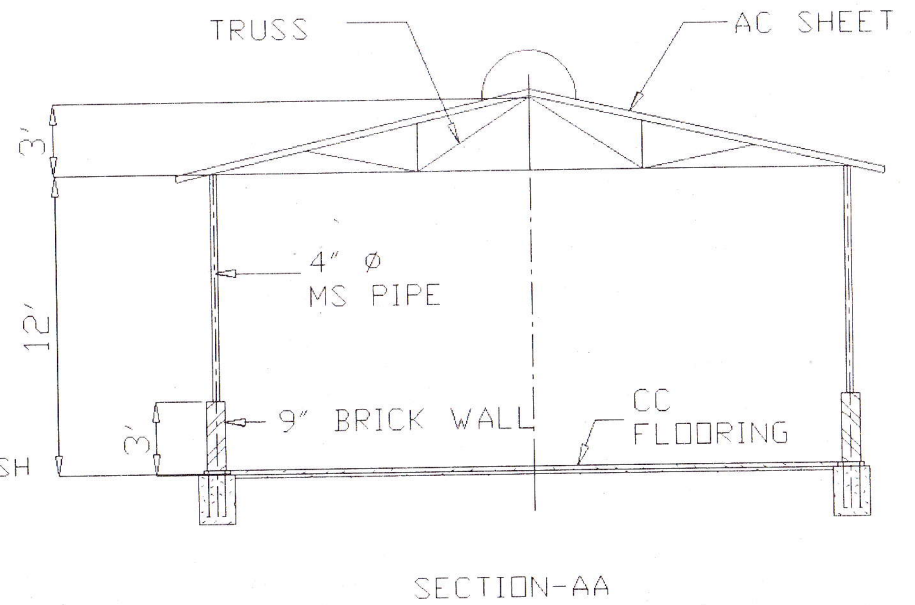
5. Mounting Hall

When the silkworms are matured, they should be placed on specifically designed frames called mountages to facilitate them to spin cocoons. Most of the farmers use the late age rearing house or veranda for placing the mountages. When rearing is continuous, the rearing houses can not be utilized for mounting purpose and hence a separate hall for mounting matured silkworms is required. The mounting hall should provide adequate space and facilities for placing different type of mountages like bamboo and rotary mountages. It should also provide good environment for spinning of cocoons. The mounting halls should be well aerated. In a mounting hall, provisions should be made to prevent entry of birds, squirrels, rats, snakes and other predators of silkworms. Today, a well designed mounting hall is required for successful and good quality cocoons in general and big farmers in particular.

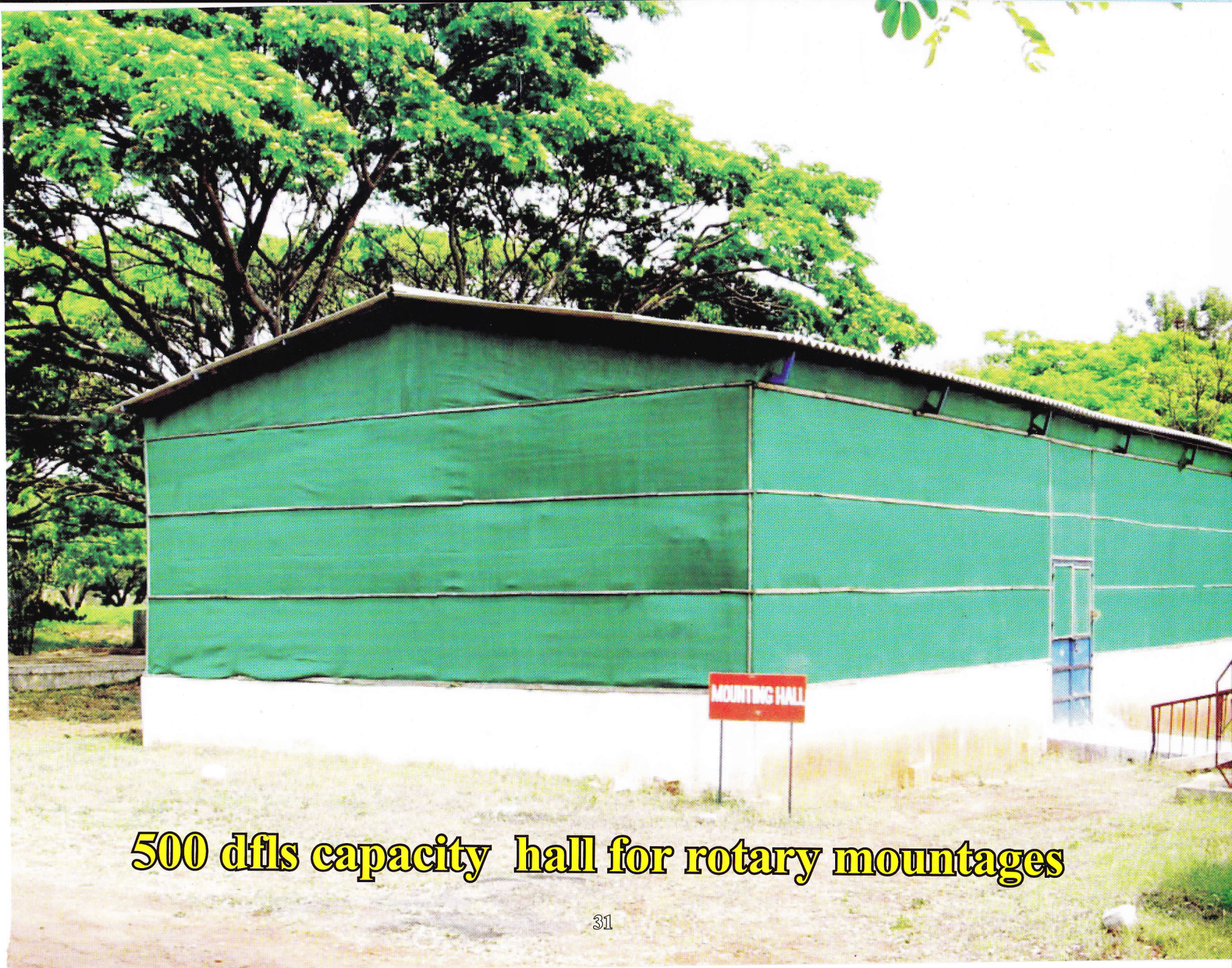




D - DOOR -- 5' X 7'



500 dfls capacity silkworm mounting hall (for rotary mountages)



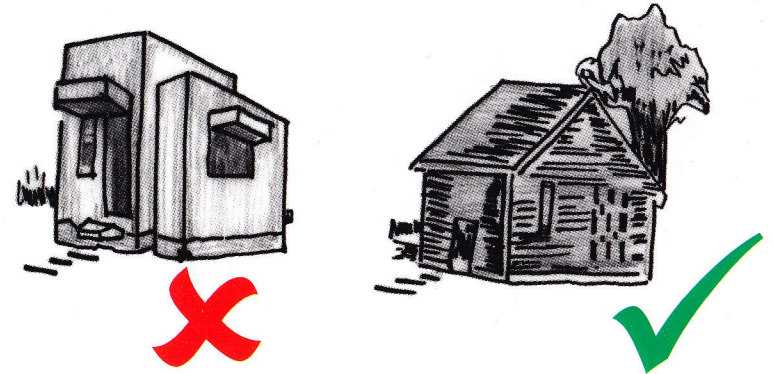
500 dfls capacity hall for rotary mountages



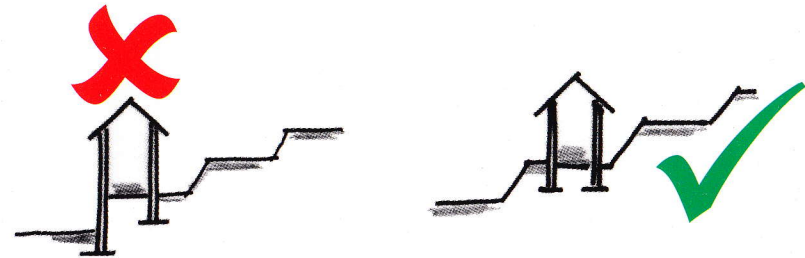
Inside view of the mounting hall

6. Tips for cost reduction in construction of silkworm rearing houses

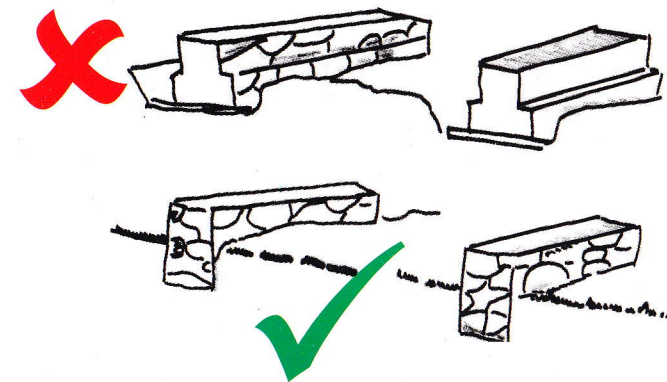
1. Go for simple buildings such as brick walls with asbestos sheet roofing in place of brick walls with RCC roofing.



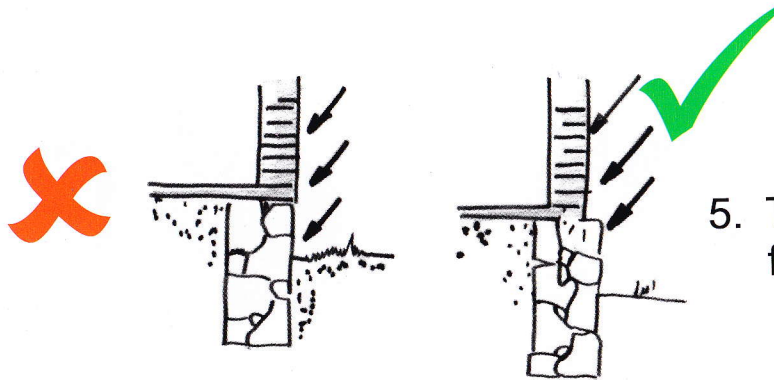
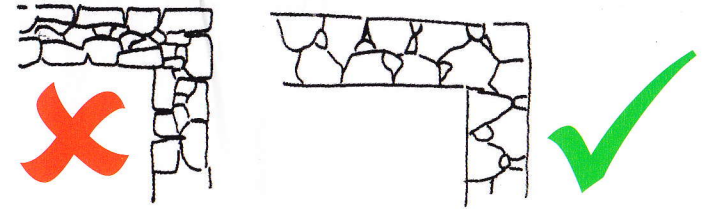
2. Construct the rearing house in the middle of terraced field and not on the outer edge of the terrace.



3. For rearing houses, an elaborate foundation is not required. A simple foundation is sufficient.

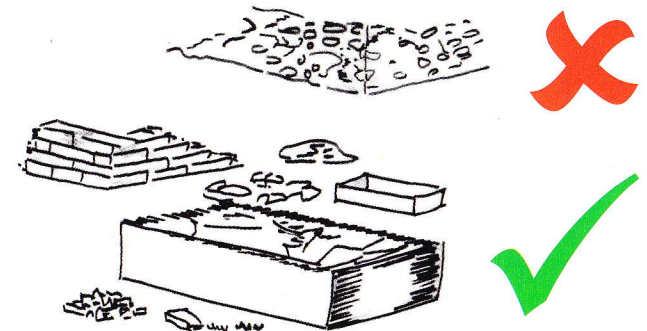


4. Good bonding (dove tailing) of stones is more important than fancy facade looks.

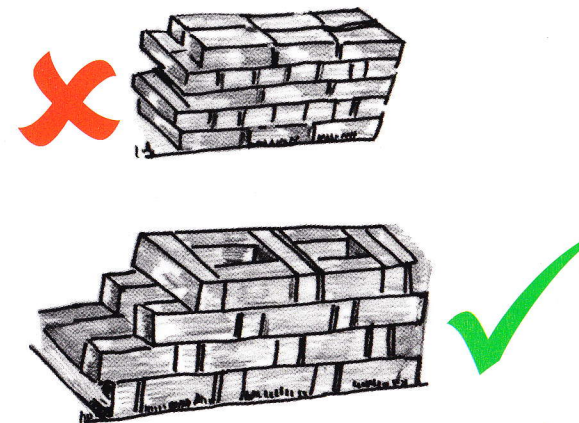


5. The superstructure walls are better on the outer foundation-basement walls.

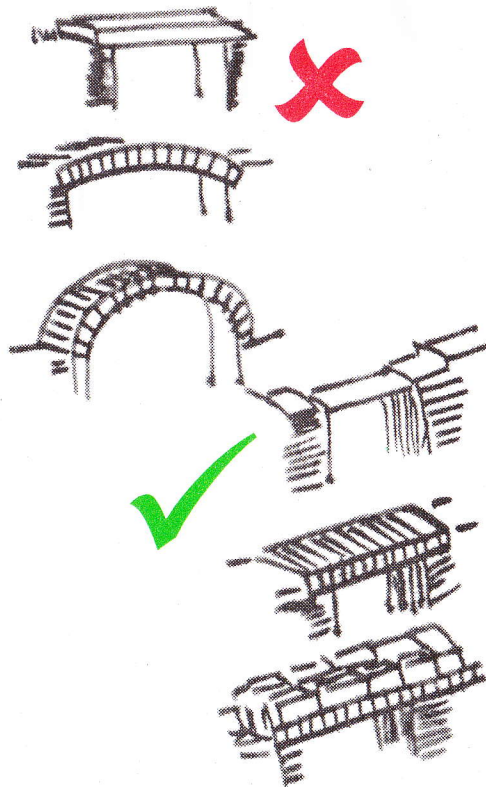
6. If local stones are small, rounded or irregular, walls will crack. Use block moulds and pack stones in with a weak concrete to form a useful strong block for building.



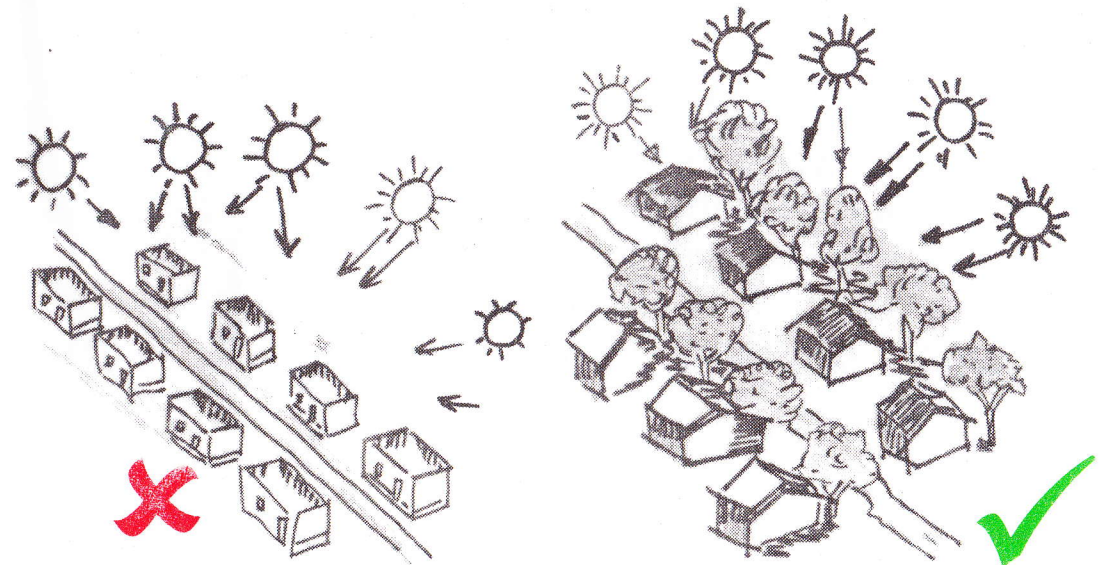
7. By using Rat-Trap bond, one can save 1/4th of all the materials and insulation value of the wall is greatly improved.



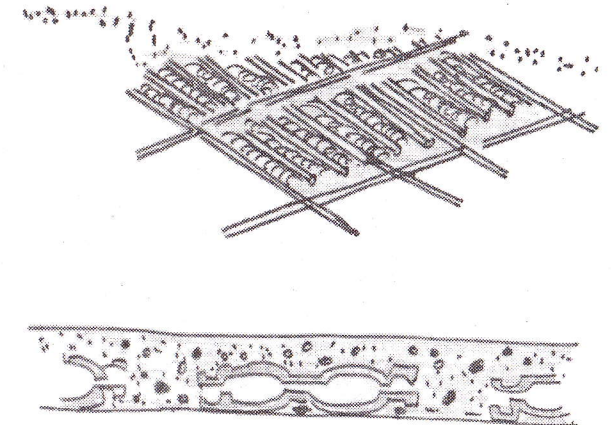
8. Grow trees on western and southern sides to give shade to the buildings. Trees will stop the sunrays falling directly over the walls and roof.



9. Avoid reinforced concrete lintels as they are expensive and unnecessary. Make arches as they look better and less costly.

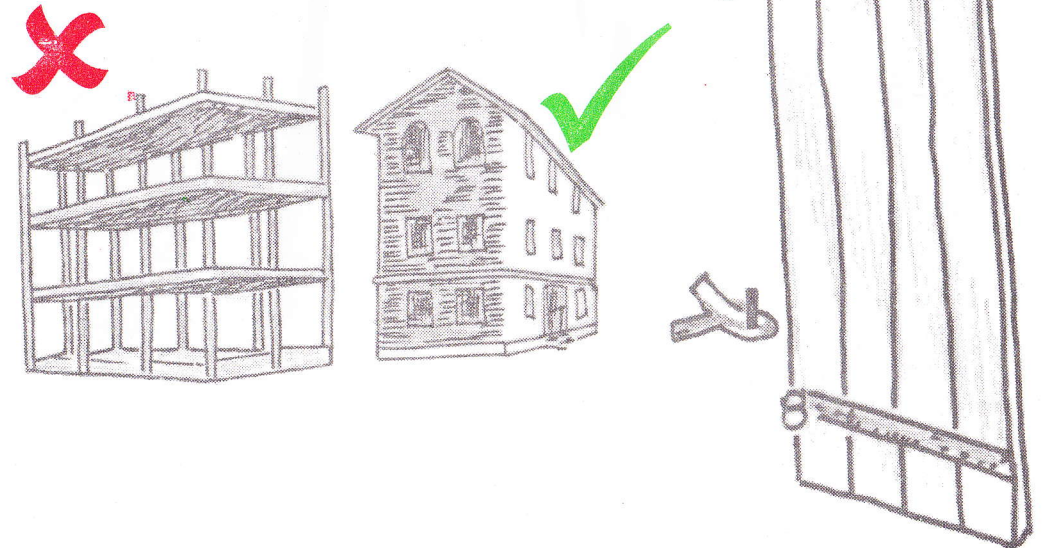


10. There is a RCC slab called Filler Slab. Unnecessary concrete between reinforcement bars is replaced by any light weight inexpensive "filler" such as Mangalore tiles. This reduces cost of RCC roof by 30 %. Filler slab roof is heat resistant.

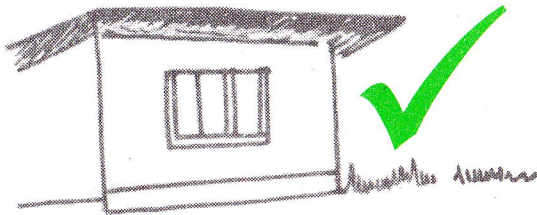
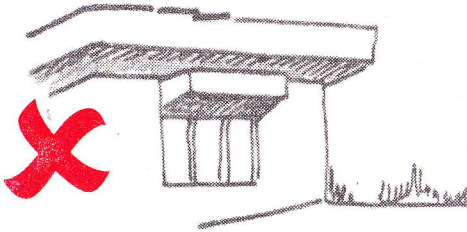


11. Frameless doors and windows cost less

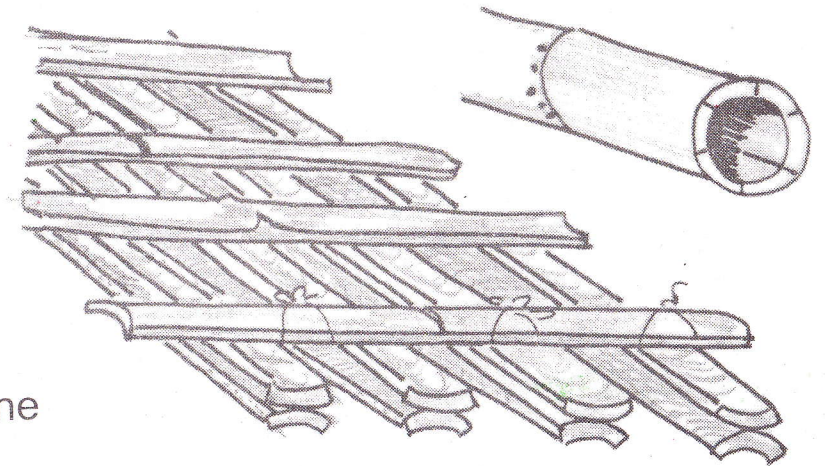
12. In 99 cases out of 100, load bearing masonry walls for building up to three storeys high are just as good and strong and durable, and much more economical to build than reinforced cement concrete frame structure.



13. Avoid unnecessary architectural gimmicks. They add to the cost of the buildings.

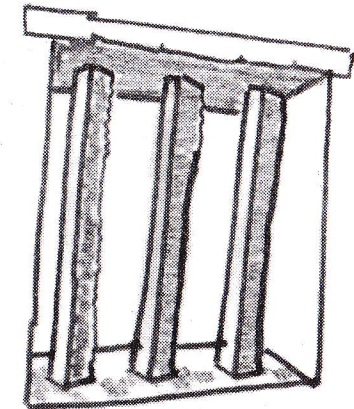
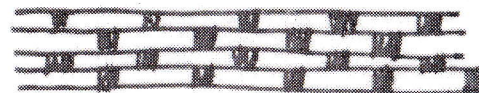
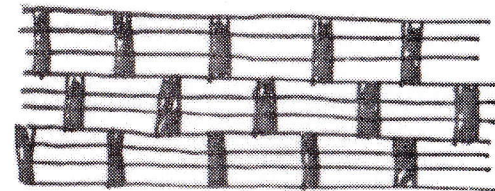
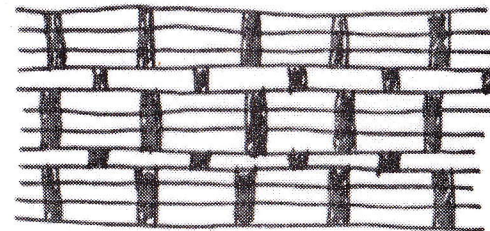
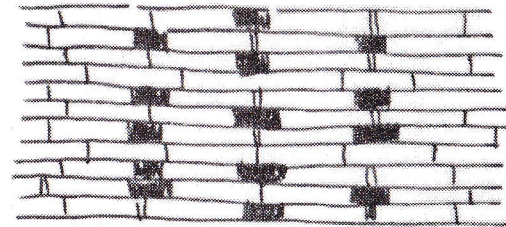
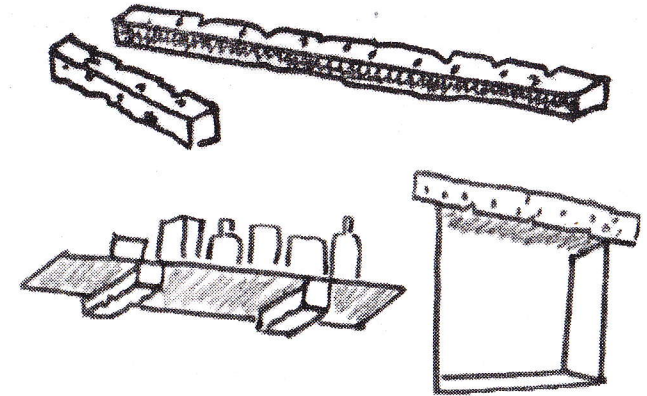


14. For false ceilings, split bamboo is a fine reinforcement.



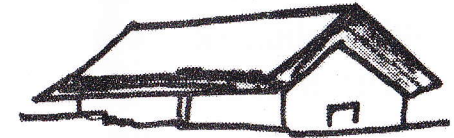
15. Split stones are much cheaper than reinforced concrete for simple extras for the buildings.

16. Brick Jali Walls are less costly than plain solid brick walls and very much cheaper than a window. They let in plenty of light and provide excellent ventilation.

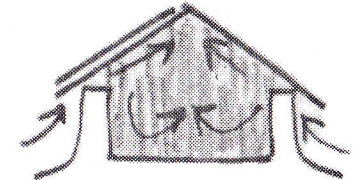


17. There are many simple and cheap methods to reduce heat entry into the rearing houses.
Some of these are suggested below :

Paint the building with lime from outside.



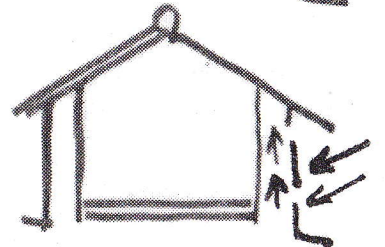
Insert a ventilator under the highest point on the roof



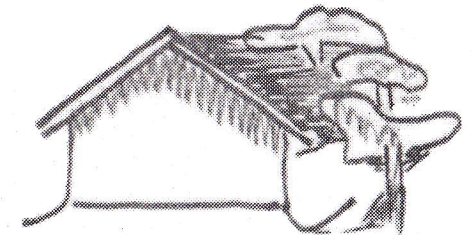
Provide a false ceiling under the roof



Use cavity walls



Grow shade trees around buildings especially on the
western and southern side

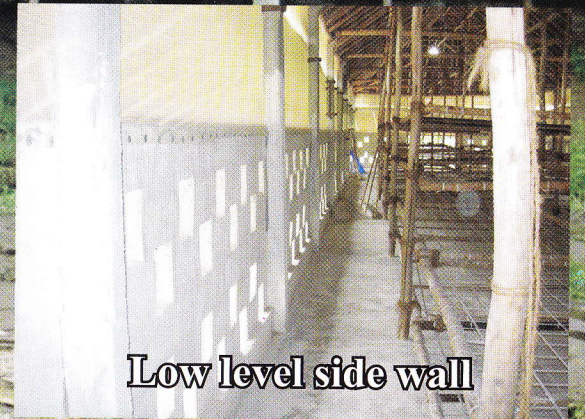


7. Low cost model rearing houses



Low cost door

600 dfls capacity
rearing house



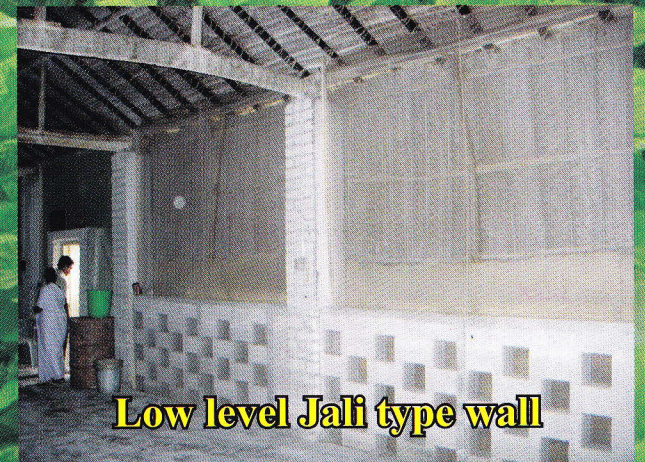
Low level side wall



800 dfls capacity rearing house



Low cost thatch roof and stands



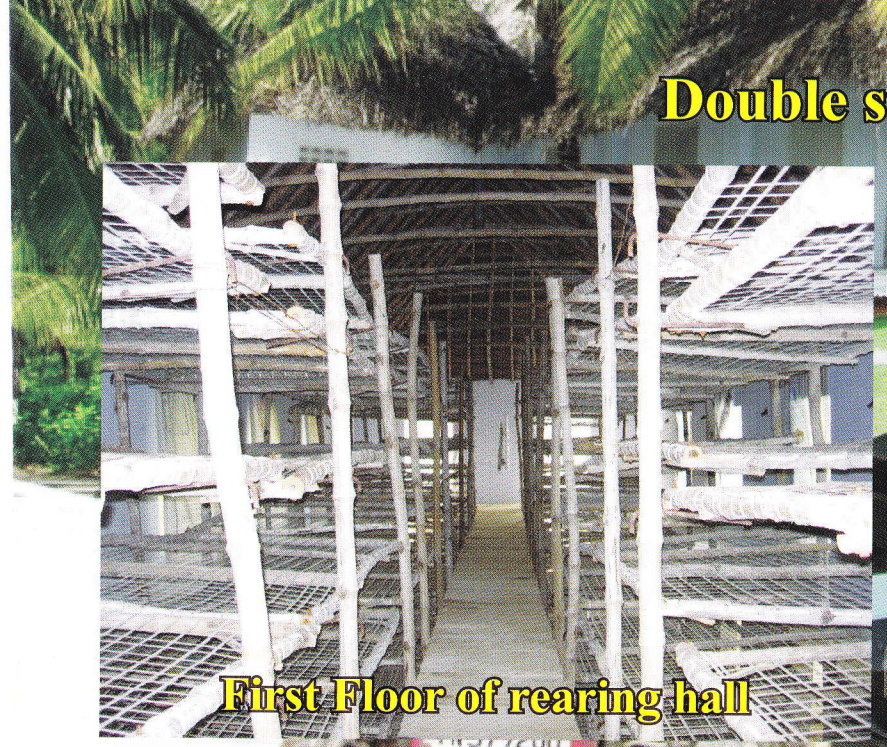
Low level Jali type wall



Ground Floor



Double story rearing house of 800 dfls capacity



First Floor of rearing hall



8. Cost of construction of rearing houses

In this chapter, the plinth area and cost of different capacity rearing houses are presented.

For Young age rearing houses (CRC)

Capacity of Young Age Rearing House (CRC)	Total Building area sqft	Cost (Rs.)
3,000 dfls/batch	1,350	2,75,000
5,000 dfls/batch	2,250	4,50,000
7,500 dfls/batch	3,350	6,50,000

Cost of construction : Rs. 20,000/sqm (Rs. 200/sqft)

Salient features of the CRC : Cement Concrete Flooring, Asbestos sheet roofing and false ceiling at height of 8' from floor.

For late age silkworm rearing

Mulberry Garden In acres	No. of crops per year	No. of dfls per crop	Rearing house plinth area* sqft	Approximate Cost of the rearing house (Rs.) for following types of roof		
				Thatch**	Asbestos	Tiles
0.5	5	125	750	80,000	1,30,000	1,50,000
1.0	10	125	750	80,000	1,30,000	1,50,000
2.0	10	250	1,200	1,25,000	2,10,000	2,50,000
3.0	10	375	1,700	1,80,000	3,00,000	3,50,000
4.0	10	500	2,200	2,25,000	3,75,000	4,50,000
5.0	10	625	2,700	2,75,000	4,75,000	5,70,000
6.0	10	750	3,500	3,50,000	6,00,000	7,20,000
8.0	10	1,000	4,500	4,80,000	8,00,000	9,60,000
10.0	10	1,250	5,500	5,50,000	9,50,000	11,50,000
20.0	10	2,500	11,000*	11,00,000	19,00,000	23,00,000

From 1 acre onward, the garden should be divided in two parts to have 10 rearings in a year in order to reduce the cost of rearing houses by 50 % and effective utilization of manpower.

* Two separate rearing houses of 1,250 dfls capacity required

** Thatch roof to be replaced every 4-5 years.

TIPS FOR A GOOD REARING HOUSE

REDUCE HEAT - INCREASE YIELD

AVOID GLASSES - USE SCREENS

A WHITE WASH OUTSIDE MEANS COOL INSIDE

KEEP YOUR WORMS HEALTHY BY DISINFECTING REGULARLY

DO NOT COOK AND REAR IN THE SAME ROOM

UZI FLY - KEEP THEM AWAY

ANTS ARE UNDERTAKERS - DENY ENTRY

LIZARDS ARE TERRORISTS - CONQUER THEM

YOUR WORMS COST MONEY - DO NOT FEED TO RATS

EVEN CLEAN FEET CARRY INFECTION - WASH BEFORE ENTRY

SHUT SINGLE DOOR EARN DOUBLE RETURNS



*A good rearing house is the key
for the success of
silkworm cocoon crop*