INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 3)
Available online at: www.ijariit.com

Intervention of civil engineers in construction of geothermal ventilation system in silkworm rearing house

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ABSTRACT

A study was conducted to ascertain the structural break in production with the introduction of new technologies in construction and design of rearing house and related civil engineering structures in the sericulture industry. A study was carried out to know the present status of rearing house structures, designs, input cost and various other parameters related to the construction of rearing house for rearing mulberry silkworm Bombyx mori Linn. in Western parts of Maharashtra. The major challenges now facing in the sericulture industry are the methodologies for the construction of low-cost rearing house by adopting different pre-fabricated techniques. Its adoption, economy and stability are the prime requisites of any structural design which gives the stable and economical structure to increase cocoon productivity. The present paper is an investigation of new techniques and materials which can be a strength parameter to increase silk production in India. The present study consists of the new innovative ideas for the design of rearing houses such as cooling by geothermal ventilation systems for relative humidity and temperature control. Hatkangale taluka of Kolhapur district was a study area. The present study will be useful to double the sericulture farmer's income by adopting new technologies for construction management of silkworm rearing house. The details are discussed in the paper.

Keywords— *Silkworm, Rearing house, Income, Geothermal ventilation*

1. INTRODUCTION

Sericulture is an agro-based rural industry, which comprises of land-based activities like raising silkworm host plantation along with rearing of silkworm, reeling of cocoon, twisting, weaving and processing of fabrics , sericulture provides a rear means for environmental conservation and checking migration of people from the rural to urban areas by proving production employment in their houses itself. It enables the woman to earn their livelihood, while taking care of household tasks like looking after children, cooking etc. On the other hand, silk which is produced by the poor in the rural areas is sold to rich in the urban areas. Silk fabrics have been all along with a pride possession of the king, nobles and elites in the society. Thus sericulture provides a medium for resources from the rich to the poor. In a nutshell, sericulture provides a solution to the issue of sustainable development in "Bridging the Rich-poor divide" on the one hand and "Taking care of the environment "on the other (Benchmin and Jolly, 1987).

Mulberry silkworm is a domesticated insect which cannot live without sufficient human care. It is also sensitive to high temperature and relative humidity. Besides good feed, a temperature range of 24°C to 28°C and relative humidity of 75-80% is ideal for silkworm. Though there are a number of modern gadgets to regulate the temperature and relative humidity, investment on them is uneconomical. Therefore, mulberry sericulture is practised only in those areas where the climate is congenial and the crops scheduled is so regulated to avoid seasons with extreme climate (Matasumura, *et al.*, 1958). Besides, the silkworm rearing house is constructed to provide sufficient ventilation and keep the ambience sufficiently cool. Due to poverty, many farmers rear silkworms within their dwelling house which cannot be disinfected due to the pungent nature of the chemicals used. However, it will be ideal to have a separate rearing house or at least a separate room for rearing purpose. A separate and isolated rearing house enables effective disinfection and hygiene maintenance and facilitates proper rearing. It should have sufficient rearing space, good ventilation and light for the healthy growth of adult silkworms. The rearing house should be designed based on the brushing capacity and the method of rearing. An ideal rearing house should have some basic requirements. It should have a separate and isolated house to avoid cross-contamination, are essentially located in the garden itself to facilitate easy transportation of mulberry leaves. The orientation of rearing house north-south facing and built on a raised platform. Shady trees around to provide aeration and cool surroundings. A high roof and preferably a false ceiling to reduce the temperature. A good number of ventilators and windows fixed with nylon nets to avoid pests like uzi fly (Jadhav and Sathe, 2008).

A separate rearing hall with an anteroom and a separate leaves storing chamber and should be rodent and fly proof with smoothly finished walls, roofs, floors and rounded corners. Remember a good rearing house should provide the most congenial atmosphere for the good growth of silkworms at a minimum cost. Some of the basic requirements of a good rearing house:
(a) A separate rearing home to avoid cross-contamination or centrally located in the garden itself to facilitate easy transportation of mulberry leaves.
(b) The orientation of the rearing house should be north-south facing and built on a raised platform.
(c) Plant shade trees all around to provide cool surroundings.
(d) Have a high roof, preferably with a false ceiling to reduce the temperature.
(e) Windows and doors fixed with nylon nets to avoid pests like uzi fly.
(f) Make rodent and fly proof rearing house with smoothly finished walls, roof, floors and rounded corners.
(g) Have a separate rearing hall with an anteroom and a separate leaf-storing chamber.

2. NEW TECHNOLOGY IN REARING HOUSE TO MAINTAIN TEMPERATURE AND HUMIDITY

Cooling of rearing house by geothermal technologies to maintain Temperature and Humidity

The subterranean world is actually only cooler in summer when the surface is warmed by the sun. In winter, underground spots are relatively warmer because of their" thermal inertia". the cooling tubes system consist of long pipes buried underground with one end connected to the house and the other end to the outside. Hot exterior air is drawn through these pipes where it gives up some of its heat to the soil, which is at a much lower temperature at a depth of 3m to 4m below the surface. This cool air is then introduced into the house. Special problems associated with these systems are possible condensation of water within the pipes or evaporation of accumulated water and control of the system.

The earth tubes approved a great deal of attention from architects and civil engineers, as an option or aid to conventional air conditioning. While the concept of routing air through underground tubes or chambers to achieve a cooling effect appears like a good proposal. Possibly a few hundred systems were constructed, but information on the practical application of the concept is imperfect. Cooling tubes are long, underground metal or plastic pipes through which air is drawn. The idea is that as the air travels through the pipes, it gives up some of its heat to the surrounding soil, entering the house as cooler air. This will occur only if the earth is at least several degrees cooler than the incoming air. A cooling tube system uses either an open- or closed-loop design. In an open loop system, the outdoor air is drawn into the tubes and transported directly to the inside of the house. This system provides ventilation while optimistically cooling the house's interior.

In a closed-loop system, interior air circulates through the earth cooling tubes. 2 closed loop system is more efficient than an open loop design. It does not exchange air with the outside (Zaki and Almssad, 2007).

3. MATERIALS AND METHODS

3.1 Tubes material

The main considerations in selecting tube material are cost, strength, corrosion resistance, and durability. Tubes made of aluminium, plastic, and other materials have been used. The selection of material has a modest influence on thermal performance. PVC or polypropylene tubes perform almost as well as metal tubes.

3.1.1 Tube diameter

Optimum tube diameter varies widely with tube length, tube cost, flow velocity, and flow volumes. Diameters between 10-25 centimetres come into view to be most appropriate.

3.1.2 Tube measurement lengthwise

There is no simple formula for determining the correct tube length in relation to the quantity of cooling preferred. Local soil conditions, soil moisture, tube depth, and other site-specific factors should be considered to determine the proper length (Zaki and Almssad, 2007)

3.1.3 Design

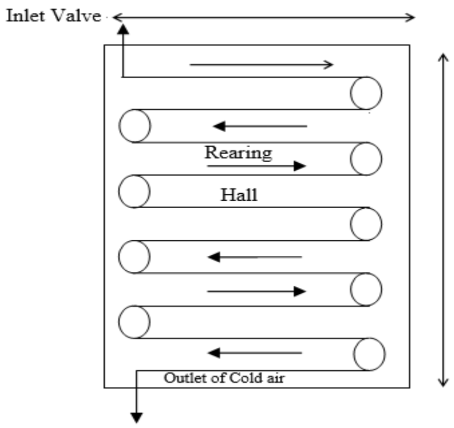

Fig. 1: Top view of geothermal cooling system rearing house

Pipeline Construction under the substructure below Plinth

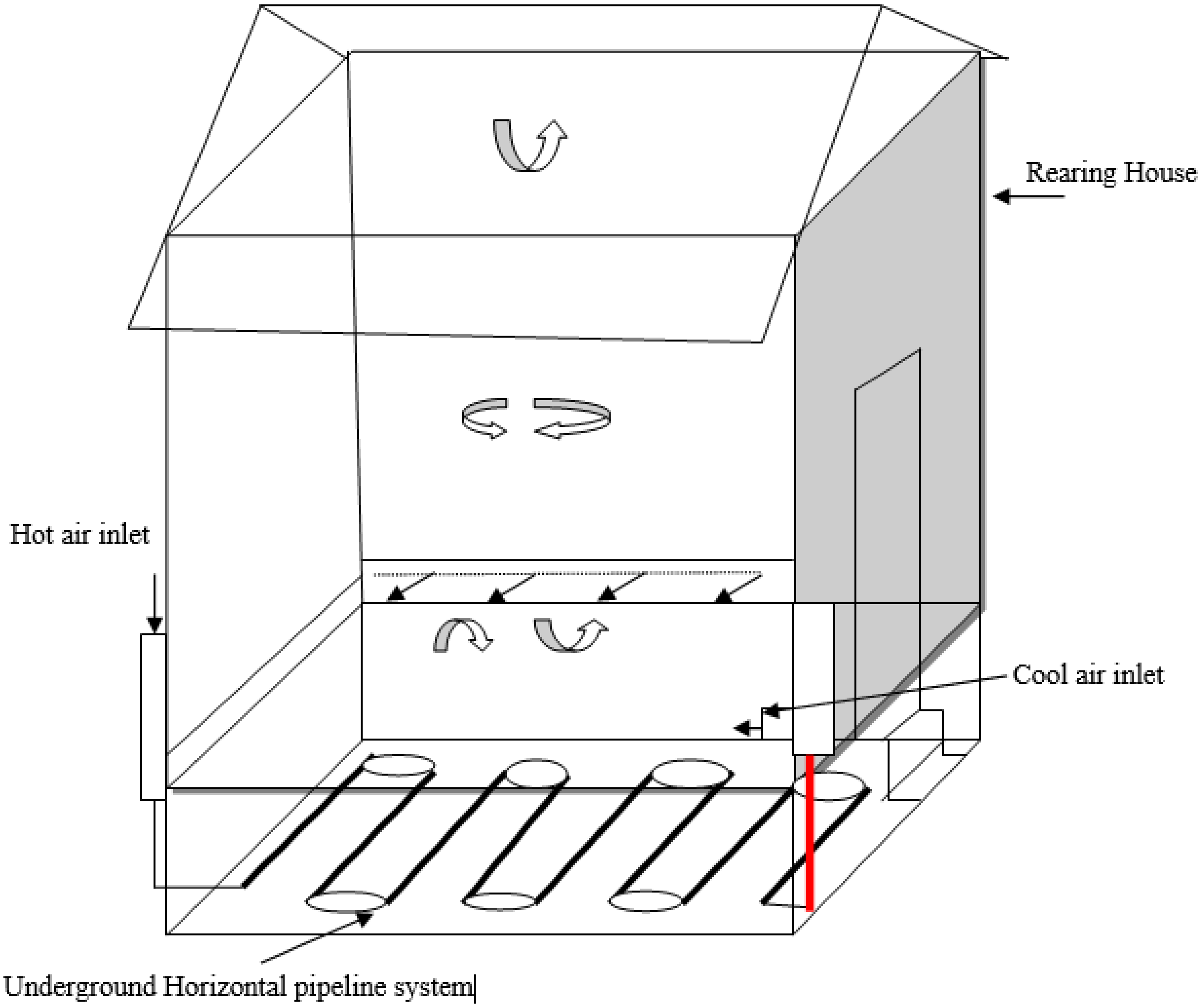

Fig. 2: Side view of the geothermal cooling system rearing house

4. OBSERVATIONS AND DISCUSSION

Silkworm hybrids such as FC_1 x FC_2, and Pure Lines FC_1 and FC_2 are potentially practised in Maharashtra for production of profitable commercial and seed cocoons respectively. It was observed that an ideal rearing house should have some basic requirements like a good site, raised the platform, high roof, false ceiling for rearing house construction, sufficient rearing space, good ventilation arrangements for light etc., (Jadhav *et. al*, 2016).

4.1 Temperature Analysis

The temperature has a direct correlation with the growth of silkworms and wide fluctuation of temperature is harmful and as for as possible it should be avoided. Table 1. Shows that, the geothermal system in the rearing house gives maximum input to the rearing house.

Table 1: Temperature analysis in rearing house

Stage of silkworms	Optimum temperature	The temperature of the geothermal cooling system in the rearing house for different stages
I	26℃ – 28℃	22℃ – 27℃
II	26℃ – 28℃	22℃ – 28℃
III	24℃ – 26℃	22℃ – 26℃

4.2 Humidity Analysis

(Table 2) The combined effect of both temperature and humidity largely determine the satisfactory growth of the silkworm and production of good quality cocoons. Its role is both direct and indirect. It directly influences the physiological functions of the silkworm. The young age silkworm can withstand high humidity conditions better than later age worms and under such condition the growth is vigorous. The humidity conditions for different early age worms are as follows.

Table 2: Humidity analysis in rearing house

Age	Relative Humidity %	Humidity in the geothermal cooling system in rearing house
I	85	84-86
II	85	85-88
III	80	80-83

5. CONCLUSION

It was observed that underground cooling pipe rearing houses were able to provide the optimum temperature of 26-28º c and RH of 60-70% for the growth of silkworm at minimum operational cost. The most important principles to be remembered in silkworm rearing house are avoid the damp condition, stagnation of air, the direct and strong drift of air, exposure to bright sunlight and radiation. Ensure an equable temperature and humidity good ventilation. The geothermal Ventilation system is very useful to maintain the building temperature up to 4°C to 5°C

6. REFERENCES

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