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Evaluation of silkworm rearing houses from Western Maharashtra

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Maharashtra has emerged as highly potential state for silk production during last one decade. Many modern technologies have been adopted by the farmers resulting in high and quality silk production. Among various technologies, silkworm rearing house is one of the most important for success of the silk crop. The farmers in Maharashtra have constructed silkworm rearing houses with large variability in design, construction materials, etc. It is time to study these rearing houses for improvement in silk production. A study was conducted in three districts of Western Maharashtra during the period from August -2018 to March-2019 to know present status of design, materials used in construction, structures, construction cost and various other parameters related to rearing houses for mulberry silkworm *Bombyx mori* L. The data was collected from sericulture farmers by personal visits and interaction at the sites. It was found that only 12.5 percent farmers possess rearing house with modern amenities for silkworm rearing. About 25 percent were having medium level structures where as 62.5 percent of the farmer's constructed low cost rearing house. The present study revealed the exact status of rearing house structures available with farmers in relation to the size, area of the rearing house, materials used for construction, location, actual area available for rearing of silkworm, capacity of dfls (Disease free layings) to be brushed and income generated. The data was also analysed for the various correlation and regression analysis to know the relationship status between the rearing house structures, area, income and many other factors. In the present investigation it was realised that, intervention of civil engineers is highly required in planning of rearing house construction, selection of site, materials to be used, and area to be considered for construction, passive heating and cooling, etc.

Keywords: Correlation, Rearing house, Regression analysis, Silkworm

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Maharashtra is the second largest state in India in terms of population and geographical area. The Directorate of Sericulture, Nagpur was established in September, 1997 for overall development of sericulture in the state[1]. Presently, the silk cocoons are produced in 28 districts of Maharashtra. Maharashtra is a non-traditional sericulture state that produces both mulberry and Tasar silk and ranked 13th among the silk producing states of India. Present production is 2,280 MT cocoons and 350 MT mulberry raw silk. Mulberry plantation is spread in about 4,327 hectares (10817.5 acres) with 9,955 farmers. Tasar silk is produced by 3,000 farmers. Tasar silk production is about 19.33 MT[2].

Sericulture is an agro-based rural industry[3], comprising of land-based activities like raising silkworm host plantation along with rearing of silkworm, reeling, twisting, weaving and processing for fabrics. The release of production-oriented technologies in sericulture evolved over the last three decades has increased the silk production in the districts of Kolhapur (301 acres, 273 farmers), Sangli (408 acres, 373 farmers), Satara (788 acres, 797 farmers). The present cocoon production in Kolhapur is 84.341 MT and that in Sangli and Satara is 67.73 MT and 106.128 MT, respectively[2].

Considering the varied eco-climatic conditions and different economic status of the farmers, different types of low-cost rearing houses were designed and tested during 1980s. The estimated cost of construction is as low as Rs.5000 for rearing houses with mud wall and thatched roof with the plinth area of 325 sqft. Low cost rearing houses were also constructed in different places in Karnataka for testing and popularization. However, the adoption rate of using separate rearing houses for silkworm rearing increased significantly with the government subsidy

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provided for construction under Catalytic Development Program (CDP)[4]. Maharashtra has also implemented various centrally sponsored schemes of Central Silk Board like CDP, CPP, RKVY, MGNREGS and Silk Samagro MN. Under these schemes funds were released for pre and post cocoon sections including subsidy for construction of rearing house[2].

The introduction of new technologies in sericulture began during 1980s[5]. Up gradation of sericulture technologies significantly contribute for improvement in cocoon productivity[6]. However, the adoption of these technologies at the field level is very important for increasing productivity, stability and sustainability in sericulture[7-9]. Sericulture has proven its potential for providing gainful remunerative self-employment to the rural poor. Transfer of Technologies (TOT) is imperative for deriving optimum benefits by sericulturists. Acceptance of new technologies by the sericulture farmers is relatively slow, mainly due to socio-economic situations.

Hence, the present study was undertaken to understand the variability of silkworm rearing house structures in different parts of Western Maharashtra. This is the first attempt in the state to know the status of silkworm rearing house structures particularly from the areas of Satara, Sangli and Kolhapur districts.

The sericulture which was a traditional occupation has become a commercial activity. Hence, the investment in sericulture in terms of money and man-power should be better managed to assume income through cocoon production. Therefore, effective management and cost-effective engineering applications in rearing house construction are highly required.

Materials and Method

A field survey on status of rearing houses and evaluation was carried out from August- 2018 to March-2019 in few villages of Satara, Sangli, and Kolhapur districts by personnel visit to the rearing house sites. The survey was conducted in total with 30 farmers those, who had adopted mulberry plantation and having separate rearing house. The farmers were interviewed with structured interview schedule and questionnaire. In total 16 structures (12 from Kolhapur, 04 from Sangli district) were visited and evaluated. Information was collected through questionnaire considering the following parameters.

- Name of the farmers
- Village and GPS location
- Variety of Mulberry
- Year of plantation
- Area under plantation (Acres)
- Size of the rearing house (sq ft)
- Material used for construction of structures and rearing racks
- Rack size and area available for silkworm rearing
- Construction cost of rearing house
- No of silkworm crops taken per year

Analysis of data

Following assumptions were made while analysing the survey data by IBM, SPSS statistics tool and Microsoft excel[10].The collected data is represented in (Tables 1-6) and (Fig.1-3).

1. Analysis of rearing house construction cost and area.
2. Correlation analysis between the various factors.
3. Regression analysis between various variables.
4. Analysis of various construction materials used by farmers.
5. Construction cost analysis in graphical manner.

Results and Discussion

Survey on status of rearing house structures from Sangli, Satara and Kolhapur districts was carried out as described in materials and method. The information on primary parameters collected is represented in (Table 1) which represents details of farmers with respect to village and GPS location of rearing houses. The location varies from longitude 74°23’57”E to 74°66’14” E and latitude 16°35’15” N to 17°88’46” N. The study revealed that, most of the farmers have gone for plantation which has been done between the years 2008 to 2018.The area under mulberry plantation varied from 1 to 7 acres. The cost of construction silkworm rearing houses varied from Rs. 2 lakh to 16 lakh for 650 sqft to 3,000 sqft areas (Table 2). From the (Fig 2) it is clear that, farmers have used various materials for construction of rearing house and internal rearing structures depending upon their need, area and year of mulberry plantation etc. Those who have better rearing experience have thought of using best and durable material for racks and house construction. However, the present investigation revealed that the farmers

Table 1 — Farmer wise details on mulberry plantation, construction cost, total area of rearing house, yield parameters and income

Sl. No.	Village Dist. Name	GPS Location of the Rearing House		Year of Mulberry Plantation	Variety of Mulberry	Area under Plantation (acres)	Cost of Construction of rearing house Rs.(lakh)	Total area of rearing house (sqft.) L×W	Cocoon Yield (Kg)	Rate (Rs/Kg)	Total income (Rs.)	Profit per acre in 6 months (Rs.)
		Latitude	Longitude									
1	Yalgud, Kolhapur	16°58’28” N	74°25’05” E	2008	V1	2½	5	60×30=1800	250kg	350/kg	87500	35000
2	Yalgud, Kolhapur	16°58’45” N	74°40’15” E	2015	V1	4	3.5	60×30=1500	147 kg	300/kg	44100	11029
3	Yalgud, Kolhapur	16°58’94” N	74°42’22” E	2008	V1	1.25	3	60×20=1200	150kg	300/kg	45000	36000
4	Yalgud, Kolhapur	16°59’76” N	74°39’13” E	2008	V1	5	9	50×20=1000	500kg	450/kg	225000	45000
5	Yalgud, Kolhapur	16°59’23” N	74°38’84” E	2017	V1	1	5	41×21=861	113kg	300/kg	33900	33900
6	Yalgud, Kolhapur	16°59’51” N	74°38’85” E	2007	V1	3	3	40×40=1600	100 kg	315/kg	31500	10500
7	Yalgud, Kolhapur	16°59’52” N	74°38’84” E	2015	V1	1½	2	40×25=1000	190kg	315/kg	59850	47880
8	Yalgud, Kolhapur	16°55’59” N	74°48’65’ E	2006	V1	4	2	30×25=750	300kg	320/kg	96000	24000
9	Islampur, Sangli	17°03’16” N	74°32’21” E	2017	V1	4	12	100×30=3000	395kg	360/kg	142200	35330
10	Islampur, Sangli	17°14’73” N	74°33’57” E	2002	V1	1½	2	60×20=1200	108kg	310/kg	33480	22320
11	Lengre, Sangli	17°83’46” N	74°62’53” E	2018	V1	2½	5	80×30=2400	150kg	300/kg	45000	18000
12	Lengre, Sangli	17°35’56” N	74°66’14” E	2018	V1	1½	4	60×22=1320	187kg	300/kg	56100	37400
13	Kagal, Kolhapur	16°35’31” N	74° 19’41” E	2018	V1	2½	2	26×25=650	84kg	350/kg	29400	11760
14	Rangoli,	16°35’20” N	74°23’57” E	2015	V1	2	7	100×30=3000	280kgs	400/kg	112000	56000
15	Hupri, Kolhapur	16°35’15” N	74°23’57” E	2015	V1	7	16	100×30=3000	850kgs	450/kg	382500	54571
16	Hathkalangle, Kolhapur	16°58’89” N	74°42’20” E	2008	V1	1.25	3	40×20=800	111kg	300/kg	33300	26640

have used low cost material to durable quality construction materials for rearing house construction. The structure, orientation, materials used for construction of rearing house in different agro-climatic conditions play a vital role for maintenance of temperature and humidity during silkworm rearing. Silkworm rearing house is a very important structure to produce quality and quantity of cocoons. The types of rearing house and micro environment maintained within have direct influence on growth and yield of silkworm of *Bombyx mori.* According to Miyashita[11] who pointed out that, for successful harvest of silkworm crop, the percent influence of various factors is as follows.

Figure 1 indicates that mulberry leaf quality and internal environment in rearing house are very important as far as successful silkworm rearing is concerned. The main constraints in silkworm rearing in Indian sub-continent are climatic vagaries, especially high temperature and relative humidity. Kumar Suresh *et al.*,[12] says performance of bivoltine breeds under optimal temperature (25±1°C) and humidity (70±5%) conditions with respect to fecundity, yield, cocoon weight, cocoon shell weight, cocoon shell percentage was better. In Maharashtra, the silkworm crops are affected due to high temperature prevailing during September-October and March-June, and low relative humidity during

December-May. These varying climatic factors like temperature, humidity exert huge amount of physical stress on the health of various stages of silkworms as silkworms are cold blooded. Hence, they cannot regulate their body temperature. Due to these fluctuations, silkworm crops are experiencing huge amount of failures incurring irrecoverable financial debts among farming community. In India, silkworm diseases cause significant cocoon crop loss at the farmer's level and put them into economic hardship[13]. The present exploration on survey status of rearing houses revealed that, the only way to address these problems, which will be supportive to maintain conducive environmental conditions inside the rearing house is appropriate design of rearing house, materials to be used for construction, site, area available for rearing, solar passive, geothermal application etc. The rearing house, which is already in vogue, can also be altered, so as to maintain desired temperature and relative humidity which would provide good environmental condition for silkworm rearing.

Micro environment in the rearing structure influence the silkworm growth and cocoon productivity[14,15]. In the present study (Table 4), the analysis of rearing house structure indicates that the farmers who have considered all the parameters required for construction of model rearing house have received better yield (850 kg) of cocoons and price Rs 450/kg as compared to 113 kg yield and Rs 300/kg rate in other structures.

The present study reveals that, out of 16 farmers only two farmers (12.5%) have thought of model rearing house construction. The parameters considered in separate rearing house were location (in mulberry garden), orientation, high roof and false ceiling, windows and ventilations, rodent and fly proof structure, finishing of roof and wall, facilities for leaf storage and spinning (Table 3). The evaluation of rearing house structures shows that 43.75% farmers were not having rearing house in mulberry garden. However, 37.5% structures were having orientation east-west. Over all 62.5% farmers did not know the importance of rearing house structure. As far as windows and ventilators aspect is concerned, 37.5% were found having least importance

Table 2 — Correlation of cost of construction, area of rearing house and income

Sl. No.	Cost of construction (Lakh)	Area of rearing house (Sqft)	Total income (Rs)
1	5	1800	87500
2	3.5	1500	44100
3	3	1200	45000
4	9	1000	225000
5	5	861	33900
6	3	1600	31500
7	2	960	59850
8	2	750	96000
9	12	3000	142200
10	2	1200	33480
11	5	2400	45000
12	4	1320	56100
13	2	650	29400
14	7	3000	112000
15	16	3000	382500
16	3	800	33300
Pearson Correlation	1	0.738**	0.888**
N	16	16	16

**. Correlation is significant at the 0.01 level (2-tailed)

Table 3 — Regression coefficient for rearing house construction materials

Materials	Unstandardized Coefficients		Standardized Coefficients		
	Beta	Std. Error	Beta	t test	Significance
(Constant)	4.227	2.411	-0.175	1.754	0.154
Asbestos sheet	-1.364	2.156	0.392	-.632	0.561
Granite floor	3.273	1.804	0.060	1.814	0.144
Steel rack	0.591	1.867	0.549	0.316	0.767
Fibrecement board	8.773	4.599	-0.101	1.907	0.129
Spilnkers	-1.000	3.198	-0.234	-0.313	0.770
G.I pipes	-2.318	2.505	0.048	-0.925	0.407
Laterite structure	0.773	3.305	-0.139	0.234	0.827
Bamboo	-2.227	3.305	0.012	-0.674	0.537
Steel structure	12.773	4.599	0.006	2.777	0.050*
Movable frames	0.091	3.340	-0.175	0.027	0.980

*Significant at 0.05%

Table 4 — Analysis of ANOVA model for cost of construction and materials used.

Model	Sum of Squares	Df	Mean Square	F test	Significance
Regression	218.545	11	19.868	3.885	0.101^{NS}
Residual	20.455	4	5.114		
Total	239.000	15			

NS: Not significant

Table 5 — Regression coefficient between cost of construction and total income

Model	Unstandardized Coefficients		Standardized Coefficients	t test	Significance
	Beta	Std. Error	Beta		
(Constant)	-0.940	1.387	-	-0.678	0.511
Area of rearing house (sqft)	0.002	0.001	0.377	3.492	0.004
Rack size (sqft)	0.005*	0.009*	0.056*	0.584	0.570
Total income	3.009E-005	0.000	0.707	6.367	0.000

NS: Not significant

Table 6 — Analysis of ANOVA model for cost of construction and income from rearing.

Model	Sum of Squares	Df	Mean Square	F test	Significance
Regression	214.614	3	71.538	35.202	0.000^{NS}
Residual	24.386	12	2.032		
Total	239.000	15			

NS: Not significant

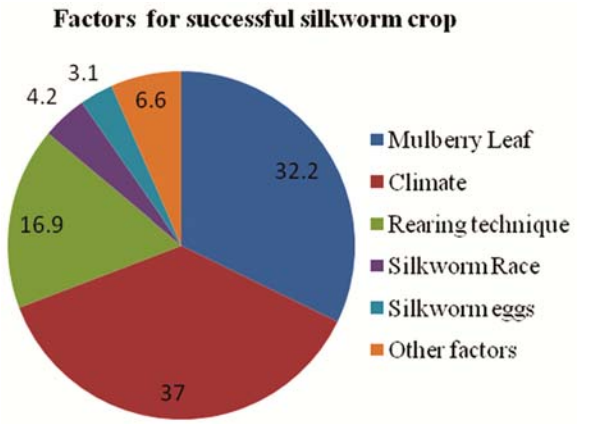

Fig. 1 — Percent influence of various factors for successful silkworm crop

about this concept. With respect to rodent and fly proof structure, none of the structure was found rodent proof. However, more than 75% structures were uzi fly proof as uzi fly is noticed in two to three

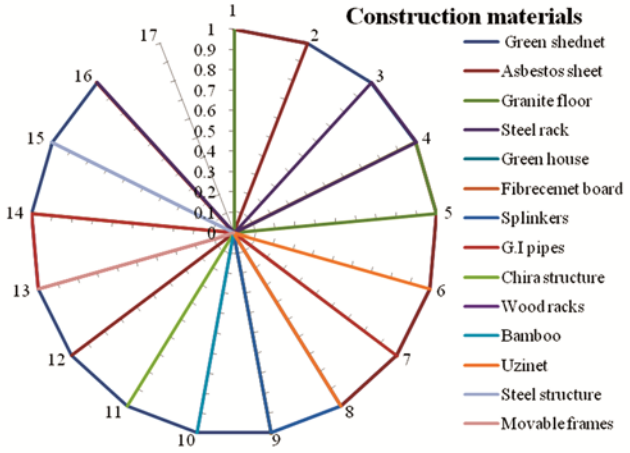

Fig. 2 — Various materials used for construction of rearing house structures by the farmers

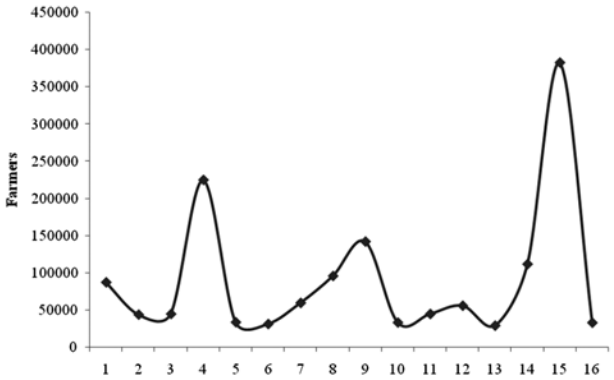

Fig. 3 — Farmer-wise cocoon income in sericulture (August 2018- March 2019)

crops every year. The finishing of roof, wall and floor were not considerable factors in the construction of rearing house for farmers which was prominently noticed in present study. In the absence of finished roof, wall and floor disinfection for pathogen free environment cannot be done. In such situation silkworm are susceptible to various kinds of diseases like, pebrine, muscardine, flacherie and graserrie. Separate facilities for storage of leaf was available with only 12.5 percent farmers, whereas none of the farmers felt need of separate spinning hall. Benchamin and Jolly[16] reported that, ventilation during rearing and spinning is more effective provided separate facilities are available. It was evident from the present study that, farmers were already following some good practices however, those were not enough and full proof.

The correlation between the construction cost of rearing house and area (Table 2) is significant. Further correlation between the cost of rearing house and total

Fig. 4 — Model rearing house structure (A), Medium rearing structure (B), Low-cost rearing house structure (C)

income generated is also significant at 0.01level (2-tailed). Correlation of construction cost of rearing house and area of rearing house is at (r = 0.738). Correlation of cost of construction and total income is at (r = 0.888). Rearing house construction materials was also significant at 0.05% (Table 3). ANOVA (Table 4) for cost of construction and material used is not significant from the collected data. The regression coefficient between cost of construction and total income is non-significant for the collected data in the present study (Table 5). The data from (Table 6) analysed by ANOVA model for cost of construction and total income generated from rearing is not significant as data observed with respect to cost of rearing house and income of farmers varies.

In the present study, based on various parameters and evaluation of rearing house structures were classified under three categories namely,

[A] Model rearing house structure
[B] Medium rearing house structure
[C] Low cost rearing house structure

Present investigation shows that only 12.5% farmers are having model rearing house with modern amenities for silkworm rearing. About 25 percent were having medium level structures whereas 62.5 percent of the farmers represent low cost rearing house structures (Fig. 4).

Conclusion

In the present investigation it is observed that, most of the farmers have not consulted to civil engineers, planners for having designs, construction, and consultancy before undertaking construction. The present study also indicates that, funds for construction, knowledge on the requirement for scientific construction of rearing house, cost effective materials to be used and need of the separate house were lacking with farmers. Present study thus concludes that, farmers need advice in planning, designing size of rearing house, site suitability, direction, capacity, construction materials, and prevention of pests in the rearing house. Intervention of civil engineer will certainly save undesirable financial burden on cost of construction and it will be helpful in maintaining healthy environment for silkworm rearing and successful cocoon crop.

Conflict of Interest

Authors declares that there is no conflict of interest

Author Contributions

TJ: convinced concept, carried out data collection and analysis, prepared manuscript. This work was the part of M. Tech. civil dissertation of TJ; ADJ: perceived concept, reviewed manuscript; ACA: perceived concept and reviewed manuscript; SV: perceived concept and reviewed manuscript.

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