

## Sericulture: management and practices of mulberry silkworm

Sajal Saha<sup>[1]</sup>, Pravesh Kumar<sup>[2]</sup>, Shubham Raj<sup>[3]</sup>, Babita Mog Choudhury<sup>[4]</sup>,  
Sentisuba<sup>[5]</sup>

<sup>[1,5]</sup>PhD research scholar, Nagaland Central University, SASRD, India

<sup>[2]</sup>M.Sc Agri, Chaudhary Charan Singh University, Meerut, U.P., India

<sup>[3]</sup>MBA (Agriculture), Assam Agricultural University, Jorhat, India

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**ABSTRACT:** Silk is called as the queen of all fabric materials over thousands of years. It's become associate in Nursing in divisible a part of Indian culture and tradition. Silk fiber in Asian country is usually thought-about to be as additional ancient and wont to wear in special occasions and events. There are variety of alternative beliefs and mythological thoughts that are thought-about to be connected to silk fiber, therefore, the silk non inheritable the place of queen of fiber.

### I. INTRODUCTION

In India, it's a rural primarily based agro business providing employment to rural population, though sericulture is taken into account to be a subsidiary occupation and technical innovation created it doable to get a lot of employment. it's the foremost labor intensive section for the economy that provides keep to an oversized section of population. Sericulture or silk farming is that the rearing of silkworm for production of raw silk. Though there square measure many industrial species of silkworms, *Bombyx moris*, the foremost wide used and intensively studied. Silkworm larvae square measure fed mulberry leaves and when the molt, climb a twig placed close to them and spin their smooth cocoons. This method is achieved by the worm through a dense fluid secreted from its structural glands, ensuing fiber of cocoon. The silk could be a continuous-filament fiber consisting of fibroin macromolecule, secreted from 2 secretion glands within the head of fauna and a gum known as sericin, that cements the 2 filaments along. The sericin is removed by inserting the cocoons in predicament, that frees the silk filaments and readies them for reeling. This can be referred to as the degumming method. The immersion in predicament additionally kills the silkworm pupae. Single filaments square measure combined to make thread. This thread is drawn below tension through many guides and spherical into reels. The threads could also be plied along to make yarn. Moriculture are

often outlined because the culture of the mulberry plant. Mulberry plant is a vital plant that may be helpful in some ways. It's wide used as feed for the mulberry silkworm, fuel, creating baskets, getting ready jam and jelly from its fruits. In Asian nation we have a tendency to manufacture every type of silk. Sericulture has become one among the foremost necessary bungalow industries in a variety of states like China, Japan, India, Korea, Brazil, Russia, European nation and France. Today, China and Asian nation square measure the 2 main producers, along producing over hour of the planet production. Production of raw silk in Asian nation was twenty three,060 MT (metric ton) in 2011-12, of which, mulberry raw silk output mass to eighteen,272 MT (79.24%). The remaining four,788 MT (20.76%) was tasar silk. Mulberry sericulture is principally practiced in 5 states specifically, Karnataka, province, state, Tamilnadu and Jammu & Jammu and Kashmir together account for regarding ninety seven of the entire mulberry silk production within the country. Asian nation is that the largest client of raw silk within the world.

### Area with mulberry in India

Mulberry foliage is that the solely food for the silkworm (*Bombyx mori*) and is grown up beneath varied atmospheric condition starting from temperate to tropical. Mulberry leaf may be a major economic part in sericulture since the standard and amount of leaf created per unit space have an immediate pertaining to cocoon harvest. In India, most states have preoccupied sericulture as a very important agro-based business in numerous places of Bharat with wonderful results. In India, there square measure several species of magnoliopsid genus, of that *Morus alba*, *M. indica*, *M. serrata* and *M. laevigata* grow wild in the chain of mountains. many different varieties are introduced that square measure *M. multicaulis*, *M. nigra*, *M. sinensis* and *M. philippinensis*. Most of the Indian types of mulberry belong to *M. indica*.

### Leaf chemical composition

It differs according to variety and maturity. However, on the basis of the analysis carried out at

CSRTI, Mysore the chemical composition of the leaf is as follows:

**Table 1:** Leaf chemical composition

Component	Range
Moisture	65-78 %
Protein	19-25 %
Minerals	10-15 %
Reducing sugars	1.2-1.9 %
Sugars	10-15 %

### Climatic requirement:

Mulberry thrives beneath various climate ranging from temperate to tropical placed north of the equator between 28° N and 55°N latitude. The most effective vary of temperature is from twenty four to 28°C. Mulberry grows well in places with associate in nursing annual precipitation ranging from 600 to 2,500 mm. In areas with low precipitation, growth is through wet stress, resulting in low yields. On average, mulberry desires 340m<sup>3</sup>/ha of water every ten days simply just in case of loamy soils and fifteen days in clay soils. Region condition at intervals the vary of 65-80 p.c is true for mulberry growth. Sunshine is one altogether the important factors dominant growth and leaf quality.

### Soil condition:

Mulberry thrives well in soils that are flat, deep, fertile, well drained, loamy to clay, and porous with smart wet holding capability. the most effective vary of soil hydrogen ion concentration is half a dozen.2 to 6.8 pH, the optimum being half a dozen.5 to 6.8. pH Soil amendments is additionally accustomed correct the soil to urge the desired hydrogen ion concentration

### Propagation of Mulberry:

Mulberry are often propagated by 2 method:-

- i) Sexual Propagation:- In mulberry the sexual propagation is thru seedlings, significantly seed propagation carries a varied population, For seed germination sure stipulations area unit required to be consummated like choice of

quality seed, preparation of land, and seed ought to be elect specified will positively germinate.

- ii) Vegetal Propagation:- In vegetal kind of propagation vegetative plant elements area unit used.
- iii) In mulberry the propagation is principally of 3 sorts.
  - Propagation by Cutting.
  - Propagation by affixation.
  - Propagation by Budding.

### Land preparation:

If the land contains a mild slope, it are often levelled by minor land shaping and providing appropriate kind of bunds across the slope. If the slope is larger, contour bunding terrace planting or isometric planting are often adopted. in additional sloping areas, platforms for individual plants on contour lines area unit a lot of appropriate since this involves less soil cutting. **Application of fertilizers:** Fertilizers conjointly should be used as per the counseled dosage mainly N.P.K. The counseled indefinite quantity of N.P.K are within the quantitative relation of assorted from place to position. Usually N.P.K. are within the quantitative relation of two.5:1:1 for irrigated conditions and 2:1:1 of N.P.K for rain fed conditions. In unsmooth areas the counseled N.P.K. area unit 100:40:40.

### Spacing:

For mild slopes, 3' x 3', 5' x 5" could also be adopted. In sloping a lot of land 10" x 10" are often adopted. Pits area unit to be ready for plantation. In deep rough-textured loose soils, forty

five x forty five cm and in exhausting shallow soils 60x60x60 cm pits area unit to be ready. for every pit, five kilogram (one iron pan) of FYM or compost should be applied.

**Planting:**

Saplings of 5 months past with five to 6 roots area unit appropriate for planting during the regular onset of the monsoon. The saplings ought to be supported with a continue guarantee straight growth.

**Maintenance:**

Once one month, all the buds except the highest 5 to 6 ought to be removed carefully while not damaging the bark. Weeds round the plant ought to be removed and regular pot watering given. Once 3 months of plantings second weeding ought to be done and 25g of suphate/plant ought to be applied in an exceedingly trench and will be coated with soil. A second dose of plant food (25 g urea/plant) ought to be applied before halt of the monsoon. Plants should be shielded from grazing.

**Mulberry cultivation and practices**

Mulberry is cultivated in an exceedingly big selection of soil. Favorable soils for mulberry growth are sandy dirt, dirt and clayey dirt. The mulberry is even full-grown on slopes of mountainous areas, that don't seem to be vulnerable to water work. Just in case of slightly sloppy lands, correct drain should be provided. In irrigated land the suggested organic manure like oxen dung compost @20 tones per hector or @ ten tones per square measure in rain fed conditions should be applied and mixed with soil by plowing 2-3 times.

**Inter Cultivation:**

To eliminate the weeds and to loosen the soil permanently aeration, around mulberry plant, lightweight hoeing ought to be done 2 months when plantation.

**Pruning:**

Pruning of mulberry trees ought to be done when one year of plantation. By pruning the mulberry branches, leaf yield is raised and production of leaf is synchronic with silkworm rearing schedules throughout the seasons. Care ought to be taken throughout pruning; bark mustn't get in the altogether off since cut wounds don't heal, that leads infections and diseases.

**Leaf Harvesting:**

In conjunction with leaf production, leaf utilization is additionally necessary. Leaf harvest depends upon sort of rearing apply. Leaf harvested

by 1) leaf selecting, 2) branch cutting / shoot harvest. Leaf harvest in time is extremely essential as mature leaf contain low nutrient price & silk worms fed upon them become malady inclined harvest.

**Leaf Picking:** In India principally leaf selecting is practiced. However, this is often a lot of labor intensive. Presently this methodology is being followed by most of the farmers. In an exceedingly year 5-6 harvests are potential. Initial leaf harvest takes place when (10) weeks of bottom pruning.

**Types of silkworm rearing in India**

Silk worm rearing is started with production of egg that's additionally called the grainage then followed by the Chawki rearing and late age rearing. Silk that's created in Republic of India is principally of four varieties as follows-

**a) Mulberry:**

Bombyx mori is reared on the mulberry, considering the economical conditions, such as :rainfall and therefore the nature of soil, completely different systems of plantations for raising mulberry ar practiced in Republic of India. The silkworm Bombyx mori are reared throughout the year. the whole lifetime of this silkworm is fifty days, out of those egg stage is ten days, larval stage is 25-30 days and therefore the insect stage is ten days. At the top of the larval length, the silkworm emits silk from its mouth and constructs a cocoon on a system. the typical annual yield of cocoons in Republic of India is as low as one hundred fifty kilo below rain fed conditions, and below irrigated conditions it's regarding four hundred kilo.

**b) Eri silk worm:**

This silk created by Philosamiaricini is named eri silk worm. it's principally fully grown in state ineastern components of Republic of India. The food plants of this silkworm is castor (Ricinus communis) the choice food plants are Heteropanax fragans, Manihotutilissima, Earica papaya, flowering tree sp., Plumeriaacutifolia. This silkworm is multi voltine and is reared inside. The worms molt fourfold throughout its larval amount of 30-32 days. It's typically hardy and not liable to malady.

**c) Tasar:**

For the extraction of tasar silk 3 species of Anthereaare used in republic of India. They are Anthereamylitta, A. perniyi and A. royeli. This silkworm is reared on trees of Terminaliatomentosa, Terminaliaarjuna. Tasar silkworms ar reared wild in nature. They are usually inexperienced in color.

**d) Muga:**

Anthereaassama manufacture golden yellow silk. This process is found solely within the river depression of Republic of India. it's semi domesticated. The worms are raised on Machilusbombycina and Litsaeapolyantha trees

**Mulberry silk production:**

Silk production is an process as follows-

**Life cycle of mulberry silk production:**

The life cycle of moth started when a female moth lays eggs. The larvae are hatched from the eggs. The worm feed on mulberry leaves and grown up to a pupa. After that it swings its head, spinning a fiber made of a protein and becomes a silk fiber, silk worm protected and covered by this fiber than we called it cocoon.

**Fig: Life cycle of silkworms**



**Source: Central Silk Board, Govt. of India**

**Egg Production (grainage):**

Grainage may be a method chargeable for the providing egg for normal rearing of the silkworm. final production of egg is to supply cocoons to induce silk yarn. Advance designing, quality production, timely offer of seed is that the vital factors in egg production. The egg is created in

"Grainages". Grainages play a significant role not solely in production of seed however conjointly within the entire seed organization. Throughout the grainage operation one should apprehend the seed quality for a specific space before cathartic commercially.



**Fig: Newly born hatched worms**



**Source: Central Silk Board, Dehradun, India**

**Rearing:**

Silkworm is domesticated over thousands of years and therefore the sole food for the growth of silkworm is mulberry leaf.

**Types of Rearing:**

Rearing of silkworm is completed in numerous ways in several areas.

Mainly the rearing of silkworm is of 2 types:

**a. Chawki Rearing:**

Rearing of young age silk worms is termed Chawki rearing. Here worms are reared up to third molt and distributed to the producer for late age rearing. Chawki rearing in mass at every CRC won't solely manage the attack of diseases however

jointly facilitate the rearing on most scientific lines and price wise it's most economical.

**b. Late Age Rearing:**

Late age rearing once third molt doesn't need warm temperature and wetness compared to chawki rearing. Late age rearing may be a very little easier method than chawki rearing. Throughout late age the amount of mulberry leaf needed is quite ninety percent of total larval amount.

**Climatic requirements: -**

Under ideal conditions silkworm completes cocoon formation in 24-28 days from the day of hatching. The following required temperature/humidity/spacing should be provided:

S.No.	Stage	Temperature <sup>0</sup> C	Humidity%	Spacing(for100df <sup>l</sup> 's) in Sq. ft
1	1 <sup>st</sup> Instar	26-28	85-90	4-14
2	2 <sup>nd</sup> Instar	26-28	85-90	15-45
3	3 <sup>rd</sup> Instar	25-26	80-85	46-90
4	4 <sup>th</sup> Instar	24-25	70-75	91-100
5	5 <sup>th</sup> Instar	23-24	70	181-360

**Rearing shed:**

Rearing shed should be made with East/West direction, ideally with the thatched roofing, mud walls or any roofing should not replicate heat on the biological body growth of silkworm. Keeping smart range of windows, correct ventilation, light, mistreatment country tiles for roofing can serve the aim of maintaining needed atmospheric conditions within the rearing house with reduced price.

**Leaf quality:**

Leaf quality plays a crucial role within the production of quality cocoons. The young age worms area unit fed with tender, succulent leaves

that contain sugar, less quantity of fiber, starch but, high wetness and super molecule that area unit appropriate for chawki worms. Harvested leaf ought to be transported in wet bagging luggage or baskets created of bamboo. Such leaf ought to be preserved in an exceedingly separate area or in an exceedingly corner of rearing area or in specially designed leaf preservation chamber created of wood with decent range of ventilators. **Leaf requirement:**

Silkworm attains nearly 10,000 times of weight ranging from hatching to spinning stage, therefore, feeding quality leaf plays a crucial role within the development of silkworm

**Leaf Requirement (about 400 eggs per DFL"s)**

S.No.	Silkworm Stage	Quantity of mulberry leaf Required (approx.) (Kg)
1	1 <sup>st</sup> Instar	2-4
2	2 <sup>nd</sup> Instar	4-8
3	3 <sup>rd</sup> Instar	30-40
4	4 <sup>th</sup> Instar	80-90
5	5 <sup>th</sup> Instar	600-650

**Fig: Feeding of mulberry leaves**



**Source: Central Silk Board, Dehradun, India**

**Rearing Equipments:**

The following equipments are required for silkworm rearing.

1. Mesh 2) Formalin 3) Sprayer 4) Mats 5) Leaf preservation chamber
6. Chopping board 7) Chopping knife 8) Chop sticks 9) Feathers
10. Ant wells 11) Foam pads 12) Paraffin Paper 13) Hygrometer
14. Thermometer 15) Bed cleaning net 16) Wash basin
17. Plastic buckets/Mugs 18) Rearing stands 19) Rearing trays
20. Feeding stand

**Disinfection:**

Disinfection may be a method of destructing the un-wellness casual organisms. There's a break of carrying the pathogens or germs through the rearing instrumentation if there's any un-wellness attack within the previous crop. Therefore, medical care is important to guard the crop from un-wellness attack. Before taking on rearing all the rearing equipments together with the rearing house ought to be disinfected totally. There square measure numerous strategies of medical care like physical and chemical. Physical disinfections square measure sun drying, steaming. In chemical medical care, all the rearing instrumentation likewise because the rearing house ought to be totally disinfected with two formal and dried.

**Incubation:**

The eggs ought to be unbroken in cooler places at 25°C temperature and 80% humidity. For uniform hatching all the egg cards or loose eggs ought to be unbroken in dark and cooler atmosphere. On the day of pin head or blue egg stage all the eggs square measure lined with a black sheet or unbroken in recording machine and called black boxing. On the day of hatching all the eggs square measure suddenly exposed to bright light weight within the early morning at around eight a.m. in order that ninety fifth hatching is achieved.

**Brushing:**

Brushing is transferring of recently hatched larvae into rearing trays. The recently hatched larvae when one hour of hatching make preparations to go after mulberry leaf. They're fed with finely cut tender mulberry leaf.

**Feeding of Leaf:**

Feeding recently hatched larvae daily at nine a.m. within the morning is very important. throughout the first arthropod relying upon the silkworm strain and different factors (environmental conditions and leaf quality) the desired mulberry leaf per a hundred DFL are going to be around 2-2.5 kg. The first arthropod stays for 3-3 1/2 days and bear molt. Shedding amount last for a few day. This may rely upon the environmental conditions.

**Spacing: -**

The number of trays and space required for each instar will increase.

Stage of silkworm	No. of trays required for 100 DFL's (Diameter of tray 3 1/2")		Space required (Bi and Multi x Bi hybrids)	
	Beginning	End of stage	Begin	End
1 <sup>st</sup> instar	2	2	4 to 15 Sq.ft	
2 <sup>nd</sup> instar	2	5-6	15 to 45 Sq.ft	
3 <sup>rd</sup> instar	5-6	10-12	46 to 90 Sq.ft	
4 <sup>th</sup> instar	10-12	20	91 to 180 Sq.ft.	
5 <sup>th</sup> instar	20	40	181 to 360 Sq.ft	

**Bed Cleaning: -**

Bed cleansing in silkworm rearing receptacle is finished by varied strategies like victimization of paddy husk, straw, and bed

cleansing internet. Throughout first arthropod, bed clearing ought to be done once throughout pre-molting, throughout 2d arthropod doubly, once when molt and before next molt. Throughout third

arthropod thrice i.e when molt, before next molt and once within the middle. Throughout fourth and fifth stage once in an exceedingly day just in case of shelf rearing.

**Feeding:**

It is estimated that 50% of the total weight will be increased in the 5<sup>th</sup> instar itself. The feeding schedule is: -

S.No.	1 <sup>st</sup> feeding	2 <sup>nd</sup> feeding	3 <sup>rd</sup> feeding	4 <sup>th</sup> feeding	5 <sup>th</sup> feeding
1	6 A.M.-6.30 A.M	11-11.30 AM	3-3.30 PM	7-7.30 PM	
2	7 AM – 7.30 AM	11-11.30 AM	2-2.30 PM	5-5.30 PM	
3	6 AM – 6.30 AM	10-10.30 AM	2-2.30 PM	6-6.30 PM	10-10.30 PM

**Mounting:**

Transferring of matured silkworm to the mountage or cocoon frames is named "mounting". This is often a crucial and ball-hawking operation. Any deviation in identification of maturity of worms adversely have an effect on on seclusion For the aim the density of worms within the mountage ought to be restricted to 40-50 worms per sq.ft.to avoid formation of double cocoon, stained cocoon. The matured worms picked up in any of the ways mentioned higher than area unit transferred to the mountages. In a neighborhood of one mt 800-900 worms will be mounted to avoid an excessive amount of density within the mountage. In bound strain of silk worms around 250-300 worms will be handily mounted in a very customary mountage of ninety x sixty cm size. Throughout mounting care ought to be taken to use the proper form of chandrike in convenient size and form.

There are different types of chandrike that are used for the purpose of mounting

- a. Plastic Mountage
- b. Bamboo made Chandrike
- c. Straw Mountage
- d. Bottle Brush
- e. Revolving Mountage

**Cocooning:**

The matured silkworm spins the outer protecting covering referred to as cocoon and remains in dormant stage within as insect. once mounting the ripen worms in chandrike the larvae sticks on to the mountage by oozing out the silk fluid which can harden like a shot once coming back in grips with air and sticks itself to the mountage. It starts to ooz out the silk by continuous movement of its head terribly} very specific manner to create the silk filament within the form of arithmetic figure '8'. Larvae moves its head incessantly concerning 70-80 times per minute until the compact shell referred to as cocoon is made and detaches itself from the last layer of silk of then reworking into insect. Silkworm completes the spinning in 2-4 days relying upon the silkworm strain and climate provided.

**Harvesting of Cocoons:**

Harvesting of cocoons is finished on the fifth day of spinning. Wherever as seed cocoons ought to be harvested on eighth day or ninth day of spinning relying upon the part temperature. Harvesting shouldn't be done like a shot once pupation. Further, harvest home ought to be done before the lepidopterous insect emerges out. Cocoons ar harvested usually with hand. In advanced temperate countries like Japan straightforward devices are accustomed harvest the cocoons from turning mountage.



**Fig: Different types of cocoons**



Source: Sajal saha, csb.gov.in

### **Reeling:**

Reeling may be a method of unreeling of silk filament from the cocoon. Reeling method is a crucial activity. Relying upon the specified thickness (denier) of silk thread filaments from variety of cocoons area unit combined along and reeled. Associate degree economical realer can maintain the fastened variety of cocoons per finish to provide uniform denier silk. Reeling is meted out by distinctive strategies

### **Types**

#### **Charka**

It is regarding five hundredth of total raw silk production is contributed by charka. Reeling machine is historically home engineered by exploitation wood material with the help of black smith and carpenter thus. Cottage Basin In bungalow basin, the cocoons area unit soft-bo singly and re-

reeling is completed singly to extend the standard of silk. In bungalow basin change of state is completed singly and therefore the reeling basins area unit mounted to a reel bench. There'll be 6-10 ends in every basin. Arrangement to produce predicament to every basin and to empty out the dirt water accumulated thanks to floss and sericin is formed. Filature or multi-end reeling machine works on the principle of picture reeling and thread production on tiny reels at an outsized range of ends per basin. Automatic reeling machine Bi-voltine cocoons area unit best suited to automatic reeling machines. This machinery needs superior quality cocoons and uniform size of cocoons with less floss. Usually the multi-voltine cocoons don't seem to be suited automatic reeling. This is often notably thanks to inferior quality. The silk made from automatic reeling machine are going to be superior.

**Fig: Silk processing machine**



**Source: Sajal Saha, csb.gov.in**

### **Hatching:**

While brushing is taken some larvae stay un-brushed as a result of they're late born. Beside some eggs stay sterile, some dead eggs, some un-hatched eggs conjointly found on egg sheets. From no. of larvae brushed late born larva square measure subtracted and divided by total no. of eggs. Its share is named hatching share. In total no. of eggs i.e. fecundity, inseminated eggs, dead eggs, un-hatched eggs and hatched egg shells square measure counted.

### **Larval period:**

It's counted from brushing time to 1st molt time for 1st arthropod larvae, molt out time to once more molt in time is counted for record of second, third and fourth stages. In fifth age amount from molt bent on spinning is counted. Total larval amount is counted by individual record of fifth stage of the silkworm.

### **Yield:**

Yield /10000 larvae brushed. This parameter for weight is counted on the premise of the great cocoons weight of space preserved (300 or 350) divided by no of larvae preserved and increased by ten thousand. For variety this parameter is counted on the premise of no. of fine cocoons (including double cocoons and also the cocoons within which pupae square measure shaped divided by the no. of larvae. cocoons, flimsy cocoons, and sensible cocoons square measure sorted out from the

harvested heap in same written account order. usually cocoons confirming their folks square measure hybrid characters with live insect square measure known as sensible cocoons.

### **Pupation percentage:**

Each sensible cocoon is gently jolted holding it between finger and thumb close to our ears. If a transparent sound comes, it shows live insect within. Live insect divided by larvae preserved and increased by a hundred is named pupation share.

### **SCW (Single cocoon weight):**

SCW, SSW, older usually ten males \*10 females insect square measure elect from plenty of three hundred larvae preserved for analysis of those on associate balance. Ten male or feminine cocoons with their insects within square measure weighted for SCW pupa and cast off square measure taken out empty cocoons shells square measure weighted once more, this is often known as SCW. Point divided by SCW and increased by a hundred is named SR share.

## **II. CONCLUSION**

As per the sensible expertise gained let me created a conclusion that sericulture could be a large field of nice economic importance and having plenty of potential. it's the capability to produce employment to the landless in addition because the little farmers which can improve the living

commonplace of the peoples. at the side of that silk that's made is have additional price than the other fiber and have capability to produce sensible returns to the economy.

### REFERENCES

- [1]. Apurba K Sutradhar, Daniel. E. Kaiser. Carl. J.Rosen and john a Lamb (2017). www.extension.umn.edu/ agriculture/nutrient management/.
- [2]. Annual Report of Sericulture 2016. Central silk Board, Ministry of Textiles, Govt. of India, Bangalore. pp 1-28.
- [3]. Anitha, R. 2011. Indian silk industry in the global scenario. *International Journal of Multidisciplinary Management Studies*, 1, 100-110.
- [4]. Best, M. L., & Maier, S. G. 2007. Gender, culture and ICT use in rural South India. *Gender Technology and Development*, 11, 137-155.
- [5]. Bhatta, R., & Rao, K. A 2003. Women's livelihood in fisheries in coastal Karnataka, India. *Indian Journal of Gender Studies*, 10, 261-278.
- [6]. Bhatikar, A.P. 1985. Sericulture and rural industrialization (part I). *Indian Silk*, 24 (2):7-16.
- [7]. Chadha, G. K 1993. Non- farm employment for rural households in india; Evidence and prognosis. *Indian Journal of Labour Economics*, 36(3); 296-327.
- [8]. Choudhury P.C., Shukla, P., Ghosh, B. And Sengupta, K (1991). Effect of spacing, crown height and method of ipruning on mulberry . leaf yield, quality of cocoon yield. *Indian J: Seric.* 30 (1) 46-53.
- [9]. Dewangan, S.K et. al. 2011 Socio economic upliftment of Tribal through Tasar sericulture- a study of Tamnar block of Raigarh district, C.G, India. *World Academy of Science, Engineering and Technology*, (72) p p: 481-492.
- [10]. Devaraja, T. S. 2011. Indian textile and garment industry-An overview. New Delhi: Indian Council of Social Science Research.
- [11]. De, U. K., & Das, M. 2010. Economics of Sericulture in Assam. A Comparative Analysis of Three. Cultivators. *South Asia Economic Journal*, 11(2), 309-336.
- [12]. Datta, R.K. (1992) Bivoltine Silkworm rearing guidelines, a Central Silk Board, Bangalore.
- [13]. Ganga, G. and Chetty, J. Sulochana 1991. An Introduction to Sericulture. Oxford and New Delhi: IBH Publishing Company.
- [14]. Geetha, G.S. and Indira, R. 2011. 'Silkworm Rearing by Rural Women in Karnataka: A Path to Empowerment', *Indian Journal of Gender Studies*, 18(1): 89- 102. Ghosh, Alok (1988) *Indian Economy, 1988-89. Its Nature and Problems*. Calcutta.
- [15]. Goswami, C., & Bhattacharya, M. 2013. Contribution of Sericulture to women's income in Assam-A Case Study in Goalpara district of Assam, India. *International Journal of Scientific and Research Publications*, 735.volume,3, Issue 3, march-2013-ISSN 2250-3153.
- [16]. Krishnaswami S., Kumaraj, S AND Vijayaraghavan, S (1978). Studies on Fortification of mulberry leaves for feeding silkworms. *Indian J. Seric.*, (11):68-72.
- [17]. Krishnaswami S (1978). New technology of Silkworm rearing. CSR&TI, Central Silk Board, India. *Bull* 1978; 2:1- 23.
- [18]. Laskar, N. and Datta, M. (2000). Effect of Alfalfa tonic and its inorganic ingredients on growth and development of silkworm *Bombyx mori* L. race Nistari. *Environ. Ecol.*,18: 591-596.
- [19]. Narayanaswamy T.K and Shankar, M.A (2003). Mulberry cultivation: A tool for quality leaf and sustainable cocoon production. Department of Sericulture and Dry land Agriculture Project, University of Agricultural Sciences, Bangalore. p. 28.
- [20]. Nasreen, A., Cheema G.M And Ashfaq.M.(1999). Rearing of silkworm *Bombyx mori* L. on alternate food plants, *Pak.J: Biol.,Sci.*, 2: 843-845.
- [21]. Parameshwara, G. 1996. Sericulture - global prospects. *Global Silk Scenario*, 2001, p 2.
- [22]. Patil, B. R., Singh, K. K., Pawar, S. E., Maarse, L., & Otte, J. 2009. Sericulture: an alternative source of income to enhance the livelihoods of small-scale farmers and tribal communities. Pro-poor livestock policy initiative, a living from livestock, Research Report, RRnt 09-03, july 2009, BAIIF Development Research Foundation, Pune, 26.
- [23]. Prabha Sekhar and Ravikumar, C. 1991. Role of rural women in Indian sericulture, *Proceedings of the International Congress on Tropical Sericulture Practices*, Op.cit. pp 65-71.



- [24]. Prakasam, K., & Ravi, G. 2014. Sericulture– An Ideal Enterprise for Sustainable Income in Erode District of Tamil Nadu. Language in India. ISSN 1930-2940, vol. 14: 9.
- [25]. Purushotham, S., Rama Mohan Rao, P. 2011. Economics of sericulture Vis-à-vis competing crops in Ananthapur district of Andhra Pradesh. Golden Jubilee Conference-Sericulture Innovation; Before and beyond 2011, CSRTI Mysore 497-499. CSRTI Mysore, Karnataka.
- [26]. Rahaman, A. H., Khan, N., Khan 2013. Spatio-temporal changes of growth and production of sericulture in Asia: An analytical and comparative study. J. Geogr. Reg. Plann. 6, 63.
- [27]. Rakesh Sharma. 1980. Economics of sericulture industry in Himachal Pradesh. Indian Silk 19(5):25-32.
- [28]. Reddy,R.M., 2010c. Silkworm food plants apply dimension under Indian condition - time for utility optimization and value addition. Sericologia. 50(1):01- 17.
- [29]. Roy, P., & Sarkar, R. 2015. Work participation and income generation from sericulture: A case Study of Alomtola Village of Kaliachak-II Block in Malda district, West Bengal. Science and Education, 1(1), 31–36.
- [30]. Ruchira Shukla. 2012. Economics of rainfed sericulture in Rajasthan, India. Bangladesh. J; Agricultural research 37(1); 49-54, March,2012.
- [31]. Shrivastav, P.K.et.al. 2005 Sericulture activities provide a perfect choice for the women. Sericulture and seri-biodiversity.
- [32]. Sreedevi TK., Shiferaw. B and Wani S. P 2004. Adarsha Watershed in Kothapally Understanding the Drivers of Higher Impact. Global Theme on Agro ecosystems Report no.10. India: International Crops Research Institute for the Semi-Arid Tropics.24pp.