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**Rubia Bukhari**

Ph.D Scholar, Sher-e-Kashmir  
University of Agricultural  
Sciences & Technology  
of Jammu, Main Campus  
Chatha, Jammu, Jammu &  
Kashmir, India

**Kiran Pal Singh**

JRF, Scholar Department of  
zoology Kumaun University,  
Nainital, Uttarakhand, India

**Rashad Hussain Shah**

Department of fisheries Jammu  
and Kashmir RFFDA Ghou  
Manhasan, Jammu & Kashmir,  
India

## Non: Mulberry Sericulture

**Rubia Bukhari, Kiran Pal Singh and Rashad Hussain Shah**

**Abstract**

India has witnessed an increasing trend in production of Tasar, Eri and Muga from 2002-03 to 2015-16. The maximum annual growth in production of Tasar of 890 (51.47%) metric tonne was recorded in the year 2013-14 during the period under consideration. The maximum annual growth in production of Eri of 1121 (35.98%) metric tonne was recorded in the year 2013-14 during the period under consideration. The maximum annual growth in production of Muga of 29 (24.37%) metric tonne was recorded in the year 2013-14 during the period under consideration. Total production of raw silk in India was 28523 metric tonne during 2015-16; out of which 8045 (28.21%) metric tonne was vanya silk. Out of these 8045 metric tonne produced vanya silk; production of Tasar, Eri and Muga was 2819, 5060 and 166 metric tonne respectively during the year. We have seen a growth of 15.82%, 7.07% and 5.06% in production of Tasar, Eri and Muga respectively during 2015-16 over 2014-15. Total production of raw silk in India was 28708 metric tonne during 2014-15; out of which 7318 (25.49%) metric tonne was vanya silk. Out of these 7318 metric tonne produced vanya silk; production of Tasar, Eri and Muga was 2434, 4726 and 158 metric tonne respectively during the year. We have seen a growth of -7.06%, 11.54% and 6.76% in production of Tasar, Eri and Muga respectively during 2014-15 over 2013-14.

**Key words:** Vanya, Silk, Production, Sericulture, Cultivation.

**Introduction**

The natural silks are broadly classified as mulberry and wild or non-mulberry. Non-mulberry sericulture is universally known as forest or wild sericulture. Tropical and temperature tasar, eri, muga are the principle non-mulberry silks. Other varieties i.e. fagara, coan, mussel and spider silks are limited interest, Nearly 95% of the global production of non-mulberry silks is tasar. All branches of sericulture require food plants and manpower. In mulberry sericulture over 60% of the cost of production goes into raising and maintaining the food plants, besides a heavy initial investment is necessary for rearing houses, rearing appliances and other essentials. Likewise, among the non-mulberry varieties, eri has the disadvantage of higher production costs. Tasar is endowed by nature with vast potential. Non-mulberry sericulture is a forest-based industry uniquely suited to the economy and social structure of developing countries because of its minimum investment requirement, high employment, and foreign exchange earning potential. In India about 12, 43 million hectares of unexploited tasar food plants in the tropical and temperate belts could be put to use without investment. Moreover, unlike large industries in which heavy investment is indispensable and the employment potential is limited, tasar culture requires a very low investment for net high returns. Various operations of tasar production can be carried out even in remote forest villages as they do not require electricity, complex machinery, specialized skills etc. Non-mulberry production offers rural populations an attractive source of income, arrest their migration to urban areas, thereby preserving their traditional skill and way of life.

In India, Non-mulberry sericulture is an age old tradition, practiced mainly by the tribal's people. Non mulberry sericulture provides them moderate earnings. Wild sericulture remained obscure as an exclusive craft of tribal and hill folks inhabiting the forests of central India, Sub-Himalayan region and north-eastern India for long time. However, in recent years, this traditional craft of tribal has gained tremendous importance. Due to its rich production potential, eco-friendly nature of the activities and steady demand for handmade textile products within and outside the country, wild sericulture is commercially exploited from traditional craft into an industry of high potential. As an industry, it has an advantage of rich natural resources like food plants and tribal manpower. Utilizing them to bring a balanced development without disturbing the existing ecological system is the great socio-economic challenge in sericulture (Shetty and Samson, 1998) <sup>[60]</sup>.

India holds an unique distinction in producing all the three kinds of non-mulberry silks viz., tasar, eri, and muga silks, produced by *Antherae mylitta* Drury, *Samia cynthia* Ricini

**Correspondence****Rubia Bukhari**

Ph.D Scholar, Sher-e-Kashmir  
University of Agricultural  
Sciences & Technology  
of Jammu, Main Campus  
Chatha, Jammu, Jammu &  
Kashmir, India

Boisduval and *Antheraea assamensis* Westwood, respectively belonging to the family saturniidae. India produced 23060 metric tons (MT) of raw silk during 2011-12, out of which 4788 metric tons (MT) is being contributed by Vanya Silkworm, which makes it the second largest producer in the world next to China, Tasar, Eri and Muga contributed 1590, 3072 and 126 MT, respectively (Anonymous, 2012) <sup>[1]</sup>. Moreover, the untapped and highly promising non-mulberry or wild silk which has attracted the attention of silk users (Raje, 2005) <sup>[52]</sup> should be given the needed attention so as to enhance production. Although, wild silk is about 1% of world silk production, its low volume supplies exclusive niche market where scarcity and naturalness is highly valued, leading to price increment for fabric made from wild silk (Veldtman *et al.*, 2002; Raina, 2004).

## History

Vanya sericulture remained obscure for a long time as an exclusive craft of tribal and hill folks inhabiting the Central and North Eastern India. It is in the recent past that this tribal tradition assumed importance and attracted attention at National level. The rich production potentialities within the country, steady demand for vanya silk products outside, eco-friendly nature of the production and processing activities, women participation, promoted commercial exploitation of this craft, which culminated in the transformation of this age old tradition to an industry of immense potentiality. Vanya silks have been commercially exploited way back in 17th Century. The Western World gained an appetite for these alien shaded silks in mid-1800 when a rampant silkworm disease destroyed the European sericulture industry. Asia could not supply enough mulberry silk to cater to the needs of Europe and North America, thus creating a market for vanya silks.

- **Tasar:** Though there is no recorded document available regarding the origin of tasar in India, one can find the mention of tasar silk in ancient epic Ramayana "Ram's nuptial gift to Sita includes tasar silk". Temperate tasar is of recent origin and was introduced during mid 1960's.
- **Muga:** The silk of Assam (Muga) was made known to the World during 1662 through a famous European traveller Jean Joseph Tavenier. Sericulture was exempted from payment of land revenue as the Kings of Assam patronised the development of sericulture. Around 1950, there was a great earth quake in Upper Assam and the large number of muga plantations was destroyed, which hampered the growth of muga industry.
- **Eri:** The word eri means castor plant, is derived from the word "eranda" of Sanskrit origin. The advent of Ericulture is lost into the antiquity but, the fact remains that Assam was the original home of eri silk from time immemorial, with the earliest reference documented in 1779. The Britishers called it as "Palma Christi" silk. The eri silk was woven into heavy clothes known as "Bar Kapoor". Captain Jenkins (1771) remarked that eri silk was of incredible durability.

## Distribution

A large number of species (400-500) are used in the production of non-mulberry silks. But only eight have been commercially exploited in Asia and Africa tribal communities. They are Tasar silk, Muga silk, Eri silk, Anaphe silk, Fagara Silk, Coan silk, Mussel silk and Spider silk. Non-

mulberry silks are commercially produced mainly in China and India. However major share of production (80%) goes to China. Climate and vegetation provide India with an abundance of non-mulberry serigenous fauna. India produces significant amounts of all the important varieties of non-mulberry silks, tropical and temperate tasar, eri and muga.

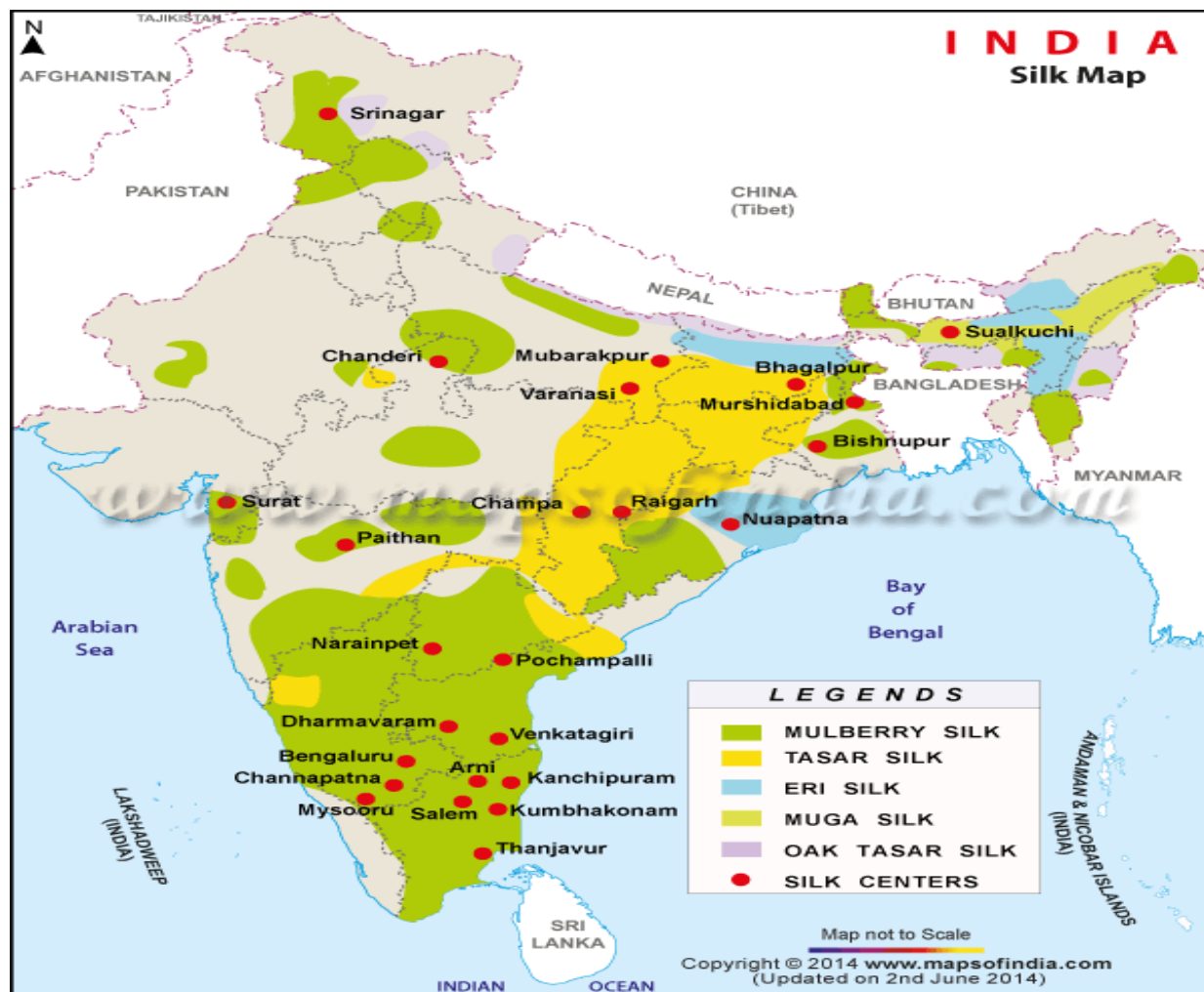
## Non-mulberry or wildmoth sericulture in the world.

In addition to the domesticated or mulberry silkworm, *Bombyx mori*, many indigenous wild silkmooths species have been utilized for over 2000 years (Peigler, 1993) <sup>[47]</sup>. Wild silkmooths cocoons are collected from the wild population and in some cases, rearing is done outdoors with little or no protection of larvae (Peigler, 1993; Kioko *et al.*, 2007) <sup>[47]</sup>. Non-mulberry sericulture holds great promise for the world's forestry and can help arrest forest destruction, as it permits gainful utilization of its natural wealth (Jolly *et al.*, 1975; Fening *et al.*, 2008) <sup>[23]</sup>. About 25 species of wild silkmooths have been exploited for wild silk production in the world, and this has been done mainly by tribal communities as reflected in some of the names of the silk (Peigler, 1993; Raina, 2000) <sup>[47]</sup>. According to Peigler (1993) <sup>[47]</sup>, India is the foremost country in the production of wild silk (Eri, Muga and Tasar) mainly for reasons being historical, cultural and economic. Wild silk varieties obtained globally include the Asian wild silk (Muga, Tasar, Fagara and Eri), the European silk (Coan) and the African wild silk obtained from indigenous wild silkmooths belonging to the genera Anaphe, Gonometa, Argema and Epiphora (Mbahin *et al.*, 2008; Ngoka *et al.*, 2008; Fening *et al.*, 2008; 2010) <sup>[23]</sup>.

Name of species	Family	Distribution
<i>Antheraea mylitta</i> Drury	Saturniidae	India
<i>Antheraea roylei</i> Moore	Saturniidae	India, China
<i>Antheraea yamamai</i> G & M	Saturniidae	Japan, Taiwan
<i>Antheraea pernyi</i> G & M	Saturniidae	China, India
<i>Antheraea assamensis</i> Helfer	Saturniidae	Assam (India)
<i>Samia cynthia ricini</i> Drury	Saturniidae	China, India, Japan, Cuba, Egypt, France, Italy

## Distribution of non-mulberry silkworms in India

- **Tasar:** Tropical Tasar growing area forms a distinct belt of humid and dense forest sprawling over the Central and Southern plateau, covering the traditional states of Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Orissa and touching the fringes of West Bengal, Andhra Pradesh, Uttar Pradesh and Maharashtra. Temperate tasar (oak tasar) extends from the sub-Himalayan region of Jammu and Kashmir in the West to Manipur in the East covering Himachal Pradesh, Uttarakhand, Assam, Mizoram, Arunachal Pradesh and Nagaland.
- **Muga:** Assam accounts for more than 95% of the muga silk production. The culture is also spread in different districts neighbouring Assam in Meghalaya, Nagaland, Manipur, Mizoram, Arunachal Pradesh and West Bengal.
- **Eri:** Eri culture was mostly confined to the Brahmaputra valley of Assam in the tribal inhabited districts, followed by Meghalaya, Nagaland, Mizoram, Manipur and Arunachal Pradesh. Ericulture is introduced on a pilot scale in States like Andhra Pradesh, Tamil Nadu, West Bengal, Bihar, Chhattisgarh, Madhya Pradesh, Orissa etc.



### Status of silk industry

Silk is the most elegant textile in the world with unparalleled grandeur, natural sheen, and inherent affinity for dyes, high absorbance, light weight, soft touch and high in durability. Because of these unique features silk is known as the “Queen of Textiles” the world over. On the other hand, it stands for livelihood opportunity for millions, owing to its high employment potential, low capital requirement and remunerative nature of its production. The very nature of this industry with its rural based on-farm and off-farm activities and enormous employment generation potential has attracted the attention of the planners and policy makers to recognize the industry among one of the most appropriate avenues for socio-economic development of a largely agrarian economy of India. Silk has been intermingled with the life and culture

of the Indians. India has a rich and complex history in silk production and its silk trade which dates back to 15th century. Sericulture industry provides employment to approximately 8.25 million persons in rural and semi-urban areas in India. Of these, a sizeable number of workers belong to the economically weaker sections of society, including women. India’s traditional and culture bound domestic market and an amazing diversity of silk garments that reflect geographic specificity has helped the country to achieve a leading position in silk industry. India has the unique distinction of being the only country producing all the five known commercial silks, namely, Mulberry, Tropical Tasar, Oak Tasar, Eri and Muga, of which Muga which is produced only in India with its golden yellow glitter is a prerogative of India.

**Table 1:** Total quantity of seed production period (2012-13 to 2016-17) (Unit: Lakh dfls)

Particulars	2012-13	2013-14	2014-15		2015-16		2016-17	
	Achmnt	Achmnt	Target	Achmnt	Target	Achmnt	Target	Achmnt
Mulberry	308.48	338.57	350.00	370.16	375.00	410.50	390.00	430.10
Tasar	39.74	38.44	44.11	42.46	47.14	51.62	47.43	48.60
Muga	4.87	5.00	6.07	6.11	7.26	7.45	8.13	6.87
Eri	4.21	3.61	4.10	5.69	4.52	5.75	5.5	4.78
Total	357.30	385.62	404.26	424.42	433.92	475.32	451.06	490.35

The CSB has a chain of Basic Seed Farms supplying basic seeds to the States. Its commercial seed production centers augment efforts of the States in supplying commercial silkworm seed to farmers. India is the Second largest producer of silk in the World. Among the four varieties of silk

produced in 2016-17(P), Mulberry accounts for 70.1% (21,203MT), Tasar 10.8% (3,259 MT), Eri 18.6% (5,629 MT) and Muga 0.56% (171 MT) of the total raw silk production of 30,263 MT.

**Table 2:** Production of Sericulture sector

	XI Plan (2011-12)	XII Plan (2012-17)	XII Plan Achievements					
	Achment.	Target	2012-13	2013-14	2014-15	2015-16	2016-17 (Target)	2016-17 (p)
Mulberry Plantation (Lakh ha.)	1.81	2.40	1.86	2.03	2.20	2.09	2.27	2.21
<b>Raw Silk Production</b>								
Mulberry (Bivoltine)	1,685	5,000	1984	2,559	3,870	4,613	5,260	5,205
Mulberry (Cross Breed)	16,587	18,000	16731	16,917	17,520	15,865	17,400	15,998
Sub Total (Mulberry)	18,272	23,000	18,715	19,476	21,390	20,478	22,660	21,203
<b>Vanya</b>								
Tasar	1,590	4,562	1729	2,619	2,434	2,819	3,285	3,259
Eri	3,072	4,238	3116	4,237	4,726	5,060	5,835	5,629
Muga	126	200	119	148	158	166	220	171
Sub Total (Vanya)	4,788	9,000	4964	7,004	7,318	8,045	9,340	9,060
Grand Total	23,060	32,000	23,679	26,480	28,708	28,523	32,000	30,263

**State-wise Production of mulberry and vanya silk during 2016-17**

During 2016-17(P), the total raw silk production in the country was 30,263 MT, which is an increase of 6.1% over the production achieved during the last year and around 94.6% of the annual targeted production for the year 2016-17. The mulberry silk production was 3.5% more during 2016-17(P) over the last year. The bivoltine raw silk production

achieved a record production of 5,205 MT during 2016-17(P) by registering 12.8% growth over previous year. Similarly, vanya silk, which includes Tasar, Eri and Muga raw silks, has achieved 12.6% growth during 2016-17(P) over 2015-16. The area under mulberry during 2016-17(P) is up by 6.0 %.

The State-wise production of Raw silk of mulberry and vanya silk during 2012-13, 2013-14, 2014-15, 2015-16 & 2016-17 (P) are given as:

**Table 3:** State wise production of mulberry and vanya silk during 2012-13 to 2016-17

#	State	2012-13 Achmnt.	2013-14 Achmnt.	2014-15		2015-16		2016-17 (P)	
				Target	Achmnt.	Target	Achmnt.	Target	Achmnt.
1	Karnataka	8219	8574	8850	9645	10000	9823	11000	9571
2	Andhra Pradesh	6550	6912	6458	6485	5700	5086	5505	5974
3	Telangana			87	101	150	116	150	119
3	Tamil Nadu	1185	1120	1739	1602	1920	1898	2000	1914
4	Kerala	6	4	6	7	9	11	10	9
5	Maharashtra	97	122	378	221	250	274	285	259
6	Uttar Pradesh	157	188	152	236	257	256	280	265
7	Madhya Pradesh	190	195	222	248	215	257	275	97
8	Chhattisgarh	391	391	301	234	253	263	290	360
9	West Bengal	2070	2079	2417	2500	2567	2391	2706	2565
10	Bihar	22	52	74	53	65	67	84	76
11	Jharkhand	1090	2003	2197	1946	2210	2284	2624	2631
12	Odisha	104	53	111	98	120	117	130	125
13	Jammu & Kashmir	145	136	217	138	135	127	170	145
14	Himachal Pradesh	23	25	40	30	30	32	40	32
15	Uttarakhand	17	22	37	29	30	30	38	31
16	Haryana	0.13	0.13	2	0.3	1	0.6	2	1
17	Punjab	5	4	14	4	1	0.8	5	2
18	Assam & Bodoland	2068	2766	2939	3222	3810	3325	4103	3811
19	Ar. Pradesh	22	15	38	12	40	37	48	45
20	Manipur	418	487	737	516	560	519	503	529
22	Meghalaya	517	644	776	656	835	857	900	927
23	Mizoram	40	44	54	50	65	64	82	76
24	Nagaland	324	606	599	619	715	631	690	678
25	Sikkim	3	0.20	13	8	7	6	16	10
26	Tripura	15	40	43	48	56	52	65	12
<b>Total</b>		<b>23,679</b>	<b>26,480</b>	<b>28,500</b>	<b>28,708</b>	<b>30,000</b>	<b>28,523</b>	<b>32,000</b>	<b>30,263</b>

**Sericulture Development in North-Eastern states**

North East has the unique distinction of being the only region producing four varieties of silk viz., Mulberry, Oke Tasar,

Muga and Eri. Overall NE region contributes 20% of India's total silk production.

**Table 4:** Production of all varieties of raw silk during the year 2016-17 in North Eastern States

Production of diff. varieties of Silks in N.E.Region (in MTs)	
Mulberry	333
Tasar	5
Eri	5,578
Muga	171
Total	6,087

### North East Region Textile Promotion Scheme (NERTPS) for Sericulture support in North East Region

Under NERTPS, 2 sericulture projects have been approved viz., Integrated Sericulture Development Project (ISDP) and Intensive Bivoltine Sericulture Development Project (IBSDP) covering Mulberry, Eri and Muga sectors in all NE States. The projects aim at holistic development of sericulture in all its spheres from plantation development to production of fabrics with value addition at every stage of production chain. These projects have been approved at a total cost of Rs.819.19 crore with GoI share of Rs.690.01 crore for implementation from 2014-15 to 2018-19. The projects are expected to contribute additional production of 2,285 MT raw silk during the project period and 1,100 MT silk per annum after project period involving 33,550 families, which will generate employment to 1,67,700 persons.

### Salient features of Non-mulberry silkworms

- **Tasar Silk** These are reared in the tropical and temperate zones. Four species of the genus *Antheraea* (Hubner) are used for commercial production. They are as follows:

**Tropical tasar silkworm:** *A. Mylitta*, D (India)

**Oak Tasar:** *A. Proyli*, J. (India)

*A. Pernyi*, G.M. (China, USSR)

*A. Yamamai*, (G.M. Japan)

The word "tasar" was derived from Sanskrit literature, and tasar silk was mentioned in 1590 B.C. There are various genera of family saturniidae, to which tasar silkworm belongs, like, *Antheraea pernyi* Guerin-Meneville (China, Japan and former U.S.S.R.), *Antheraea yamamai* Guerin-Meneville (Japan), *Antheraea proylei* Jolly (Indian temperate tasar variety) and *A. mylitta* (Indian tropical variety). India is the only country in the world where all four types of commercial silk are produced. This is due to diverse agro-climatic condition of India. Under non-mulberry though tasar, eri and muga varieties of silk are covered but the major production of non-mulberry silk is of tasar next to eri silk. Tasar silkworm belongs to the genus *Antheraea*.

For the development of wild silk industry, host food plants play a crucial role. There is practically no systematic plantation of food plants for rearing non-mulberry silkworms in India. Therefore, the rearing of tasar silkworm depends

upon the availability of wild food plants available in the forest.

Recently, Central Silk Board (CSB) has introduced the concept of systematic plantation of food plants for all nonmulberry silkworms to improve the productivity of vanya silk in India (Shetty and Samson, 1998) [60]. According to Sathe and Jadhav (2001) tasar silkworm rearing is practiced mainly in the Central and Southern Plateau region in the humid and dense forest area covering Bihar, Madhya Pradesh, Orissa and West Bengal, extending to the fringes of Uttar Pradesh, Andhra Pradesh and Maharashtra. It is estimated that in India, there is 11.168 million hectare of forest having different primary and secondary food plants for wild silkworms, which are being utilized for tasar silkworm rearing.

However, deep interior forests remained unexploited. In India, about 1.40 lakh tribal families have been engaged in tasar silkworm rearing and get benefited socio-economically. It is an excellent example of healthy biological interaction between primary producer (plant) and consumer (silkworm). It forms an integral part of the ideal ecosystem and probably both of them will not survive without each other. In general, tasar silk was found to display lower strength than that of mulberry silk. A drop in strength of mulberry silk fabric following exposure to sunlight was noticed. Among these wild host, arjun tree (*T. arjuna*) is very important plant species grown under agro-forestry plantation system. Present literature suggested that this plant serve as a suitable host for *A. mylitta* at various locations in India.

### • Tropical Tasar (*A. mylitta*)

These are in dense, humid tropical forest of central and southern parts of India. The major cocoon-producing districts are Singhbhum and Santhal Pargana in Bihar, Raigarh and Jagdalpur in Madhya Pradesh; Mayurbhanj and Keonjhar in Orissa; Purulia and Bankura in West Bengal; Bhandra in Maharashtra; Adilabad, Warangal, Karimnagar, Khammam, Mahaboobnagar, Visakapatnam of Andhra Pradesh; Belgaum in Karnataka.

Tasar silkworm is polyphagous. The primary food plants are eight types. Besides more than two dozens of secondary food plants.

1. *Terminalia tomentosa*, W & A
2. *T. arjuna*, W&A
3. *Shorea robusta*, Roxb
4. *Lagerstroemia parviflora*, Roxb.
5. *L. Speciosa*, Pers.
6. *L. indica*, Linn.
7. *Zizyphus mauritiana*, Lam.
8. *Hardwickia binata* Roxb.

**Table 5:** State wise tropical tasar raw silk production (MT)

State	Andhra Pradesh	Bihar	Chhattisgarh	Jharkhand	Madhya Pradesh	Maharashtra	Orissa	Uttar Pradesh	West Bengal	Total
2007-08	7.00	1180	146.00	143.00	30.00	4.00	47.68	4.00	29.00	424.48
2008-09	13.00	16.00	147.00	296.00	30.14	4.28	57.00	4.15	31.23	599.00
2009-10	10.00	27.00	161.00	403.70	74.00	8.00	71.00	6.00	37.00	797.70
2010-11	4.00	30.00	168.00	766.00	58.00	9.00	78.00	9.00	41.00	1163.00
2011-12	133	29.37	293.78	1025.24	79.20	1235	89.70	10.80	43.96	1585.32
2012-13	0.64	7.30	384.87	1088.35	83.00	9.75	95.00	12.30	43.76	1724.97
2013-14	0.46	32.00	384.30	2000.00	86.00	10.20	45.10	13.70	42.20	2614.00
2014-15	0.26	33.00	225.40	1943.30	59.00	19.00	88.30	18.00	43.10	2429.00
2015-16	-	41.00	254.00	2281.00	56.00	21.00	107.00	20.00	34.00	2819.00

Source: Central silk board, banglore

### • Oak Tasar

This is a hybrid worm. The oak tract extending from Jammu and Kashmir in the West to Manipur in the east, embracing Himachal Pradesh, Uttar Pradesh, West Bengal, Sikkim, Assam, Arunachal Pradesh, Meghalaya, Mizoram and Nagaland inhabits the temperate tasar silkworm. The food plant is oak plant. There are four species in temperate tasar.

1. *A. proylei*, Jolly
2. *A. roylei*, Moore

3. *A. pernyi*, Guerin-Meneville
4. *A. yamamai*, Guerin-Meneville

### The primary food plants are

1. *Quercusincana*
2. *Q. Serrata*
3. *Q. delabata*
4. *Q. Himalayana*
5. *Q. Semiserrata*

**Table 6:** State wise oak tasar raw silk production (MT)

State	Arunachal Pradesh	Manipur	Mizoram	Nagaland	Jammu and Kashmir	Uttarakhand	Total
2007-08	0.03	3.00	0.02	0.16	-	0.50	3.71
2008-09	0.10	3.00	0.10	0.50	0.01	0.50	4.21
2009-10	0.10	3.50	0.20	0.50	0.50	0.50	5.30
2010-11	0.10	2.00	0.40	0.30	0.10	0.10	3.00
2011-12	0.34	2.45	0.93	0.06	-	-	3.78
2012-13	-	2.80	0.72	0.21	-	-	3.73
2013-14	0.20	4.10	0.70	0.29	-	0.06	5.35
2014-15	-	4.17	0.02	0.10	-	0.02	4.31
2015-16	-	4.00	0.01	0.07	-	-	4.08

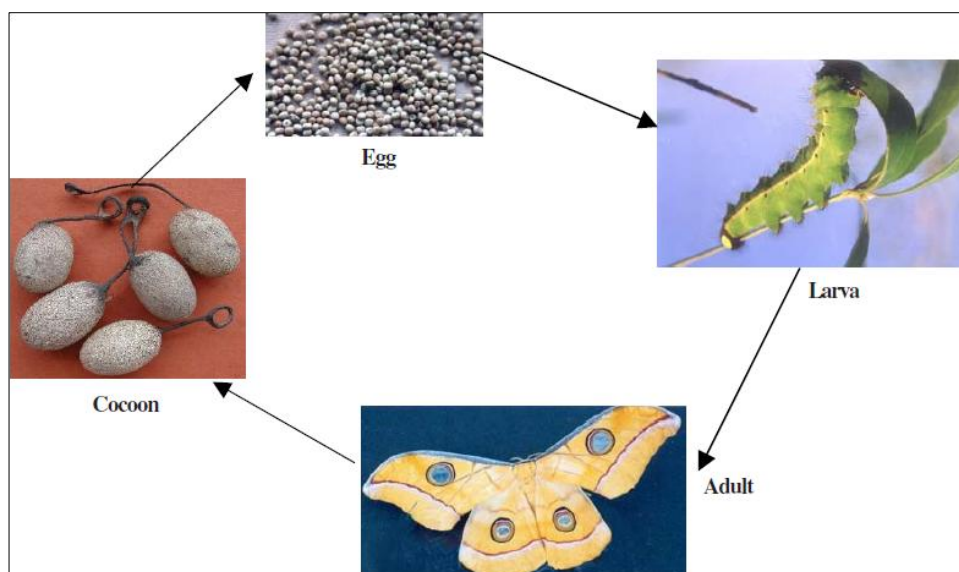
**Source:** Central silk board, banglore

### Life cycle

- **Egg:** The egg is oval in shape, dorso-ventrally flattened and bilaterally symmetrical along the antero-posterior axis. Eggs of tropical tasar measure about 3 mm in length and 2.5 mm in diameter and weighs approximately 10 mg, while, oak tasar, eggs measure about 2.5 x 2 mm and weighs about 7 mg. Freshly laid eggs are dark brown in colour. After washing, it becomes white, light yellow or creamy. The eggs hatch in around 12 days from the day of hatching.
- **Larva:** The newly hatched larva is dull brownish yellow with black head, measuring about 7mm long and 1 mm diameter and weighs about 8 mg. The larva at maturity measures about 13 cm long and 2.1 cm diameter and weighs about 50 gm. Various types of tubercles are present on the body. There are several hairs and setae, which are white, minute and irregularly distributed over the body. Shining spots are also present at the base of dorsal tubercles. The tasar silkworms moult four times and pass through five instars. The larval period varies

between 30 and 70 days during different seasons in different races. The fully grown larva spins a cocoon taking support of one or two leaves and forming a hammock and a peduncle to firmly cling to the plant. The process takes place in 4-6 days and the shell is very hard.

- **Pupa:** The pupa is the resting stage in the tasar insects. Pupal period varies greatly lasting from days to months depending upon the voltinism.
- **Moth:** Females are bigger (4.5 cm) with a broad abdomen and narrow bipectinate antennae of 1.5 cm long. Males are smaller (4.0 cm) with a narrow abdomen and broad antennae. The females are gray or yellow, whereas, males are brown or yellow or gray. Mouthparts are reduced, as moths do not feed. In male, the wingspan is about 16 cm, while, in female, it is about 18 cm. Post-median lines (PM) is red with a white line on the border. The ocellus with a transparent area is prominently positioned at the centre of the wing. Each female moth lays around 200 eggs which continue their generation.

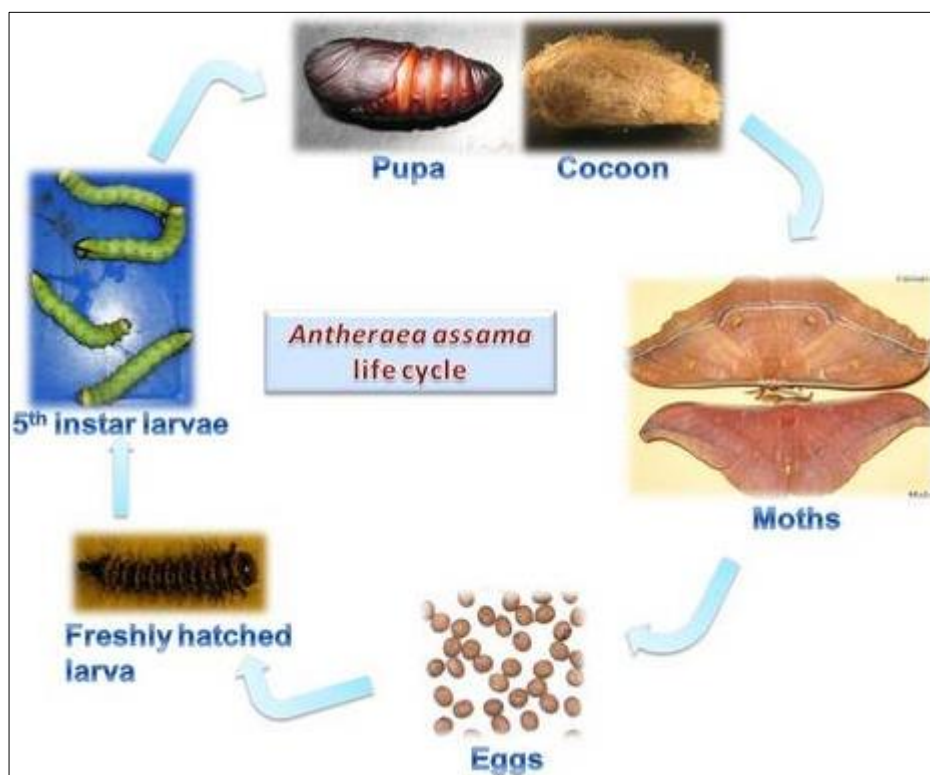


### • Muga Silkworm

The golden yellow silk is secreted by multivoltine silkworm *A. assamensis*, distributed in Assam. The popular items made from this silk are 'dhoti', 'chaddar', 'chapkan', 'pugree' and 'mekhala'. Assam accounts for more than 95% of the muga silk production. The culture is also spread in different districts neighbouring Assam in Meghalaya, Nagaland, Manipur, Mizoram, Arunachal Pradesh and West Bengal. This silk is very much admired for its durability, lustre and creamy white shade. The muga silk worm is multivoltine and passes through four moults and five instar stages. Generally 4-5 crops are raised in a year.

Like other Lepidopterans, muga silkworm is a holometabolous insect passing through a complete metamorphosis from egg (Koni) to adult (Chakari) stage through two intermediate stages of larva (Polu) and Pupa (Leta). The entire life cycle lasts for about 50 days in summer and 120 days in winter. The wings and body of the male moth are copper brown to dark brown, while those of female, yellowish to brown. Both pair of wings bears eye spots. Besides colouration, the male moth can be distinguished from the female by its slightly smaller size, slender abdomen, bushy antennae and sharply curved forewing tips. It is a semi-domesticated species in the sense that only the larval stage is spent in open, and the ripening worms are brought indoors for spinning the cocoons.

### Life Cycle



### • ERI Silkworm

The white or brick – red eri silk (endi, errandi) is produced by *Samiacynthiaricini*, - a domesticated multivoltine silkworm. It is widespread in Assam and also practiced in Bihar, Meghalaya, Nagaland, Mizoram, West Bengal, Manipur, Orissa and Tripura. Among the non-mulberry varieties, eri has the disadvantage of higher production costs because it is made from domesticated silkworms. Among the non-mulberry silkworm species, only eri silkworm is completely

Their life cycle is similar to that of mulberry silk insect and completes in about 50 days in summer and 120 days in winter. Like the mulberry silk insect, the muga silk insect also has four stages in the life cycle - egg, larva, pupa and adult.

- **Egg:** Each female moth lays around 150 eggs. The egg is oval in shape, dorsoventrally flattened, bilaterally symmetrical and creamy to brownish grey in colour and measures 2.3-2.8 mm × 2.4 mm. They hatch in about 7 days in summer and 16 days in winter.
- **Larva:** The newly hatched larva is black in colour with distinct yellow lines at the inter-segmental region. The body tubercles are yellow and are provided with setae. The head is small but distinct and black in colour. They measure 0.6-1.3 cm in length. They actively feed on the leaves of their food plants and pass through four moults like the mulberry silkworm and reach a size of 4.0 - 5.5 cm in length and weighs approximately 4.10 - 5.15 gm. The dorsal surface of the body is light green while the ventral surface is deeper in colour.
- **Pupa:** The fully grown larva spins a cocoon around it and then transforms into a pupa. Spinning of cocoon takes 3 to 7 days in different seasons. The pupal stage lasts for 14 days in summer and 40 days in winter. The population in the hills undergoes diapause at the pupal stage to overcome the winter.
- **Adult:** Moths emerge from the cocoon, mate and lay eggs and continue their generation. Like the mulberry silk moths, they do not have mouth parts and die in about a week.

domesticated and reared indoor. It is a multivoltine insect completing six to seven generations in a year. The word 'Eri' is derived from the Sanskrit term "Eranda" which refers to the castor plant and also known as Ahimsa Silk. Eri culture is an age-old tradition and culture of weaker sections of the society particularly in NE India. Eri silkworms require comparatively minimum care as they are easy to handle. India produces 3,116 MT of eri silk during 2012-2013. North-eastern region

of India is a homeland of about a dozen of sericigenous insects (Chowdhury, 1982).

Eri silk is widely used for preparing warm clothing like 'Erichadar', quilts and scarves, but other products like kurtas, maxis, dokhans etc. are also available. Eri fabrics warm and more durable than mulberry silk. It is also resistant to perspiration, dust etc. Further, the texture improves by use and wash and the colour also become brighter. Ericulture is believed to have originated in the North-eastern India especially Assam. North – eastern region of India produces more than 90 per cent of eri silk. Assam produces more than 50 per cent of eri silk of the world. Though castor is the main host plant of eri silkworm, but it is mainly annual in nature and has to be grown a fresh every six months. Castor leaf is not available throughout the year.

### Life Cycle

The life cycle of Eri silkworm has four stages - egg, larva, pupa (Cocoon) and adult (moth). A complete life cycle lasts about 44 days in summer and 85 days in winter.

- **Egg:** The eggs are ovoid in shape, candid white in colour, measures 1.5 x 1.0 mm and weighs 6 mg. By the time

they hatch, they become ash to blackish colour. They hatch in 9-10 days in summer and 14 - 15 days in winter.

- **Larva:** The new born larva is greenish yellow in colour measuring about 5 x 1 mm. The fully grown larva measures about 7.0 x 1.5 cm. and weighs 8 g, translucent and covered with a white powdery substance. Different strains have different colours and body marking pattern. The larval span varies from 20 days in summer to 50 days in winter.
- **Pupa:** Fully mature larva spins a cocoon around it and then transforms into a pupa. Spinning takes around two days and pupation takes another two days. The cocoons are long, soft and without a peduncle. One end is narrow and open. Pupation usually takes around 10-20 days depending on the temperature.
- **Adult:** The adult moth emerges from the cocoon in about 10 days from the day of spinning. After mating, each moth lays around 400 eggs which depend on the feed and the season. The total life cycle lasts about 45 days in summer and 90 days in winter.



### Vanya Silk Conservation and Rural Livelihood

The total forest cover of India as per State of Forest Report 2003 is 678,333 km<sup>2</sup>, which constitutes 20.64 % of the geographic area of the country, plays a significant role in biodiversity protection, global environment conservation, landside prevention and soil preservation, headwater conservation, health, recreational and cultural, material production (silk, timber, food such as mushroom etc, fertilizers, feeds, raw material for pharmaceutical and other industrial products, extracted ingredients, greening materials etc.). These huge forest bio-resources may effectively be utilized for conservation and economic exploration of sericigenous insects available in the country for sustainable rural livelihood and poverty alleviation which is the major issue of developing country including India. It is evident that productivity improvement in mulberry sericulture sector is

stagnant in spite of technological intervention in silkworm improvement as well as host plant management. However, growth rate of vanya silk is quite encouraging due to effective utilization of forest cover, improvement of rearing techniques, effective technological support in post-cocoon sectors. The North Eastern states, Jharkhand and Chattisgarh states of India are primarily dominated by tribal populations. The vanya silks are practiced mostly by these tribal and socio economically disadvantaged sections of the society. Women constitute over 60 % of those employed in downstream activities of sericulture in the country. So, it is a predominantly a women-friendly activity, from rearing to marketing are carried out mostly by women. Even silk reeling and spinning (in case of eri silk activities including weaving is largely supported by them. Every 3.07 kg of silk produced and used in handlooms generates gainful employment of one

man year. This potential is par-excellence and no other industry generates this kind of employment, especially in rural areas, hence, sericulture is used as a tool for rural reconstruction. Further, 57 % of the gross value of silk fabrics flows back to the cocoon growers with share of income to different groups (56.8 % to cocoon grower, 6.8% to the reeler, 9.1% to the twister, 10.7% to the weaver and 16.6% to the traders). Thus, large chunk of income goes back to the villages from the cities. Features such as low gestation (20-45 days), high returns make sericulture an ideal programme for weaker sections of the society. Finally, as a perennial crop with good foliage and root-spread, host plants contribute to soil conservation and provide green cover. Waste from silkworm rearing can be recycled as organic manure to garden. Dried twigs and branches are used as fuel in place of firewood and therefore reduce the pressure on vegetation/forest. Further, being a labour intensive and predominantly agro-based activity, it is considered as eco-friendly activity to address the ill-effect of climate changes.

### Initiatives from Govt. of India

Central Silk Board, Government of India has branded the vanya silk and symbol is registered as trademark. It depicts a very unique concept of Indian-ness personified by the calligraphic Devanagari letter 'Va' crafted with bold brush strokes inside a cocoon. These symbolize multiple strands of silk. The term "Vanya" is of Sanskrit origin, meaning untamed, wild, or forest based Vanya!—the wild silks of India. The Government of India established the Central Muga and Eri Research & Training Institute, Jorhat under administrative control of Central Silk Board is the only institute for providing research and developmental support for the growth of Muga and Eri industry in the country. Similar institute for Tasar silk has been establishment at Ranchi, Jharkhand state. The deep strides on R&D aspects have been made in respect of vanya silk conservation and their exploration for socio-economic development of rural masses in the country. To achieve this goal, one exclusive Germplasm Conservation Centre has been developed at Jorhat (India). Further, the centrally sponsored scheme known as Catalytic Development programme (CDP) initiated from IX plan period (1997-2002) onwards to ensure coordinated effort to support sericulture at all stages of value addition, promote new technologies and package of practices, support to efforts of NGOs, Cooperative Societies, Forest Management Committees, Self Help Groups etc. facilitating linkages amongst stakeholders and strengthening the supply-chain for silk production, improve productivity and reduce input costs, focused largely on supporting stakeholders ranging from food plant to marketing products, creating employment opportunities in rural areas and market orientation to Vanya silks besides public-private partnership in areas of production chain. The Government of India under Forest (Conservation) Act, 1980 has issued notification in respect of vanya silk cultivation. Under this Act, The State/UT Forest Department should encourage silk cultivation in forests areas by tribals and non-tribals who live in and around the forests and are dependent on such forests for their livelihood. However, priority should be given to the tribals and to those enjoy traditional rights on such forests. The State/UT Forests Departments should permit such activities in already identified naturally grown forest areas for silk cultivation and the plantation raised for the purpose

thereof in coordination with the State/UT Sericulture Department and Central Silk Board. Cultivation of trees on which vanya silks or silk worms of Tasar, Oak Tasar, Muga and Eri could be reared by tribals and non-tribals living in and around the forest areas for their livelihood without undertaking monoculture plantations should be traded as forestry activity. Therefore, no prior permission of the Central Government under Forests (Conservation) Act, 1980 is required.



Research and Development (Highlights on Research Programmes)

### Vanya Host Plant

- Identified an alternative food plant *Lagerstroemia speciosa* for Tasar silkworm rearing, which is easy rooter and fast growing. Trials are on to validate the rearing performance.
- Integrated Nutrient Management (INM) package developed for castor cultivation and it is under field testing.
- *Ailanthus grandis* (Borpat) has been established as the best perennial host plant for Eri silkworm rearing and recommended for field utilization.
- Package of practices is recommended for the efficient utilization of Sal flora in Jharkhand and also to improve the Laria productivity on Sal.
- Biochemical analysis proved similarity in the leaf biochemical of both Castor and *Ailanthus grandis*.
- Two Som accessions (S3 & S6) resistant to leaf spot disease, leaf blight and rust are being popularized in the field.

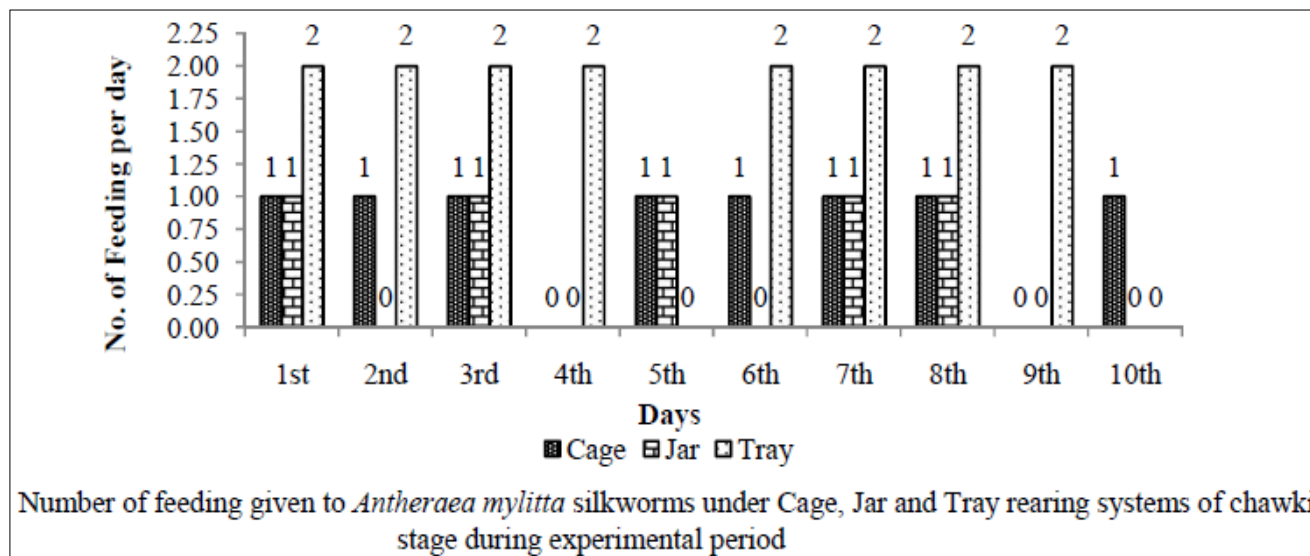
### Vanya Silkworm

- Tasar Daba bivoltine silkworm 'BDR-10' is under popularization and "CTR-14" is under field testing.
- Eri silkworm breed 'C2' is under popularization.
- Two superior Muga silkworm lines CMR-1 and CMR-2 are under field testing
- Muga silkworm eggs preservation schedules developed to facilitate uniform hatching is under field testing.
- The in-situ conservation for Muga and other wild silk moth's species is being done under North East Region Textile Promotion Scheme (NERTPS) programme in four states viz., Assam, Meghalaya and Arunachal Pradesh.
- Developed an organic module against pest and diseases of muga silkworm.
- Viral & bacterial pathogens associated with flacherie disease in *Antheraea mylitta* D. were isolated & identified.
- A new chemical disinfectant has been formulated for controlling bacterial flacherie disease in muga ecosystem and testing of the same under laboratory condition is under progress.

The silkworm breeds/hybrids authorized recently for commercial exploitation by the Hybrid Authorization Committee (HAC) are being popularized in the field. Important among them are:

**Table 7:** New breeds/varieties approved for popularization

New breeds/ varieties	Region
Mulberry Sector	
CSR50 x CSR51	For south zone
(CSR52 x CSR50) X (CSR51 x CSR53)	
N x (SK6 x SK7)	
M6DP (C) x SK4	For Eastern Zone
Vanya Sector	
BDR-10 (Tasar)	All regions suitable for tasar culture
C2 (ERI)	All regions suitable for eri culture

**Table 8:** Study on performance of tasar silkworm, *A. mylitta* Drury under different chawki methods

From the above results it could be concluded that tasar silkworm grown under different rearing methods for chawki silkworm stage is influencing on feeding habits and morphological growth of silkworm larva. Tasar silkworm larva grown under Jar method had performed better in respect to food habits and larval growth and development followed by cage rearing method. However, when considering in large scale rearing of chawki silkworm Jar method is question. So, this jar method can be adopted in small scale particularly,

experimental purpose. In this large scale situation, cage rearing method for chawki larva can be recommended to farmers who practicing in extensively. Therefore, the cage rearing method of chawki tasar silkworm could be economically feasible, locally available and technically viable.

Cocoon weight, pupal weight, shell weight, shell ratio, cocoon size of *A. assamensis* reared in indoor and outdoor conditions during jarua(winter season).

**Table 9:** Effects of cocoon parameters reared on primary host plants of muga silkworm, *A. assamensis* W under indoor condition.

Treatments	Cocoon weight (g)	Pupal weight (g)	Shell weight (g)	Shell ratio (%)	Cocoon size	
					Length (cm)	Breadth (cm)
T <sub>1</sub>	3.19	2.92	0.23	7.46	3.67	1.73
T <sub>2</sub>	3.15	2.85	0.22	7.51	3.68	1.76
T <sub>3</sub>	3.17	2.93	0.23	7.38	3.74	1.72
T <sub>4</sub>	3.12	2.84	0.22	7.63	3.72	1.70
T <sub>5</sub>	4.12	3.83	0.33	8.07	4.06	1.96
T <sub>6</sub>	4.32	3.98	0.35	8.17	4.12	2.05
S.Ed.±	0.07	0.07	0.01	0.06	0.023	0.028
CD (5%)	0.15	0.15	0.02	0.13	0.051	0.061
CD (1%)	0.21	0.21	0.03	0.18	0.071	0.086

From the findings, it was observed that the treatments of indoor (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>) differ significantly from the outdoor rearing (T<sub>5</sub>&T<sub>6</sub>). No significant difference was found in the treatments of indoor rearing. Cocoon weight, pupal weight, shell weight, shell ratio, cocoon size were higher in T<sub>6</sub>. On the

other hand, in the indoor rearing, the cocoon and shell wt. was higher in T<sub>1</sub> whereas, pupal wt. was found highest in T<sub>3</sub>. It might be concluded that indoor rearing could be done to a very limited extent but would be very difficult for mass scale rearing.

**Table 10:** Host Plants Relationship in terms of Cocoon Colour and Compactness of Eri Silkworm (*Samia ricini*) Effect of host plants on cocoon colour of Eri silkworm.

Host plants	Colour (% of respondents)			
	White (A)	Bright white (B)	Creamy white (C)	Dull white (D)
Castor	30	15	47	8
Tapioca	40	10	50	-
Kesseru	90	15	60	5

The colour is a racial character and it is due to the presence of pigments in the sericin layer of the bave. The present investigation revealed that colour was significantly influenced by different food plants. Majority of respondents rated the tapioca fed cocoon as white followed by castor and Kesseru.

Similarly tapioca and Kesseru fed cocoons were rated as creamy white followed by castor. Saikia (2008) <sup>[64]</sup> also observed highest white coloured cocoon on Barkesseru followed by Barpat and castor.

**Table 11:** Effect of host plants on cocoon compactness of eri silkworm.

Host plants	Colour (% of respondents)			
	White (A)	Moderate (B)	Soft (C)	Very soft (D)
Castor	10	85	15	-
Tapioca	20	60	20	-
Kesseru	40	45	35	-

It was revealed that host plants had significant effect on the compactness of cocoons. The cocoon spun by the eri silkworm fed on castor leaves were rated as more moderate followed by tapioca and Kesseru. Cocoons obtained from the eri silkworm fed on Kesseru leaves were rated as more hard followed by tapioca and castor. Result of this investigation supported by Saikia (2008) <sup>[64]</sup> observed highest moderate cocoons on Barkesseru followed by castor and Barpat.

## Conclusion

Non-mulberry sericulture is a forest-based industry uniquely suited to the economy and social structure of developing countries because of its minimum investment requirement, high employment, and foreign exchange earning potential. Non-mulberry production offers rural population an attractive source of income, arrests their migration to urban areas, thereby preserving their traditional skill and way of life.

Vanya silk culture is neither detrimental to the food plants available in forests, nor disturbing the forest ecology. When Vanya silkworms are reared on the food plants, they feed on the leaves and the litters spread in and around the plant, resulting in effective nutrient recycling. In recent times, Vanya silks have assumed more importance in view of the scope for the transformation of this age- old tradition into industry with immense potential.

The country has rich natural resources and manpower and the challenge is to utilize these to bring about a balanced development without much disturbance to the forest ecology, traditional culture and the way of the way of life of the primary producers. Vanya Silk production (Tasar, Muga and Eri – exclusive silk of India) has reached to 8,045 MTs compared to 7,318 MTs during 2014-15 showing an increase of about 10% over the previous year. During the current year 2016-17 silk production in the country is 9060 MTs increase of 13 % from previous year.

However, continuous deforestation resulted in depletion of non-mulberry food plants. One should not forget that non-mulberry sericulture holds great promise for the world forestry as a supplementary activity.

The importance of these lesser known silk producing insects and their host plants should be studies and explored for betterment of mankind. In the recent times, Japan, China, Thailand and Korea have embarked on production of various other products from silkworm and their host plants, which

makes sericulture more profitable and highly sustainable. It is now essential for India to develop allied industries related to sericulture and make total use of the food plants and silkworm for different products, particularly pharmaceutical products. Being forest based, the wild silkworms contribute to the development of sustainable natural environment, which is very much required these days, since ozone layer is very much in threat due to rapid industrialization and other man made hazards. Further, a collaboration approach should be followed by the national agencies and regional bodies/ state government for policy, planning, Research & Development for vanya silk and forestry to cover biodiversity in a general and seri-biodiversity in particular with an objective of poverty alleviation and sustainable socio-economic development.

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