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HOST PLANT MANAGEMENT STRATEGIES FOR QUALITY TASAR SEED COCOON PRODUCTION

M.S. Rathore*, Vishaka G.V., Chandrashekharaiah M, Hasansab Nadaf, Chowdary N.B and Sathyanarayana K.
Basic Tasar Silkworm Seed Organization (BTSSO), Central Silk Board
(Ministry of Textiles, Govt. of India), 1st Floor, Pendari, Post office-Bharni,
Via-Ganiyari, Bilaspur-495 112 (C.G.), India
*Corresponding Author; e-mail: mahendersr.csb@gov.in ; mahendersr@gmail.com

ABSTRACT

The tropical tasar silkworm, *Antheraea mylitta* Drury (Lepidoptera: Saturniidae) a polyphagous insect, distributed in majority of the agro-ecological conditions in India with varied phenotypic, physiological and behavioral characters. Tropical tasar has special significance owing to its potential in providing self-employment to these marginal farmers. Presently projected tasar raw silk production target is 3840 MT and by 2030 it is anticipated to be 6000 MT, the base of sericulture industry is the seed sector and production of quality dfls which in terns comes from quality cocoons and is vital aspect in tasar silk industry. Majority of silkworm rearing happens in conventional forest patches (natural habitat) where constraints like exposure to predators, parasites, diseases and natural vagaries are prominent. The present average rearing capacity is around 150-200 dfls/ha and the productivity ranges from 30-35 cocoons/dfl with a success rate of 15 to 20%. Quality tasar seed cocoon production depends upon successful management of host plant as the nutritional status of food plant plays a pivotal role on silkworm life cycle and its reproductive potential. The swift progress in technologies adoption like preparation of farmland, high yielding host plant lines, harnessing potential of alternate primary food plant like *Lagerstroemia speciosa*, nursery raising techniques, separate chawki garden and planting procedures (proper spacing), following calendar of activities for maintenance of host plant, protection of host plants from pest and disease through recent interventions, farm mechanization, integrated farming practices, application of organic inputs are required for improvement of quantity and quality of leaf. The adoption of proper management approaches improves the water use efficiency, soil health status, leaf nutrient quality, lower pest load thereby increasing the rearing capacity upto 250 dfls /ha with an average yield of 45 to 50 cocoons/dfls in-turn making the venture more productive and remunerative.

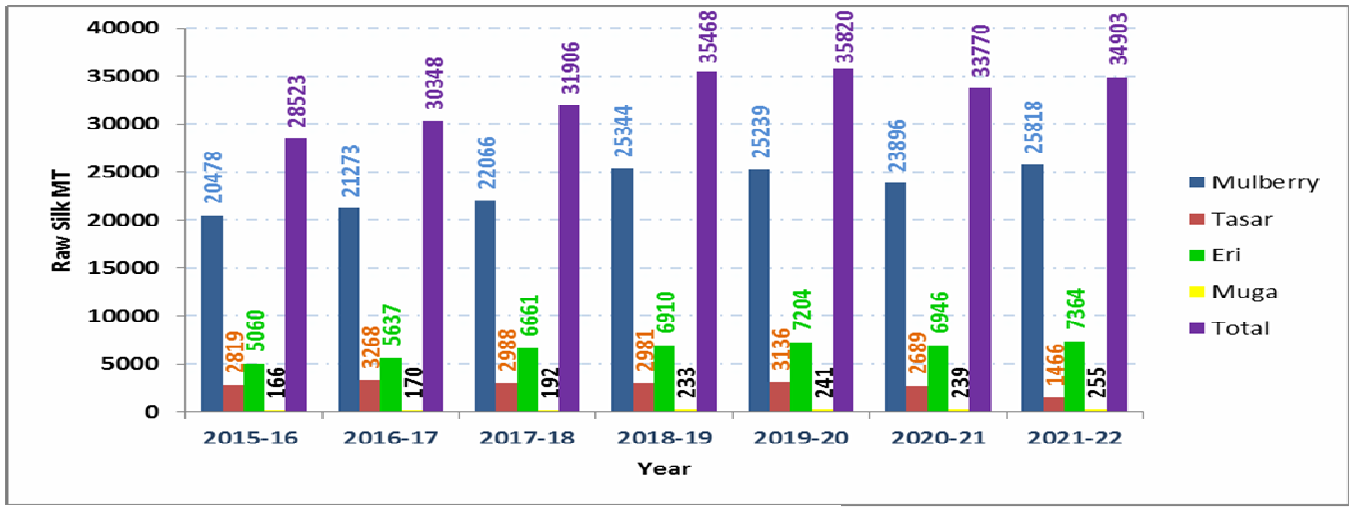
Keywords **:** *Antheraea mylitta*, bivoltine, mechanization, remunerative and soil health.

Introduction

Sericulture in India is an age old custom for sustaining livelihood of marginal peoples. Out of four types of silk found in India, Tasar silk (*Antheraea mylitta*) is the mostly practiced tradition in the tropical states of India. *A. mylitta* was once available throughout the Indian peninsula. *A. mylitta* Drury (Lepidoptera: Saturniidae) is having many ecoraces distributed along central India (12-31°N latitude and 72-96°E longitude) with varied phenotypic, physiological and behavioral characters. This wide gene pool acts as basis for all breeding programme and as a base material for gene prospecting. Tasar silk production is practiced mainly by marginal farmers mostly by tribes which is a forest based agro-industry. It provides a great opportunity for tribal in providing them livelihood (Bawaskar *et al.,* 2022 and Rathore *et al.,* 2019) Tasar silk industry has potential as it provides livelihood opportunities to up to 3.5 lakh rural families of the country directly or indirectly. Out of the country total raw silk production the vanya silk contribute to around 28.87% and tasar silk around 8.38% (Graph 1).

Tropical tasar has special significance owing to its potential in providing self-employment. The activities under tasar seed production includes production of egg, cultivation of host plants, silkworm rearing and cocoon production. The total sericulture industry revolves around the seed sector and production of quality seed is the vital aspect in silk industry (Dimple *et al*., 2018; Rathore *et al*., 2018a). Quality tasar seed production totally depends upon successful management of host plant plantation, grainage and rearing of silkworm crop either Bivoltine or Trivoltine. The industry is facing many constraints like changing climate, shifting land use pattern, shrinking forest covers, lack of adoption of improved package of practices, infrastructure facilities, adequate manpower, augmentation and maintenance of plantations raised under various schemes, absence of seed zones and lack of private participation (Rathore *et al.*, 2018b and Vishaka *et al.*, 2019). Among other factors, disease and pest are the crucial negative factors for the tasar sericulture industry. In this regard management of these harmful pests and predators is also important for increasing and sustaining productivity in the existing system. As indicated the projected raw metric ton

target for the year 2030 is 6000MT. With the present rearing capacity of 150-200 dfls and success rate of 15-20% it would be difficult to achieve the projected target of 24.60 lakhs nucleus dfls with a cocoon dfl ratio of 4:1. In order to make tasar sericulture more sustainable and remunerative the production capacity in the existing system needs to be improved by adopting improved package and practices from soil to silk. In this manuscript the improved strategies for host plant management are discussed.



(Data Source: https://csb.gov.in/wp-content/uploads/2022/07/Raw-Silk-Production.pdf)

Graph 1 : Raw silk production in the country, status of different types of silks.

Strategies for quality cocoon production

1. Soil Health Management

Tasar silkworm (*Antheraea mylitta* D.) is a polyphagous insect which feeds primarily on Arjun (*Terminalia arjuna*), Asan (*T. tomentosa*), Sal (*Shorea robusta*) and secondarily on many other food plants like *Lagerstroemia speciosa* (Gargi *et al.,* 2022 and Das *et al.,* 2020). Soil is the most important factor which needs attention. As majority of stakeholders practice tasar sericulture on the nutrient deficient system, the quality of leaf is severely affected. The farmers are ignorant on the part of role of macro and micronutrients in the soil. As a part of adoption programmes by BSMTCs the adopted farmers get the supply of inputs thereby sustaining the fertility. However in the other systems either the application is not possible or the procurement is not there. In the both the ways the system is under stress, there by leading to decrease in productivity and quality (Doran and Zeiss, 2000).

The first priority is to select optimum site for raising of host plantation, it should not be a rocky, barren or fully sandy soil. If the plantation already exists then we have to get the soil analyzed from any recognized soil testing laboratory. The samples may be collected by following zig-zag manner followed by quartering method. The present day tools of GPS tagging of soil sampling sites may be used accurate sampling each year (Fig. 1A-C). Proper management approaches should be adopted based on the soil analysis report (Sinha *et al*., 2002 and Rathore and Srinivasulu, 2018). Ensure to adopt greener ways of soil health sustenance i.e. using green manuring, vermicomposting and application of biofertilizers which increases the soil organic content (SOC). Likewise the leaf quality can also be analyzed to land on the quality status of nutrients.

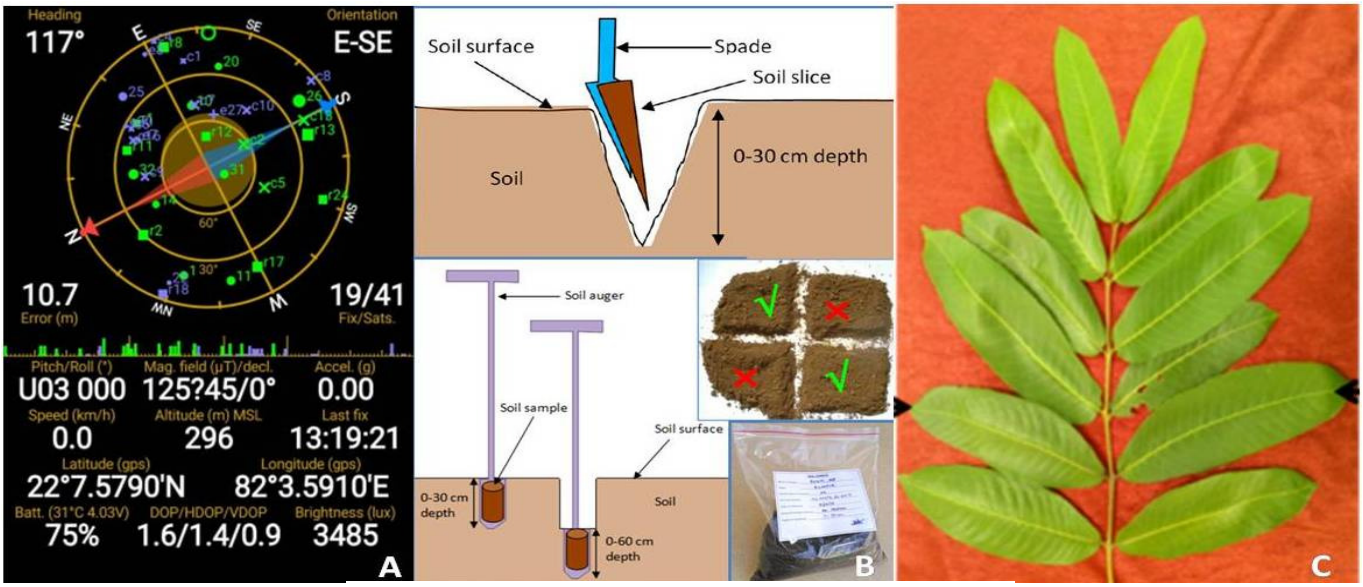


Fig. 1: A) GPS based soil sampling; **B)** Soil sampling method;
C) Plant sample collection for biochemical analysis - 4th to 6th leaf.

Table 1 : The optimum levels of soil and plant nutrients requirement:

Soil Parameters	Optimum Range	Parameters of Leaf	Optimum Range
pH	6.2-7.2	Protein(mg/g) (Dry leaf protein)	18.0-20.0
Av. N (Kg ha^{-1})	250-345	Carbohydrate (mg/g)	85.0-95.0
Av. P (Kg ha^{-1})	15.0-20.0	Ascorbic acid (mg/g)	20.0-25.0
Av. K (Kg ha^{-1})	125.0-200.0	Total Phenol (mg/g)	15.0-19.0
S (Kg ha^{-1})	10.0-15.0	Nitrogen (%)	2.5-3.2
Zn (ppm)	1.8-2.5	Potassium (%)	2.8-3.0
Fe (ppm)	15.0-20.0	Phosphorus (%)	0.15-0.18
Mn(ppm)	5.0-10.0		
Cu (ppm)	0.2-0.5		
OC (%)	0.5-0.9		

2. Raising New Plantation

In case of systematic plantation, flat or slightly sloppy, fertile, porous, loamy, sandy loam, or clay loam area is selected. The soil pH range may be kept between 6.5 to 7.5. Soil correction is also taken up wherever necessary. The nursery raising should be in high and dry land without water logging and should have proper shade. Ripened and mature seeds are collected from the plant before natural shedding during April- May. Soaking of seeds facilitates softening seed coat before sowing. They are soaked in plain water for 96 hours (*Arjun*) and 48 hours (*Asan*). The soaked seeds are removed from gunny bags and heaped under a tree shade and is covered with wet gunny cloth/bags. Sprinkling of water helps in retention of humidity until seed germination, heaping of 1,500 to 2,000 seeds is considered as ideal.

Germination of seedlings starts within a week, the soil used is a mixture of Farm Yard Manure (FYM): Soil: Sand in ratio 3:2:1 and 1:3:1 for *Arjun* and *Asan* respectively. The seedlings thus raised are kept in shade conditions for at least 2.5-3 months under relative humidity above 50% conditions (Fig. 2A-B). Seedlings are transplanted to the plantation site when it attains a height of 1.50 m preferably of minimum one year of age (Fig. 2C). The field where the saplings are to be transferred should be well prepared the basins should be of 1x1x1 foot dimension. After transplanting the sapling may be provided with FYM or vermicompost as per the recommended doses. The transplanting is preferred to be done in monsoon season to increase survivability. Irrigation if available may be done fortnightly for initial one month.

Fig. 2: A) and **B)** Raising of host plant seedlings; **C)** One year old saplings of *T. arjuna* ready for field transfer

3. Host Plant Management

The host plant field is exposed to many biotic and abiotic factors, which needs proper management to get optimum results in term of leaf yield and quality. Following cultural measures are to be followed to optimize the yield potential:

- Tilling of soil during rainy season one time or maximum two times in a year.
- Mulching: materials applied to bare soil or around existing plants (grass clippings, leaves, hay, straw, bark piece, sawdust, woodchips, etc.)
- Bunding: The entire rearing field divided into small blocks with known size to retain the rain water and avoid soil erosion
- Circular basin formation: basin farmed around the tree for efficient use of inputs and preparation of staggered trenches for rain water harvesting
- Pollarding: Cutting of the plants at 5-6 ft height once in 3-4 year using tree cutter during February for 1st crop and April for 2nd crop, depending on the height of trees (Fig. 3A)

- Pruning performed in 2nd -3rd year after pollarding by clipping of thin branches to maintain the plant height of 6-8 ft during March-April
- Spacing for chawki garden: 4'x4' (70 plants for 250 dfls per crop) and for late age rearing plantation with 8'x8' or 10'x6' has to be maintained for ease in mechanization
- Weeding: Removal of weeds either by brush cutter / grass cutter / mechanical ways and maintain rearing field weed free
- Removal of old bark , residues of host plants and incineration of crop residues outside the field to avoid cross contamination
- Neem based pesticide is used for management of bark eater in host plant (Singh *et al.,* 2022)

Maintenance of chawki garden (~70 plants at 4'×4' for rearing 250 dfls) at each rearing field and make it ready for rearing well in advance by pruning the plant during March for first crop and clipping upper branches during July for 2nd crop. Chawki garden must be covered with the nylon net during brushing (Mathur *et al.,* 2022). NPK may be applied as per the recommended dose by CTR&TI, Ranchi.

4. Organic and inorganic inputs

Today all over the world for sustainable agriculture, integrated nutrient management (INM) approaches are being promoted (Rathore and Srinivasulu, 2018). The ratio of organic and inorganic inputs is applied in a scientific manner such that quantum and quality both are achieved (Nadaf *et al.,* 2022). In tasar host plant, application of vermicompost during June @ 2 kg per plant for main plantation and 1 kg per plant for chawki garden is required to be applied. Suitable vermicompost bed type should be constructed nearby so as to cater the total requirement of the plantation available in the unit (Rathore and Srinivasulu, 2018). Application of sunn hemp (*Crotalaria juncea* L.) or dhaincha (*Sesbania aculeata*) @ 50 kg/ha is adovocated as green manure during pre-monsoon period and mulch the green manure crop after 8-10 weeks after sowing (before flowering) and can plough it into the soil with a suitable plough (Nadaf *et al.*, 2022) (Fig. 3B).

Application of biofertilizers nitrogen fixing / phosphate biofertilizer / micro nutrients / rhizobacteria (as per the standard procedure mentioned in the leaflet provided with the product) and innovative ideas like biochar (organic product) and now a days nano-urea application can boost production. Coupled with rainwater harvesting approaches improves soil organic carbon (SOC) and soil moisture content/water holding capacity (Fig.3C). Urea solution spray is also done prior to 15 day of brushing, spay the urea solution @ 1.5 % (15 g / litre of water) to obtain good quality leaves.

5. Plant protection practices

Host plant is vulnerable to attack of many pests and predators which affects the leaf yield and quality (Reddy *et al.,* 2021 and Chandrashekharaiah *et al.*, 2022). Various chemical and mechanical approaches are under use for their control. Application of Neem khali (@150kg/ha) and Acetamiprid 20SP (0.2g/l) or Dimethoate (30 EC) @ 0.09 % may be followed for control of leaf gall (Mittal *et al.,* 2022) and other sucking insects. Spray of Acetamiprid 20 SP thrice at an interval of 15 days is done after fresh leaf sprouting in first half of May month. Leaf surface microbes (LSM) solution is used on host plant to control bacterial disease in silkworm (Roay *et al.,* 2022). The pests of host plant may be managed by following recommended package and practices of CTR&TI, Ranchi.

6. Preparations for nucleus and basic seed rearing

Nucleus seed rearing should be followed mostly in the departmental farms, which is having at least 1.5 km isolation from the other rearing fields in exclusive seed zones. Basic seed crop should be practices in both departmental as well as state farms through Adopted Rearers (ARs). The nucleus and basic seed crop rearing fields must be fixed in each location and maintained as per the standard package of practices. The fields should not be interchanged and no commercial crop rearing should be allowed in these fields (Rathore *et al.,* 2018a). The rearing plot should be disinfected by incineration of the field residues as well as ground and trunk of tree by control firing each year, disinfection through lime and bleaching (9:1) (Fig. 3D). Select dfls for basic crop rearing from the Seed Act certified grainage by following three-tier mother moth examination which are free from the disease (Chandrashekharaiah *et al.*, 2022). The instruments used in handling the seeds are also to be disinfected before use to minimize any chance of contamination.

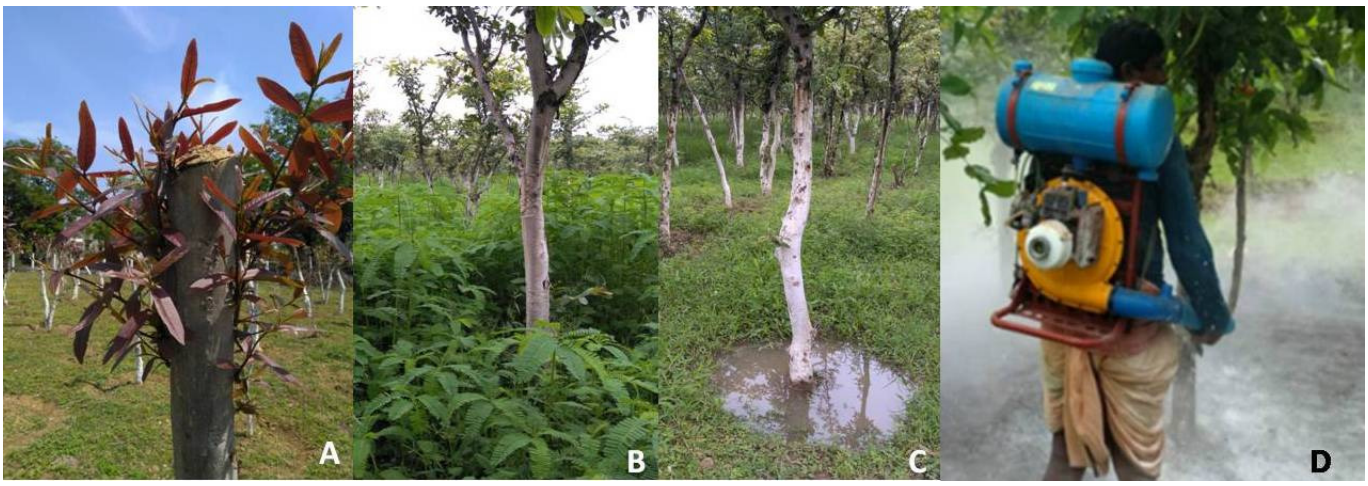


Fig. 3: A) fresh sprouts in pollarded plant; **B)** Green manuring; **C**) Rain water harvesting; **D)** Disinfection in field through mechanization.

Challenges of Climate change

As today we are witnessing the serious implications of climate change in tasar seed sector. The quality and quantity of tasar host plants is directly correlated to its environment, even micro climate change influence the soil micro flora thereby affecting the mobilization of minerals. The nutritional quality of leaf influences the feeding behavior, growth and finally development of silkworm which later affect the cocoon quality and dfl production (Bhatia and Yousuf, 2014 and Ram *et al.*, 2016). Prolonged rearing duration due to low nutritive value of foliage has serious implications like predatory pressure, population segregation and occurrence of pests and diseases (Bora and Saikia, 2022 and Lokesh *et al.,* 2016). The abnormal changes in the environment like scarcity of rains in some part contrary to heavy rains in the other part of country (erratic/unseasonal monsoon) had greatly contributed in increased predators and parasitoids activities like *Xanthopimpla konowi* (yellow fly), *Blepharipa zebina* (uzi fly) and predators like wasps, which mostly attack on silkworm during rearing and reduces the larval population leading to reduced cocoon yield (Rathore *et al.*, 2018c and Chandrashekharaiah *et al.,* 2022). Similarly, nematode parasitoid (family Merminthidae) infestation is also observed due to sporadic changes in environmental conditions.

Conclusion

Since from the beginning, humans have been depended on local biodiversity for livelihood. The degradation and disintegration of forests, which generally precede deforestation, significantly affect the biodiversity. With the exploitation of biodiversity, people threats have increased to face challenges raised by changed land use pattern, climate transformation and sustaining increasing population. The rural and tribal people with marginal income in central India are majorly practicing tasar silkworm, on conventional host plants with old practices. Ignorance or lack of implementation of improved technologies and package of practices followed by non adoption of mechanization has severely hampered the productivity in prolific areas. To achieve the future sustainable sericulture goals, collective efforts of government agencies, producer groups and other stakeholders is urgently required to address the issue and fulfill the industry demands.

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