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Diversity and management of plant species in an Eri silkworm agroforestry system by Mishing tribe of Assam, India

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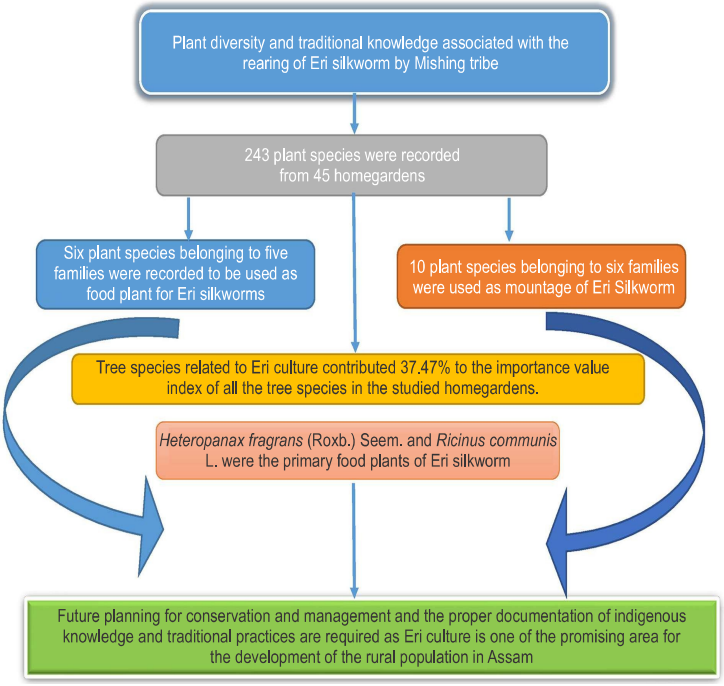
Abstract

Aim : The present study was conducted to investigate the status and diversity of plant species used for rearing of Eri silkworm and their traditional management in the homegardens of Mishing tribe.

Methodology : A total of 45 homegardens from three villages were surveyed randomly which were primarily associated with rearing of Eri silkworm. Vegetation was studied using quadrat method. The data on traditional knowledge associated with the management of plants species for rearing of Eri silkworm were collected using semi structured questionnaires.

Results : The average size of studied homegardens was 0.35 ha. A total of 243 plant species were recorded from the studied homegardens of which six species were used as food plants for rearing of Eri silkworm and 10 species were used in construction of mountage. Trees related to Eri culture contributed to 37.47% of the total importance value index (IVI) in the studied homegardens. *Heteropanax fragrans* (Roxb.) Seem and *Ricinus communis* L. were the primary food plants of Eri silkworm and were found to be dominant in the homegardens. Activities such as land preparation, sowing, pruning, weeding and watering are carried out for the management of Eri silkworm food plant species and were found to vary for different species.



Interpretation : There is an urgent need to document the indigenous knowledge and traditional practices associated with the management of host and food plants used in the rearing of Eri silkworm in the present day context as it is a part of their cultural heritage and should be reoriented through integration of modern farming technique.

Key words: Eri silkworm, Home gardens, Mishing tribe, Plant diversity, Sericigenous insects

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Introduction

Homegardens are an integrated land use approach which consists of deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and livestock within the compounds of individual houses, where the entire unit are being intensively managed by family labour (Fernandes and Nair, 1986). This system has been one of the best recognized traditional practices for livelihood, suitable landuse management and sustainable development (Vibhuti *et al.,* 2018; Bargali *et al.,* 2015; Parihaar *et al.,* 2015). Homegardens are considered as an unique repository of species diversity that helps in conserving plant genetic resource in which indigenous germplasm varieties are maintained and preserved through generations, thereby, providing the much needed goods and services for the future. (Bargali and Vibhuti, 2019; Vibhuti *et al.,* 2018). Homegardens have been found to enhance the livelihood options by providing source of income and maintains soil fertility and soil structure as well as nutrient cycling (Linger, 2014; Schroth *et al.,* 2001). The practice of this agroforestry system is an important feature in the rural landscape dominated by tribal population due to their potential for local subsistence. The indigenous knowledge of tribal communities associated with the traditional homegardens always contribute towards food security and biodiversity conservation (George and Christopher, 2019).

North East India apart from being rich in floristic diversity is also rich in its ethnic diversity wherein the local community possess tremendous traditional knowledge for the efficient use of natural resources around them. The indigenous communities are basically farm-based and have customary laws that accommodate socio-cultural patterns, land tenure system and unique cultivation practices. Homegarden, a traditionally diverse land use system has been practiced since ages where important plant species are maintained to fulfill various needs. Assam located in the North Eastern region of the country is rich in biodiversity as well as its ethnicity. There are 23 tribal communities in Assam which constitute 12.82% of the total population of the state (Anonymous, 2011). Mishing are the second largest tribal group in the state of Assam which accounts for about 17.8% of the total tribal population.

Rearing of sericigenous insects is an age-old tradition for the people of the North East India, with Assam being the only state in India that uses all the four silk-producing species which are locally known as Pat (*Bombyx mori*), Muga (*Antheraea assamensis*), Tasar (*Antheraea mylitta*) and Eri (*Samia cynthia ricini*) (Unni, 2009). The Mishing tribe of Assam are intricately involved in the rearing of Eri silkworm since early times for the production of Eri silk from which they weave their traditional cloth. It is a promising area for the economic development of the communities. Eri culture is regarded as a part and parcel of the cultural heritage of the Mishing tribe. Eri silkworm feeds on a wide variety of plants. The growth, development and physical characteristics of Eri silkworm are greatly influenced by a variety of food plants it feeds on and the nutritive contents of the foliage (Singh and Das, 2006). The better the quality of its feed, the greater will be the cocoon production and subsequent productivity (Yadav and Mahobiam, 2010). These agroforestry systems help in maintaining a good population of plants that act as host and food plants to many important plants and animals. However, there is hardly any work that depicts the management of the food plants used in the traditional sericultural activities, especially by the Mishing tribes residing in the Brahmaputra Valley in Assam. Therefore, the present study was conducted to investigate the status and diversity of plant species used in the rearing of Eri silkworm and also to assess the traditional practices associated with the management of food plants of Eri silkworm by the Mishing tribe of Dhemaji district, Assam, North East India.

Materials and Methods

Study Area: The study was conducted in Dhemaji district of Upper Assam, Northeast India that covers an area of 3237 sq. km. It is basically a plain area located at an average altitude of 104 m above the mean sea level. The climate of this region is typical tropical characterized by hot and humid summer and cool winters. The annual rainfall ranges from 2600 mm to 3200 mm, mostly concentrating in the month of July. It comprises of Dhemaji and Jonai sub-division and Machkhowa, Bordoloni, Dhemaji, Sissiborgaon Murkongselek Development Block. Mishing are the most dominant tribe of Dhemaji district, while the other tribes residing in the area are Bodo, Sonowal Kachari, Rabha, Deori, Lalung and Hajong. Agriculture is the main occupation of the tribe. Traditionally, the Mishing communities live near the banks of river and live in their "Chang Ghar".

Three villages viz. Digholgorah, Grejing and Patirchuk from Machkhowa block of Dhemaji district dominated by the Mishing tribe were surveyed in the present investigation. Fifteen homegardens from each village (45 homegardens from three villages) were selected using random sampling technique to study the Eri culture based agroforestry system of Mishing tribe of Dhemaji district. Vegetation of the area was studied by quadrat method (Misra, 1968). Random quadrat of 10 m x 10 m size were laid for enumerating tree species (n=210) and within these quadrat, one 5 m x 5 m nested quadrat for shrubs (n=210) and two 1 m x 1 m quadrat (n= 420) were laid for assessing the herbs in the home gardens. The number of quadrat studied in the different home gardens varied from 3-9 depending on the homegarden size. The circumference at breast height (CBH at 1.37 m above ground) for all the individual trees were enumerated during the study. The quadrat were enumerated for the individuals of different species present, occurrence and basal area. Local name of all the plant species were recorded from the community people and the accompanying local persons. Unidentified plant specimens from the homegardens were collected and identified by consulting the regional flora (Kanjilal *et al.,* 1934-40) and confirmed by visiting the herbaria of the Botanical Survey of India, Eastern Regional Centre, Shillong, Meghalaya.

To collect data on the traditional practices for the management of plant species associated with the rearing of Eri silkworm, 30 households from each village were surveyed. A total of 90 households were surveyed from three villages. The respondents ranged from 25 to 60 years in age. The data on traditional knowledge associated with the management of plants species for the rearing of Eri silkworm were collected using questionnaire survey, self-observation of rearing technique, focus group discussion, key informant interview and household survey (Anon, 2012; Fanning, 2005). The questionnaire was made with the intent to assess the informant profile, status of plant species used for rearing of Eri silkworm and plants used for making mountage, and different traditional practice followed for the maintenance of food plants of Eri silkworm.

Data analyses: Field data were tabulated and transformed for analysis in MS Excel 2010. The data were analysed for frequency, density, basal area and abundance (Philips, 1959). Species richness was calculated as the number of species per unit area (Margalef, 1958). Importance Value Index (IVI) was computed by summing up relative density, relative frequency and relative basal area. The abundance to frequency ratio (A/F) was determined for eliciting their distribution pattern (Curtis and Cottam, 1956). Species diversity was calculated following Shannon and Weaver (1963), whereas Simpson's index of dominance (D) was calculated following the protocol of Simpson (1949).

Results and Discussion

The homegardens studied ranged in size from 0.04 ha to 0.86 ha with an average size of 0.35 ha, which are well within the range of global inventory of other tropical homegarden (Farnandes and Nair, 1986). A total of 243 plant species were recorded from 45 homegardens studied belonging to the Mishing tribe of Assam which is comparatively lower than those reported from the homegardens of Mizoram where 333 species belonging to 128 families were reported by Barbhuyan *et al.* (2016). Tynsong and Tiwari (2010) reported 197 plant species from the homegardens of War Khasi community in Meghalaya, while Vibhuti *et al.* (2018) reported 111 numbers of plant species belonging to 55 families from Central Himalaya. The species richness was observed highest for herbs (105), closely followed by trees (104) and shrubs (34). Zimik *et al.* (2012) in their study also reported similar trend from homegardens of Assam and Arunachal Pradesh. The tree species richness in the present study was found higher than those reported from the homegardens of Barak Valley region of Assam (Das and Das, 2005; Devi and Das, 2013).

The Shannon diversity index for herbs (3.79) was recorded more than trees (3.57) and shrubs (2.92). The species diversity index values were higher than the corresponding values of home gardens in various parts of the world (Zhang and Jim 2014; Larios *et al.,* 2013; Roy *et al.* 2013,). The high diversity of

Table 1: Status of plant species used as food plant and construction of mountage for Eri silkworm in the homegardens of Mishing tribe

Species name	Vernacular Name	Family	Life form	Density (Indv. ha^{-1})	Frequency (%)	IVI	Distribution	Usage
Artocarpus heterophyllus Lamk.	Konthal	Moraceae	Tree	13.8	10	9.8	0.13	Moutange
Bambusa tulda Roxb.	Jati bah	Poaceae	Grass	132.5	16.25	21.95	0.06	Moutange
Carica papaya L.	Amita	Caricaceae	Tree	13.33	9.04	5.04	0.16	Food plant
Glycosmis pentaphylla (Retz. DC.)	Jali	Rutaceae	shrub	49.52	5.71	10.77	0.37	Moutange
Gmelina arborea Roxb.	Gamari	Lamiaceae	Tree	20.00	10.95	11.59	0.16	Food plant
Heteropanax fragrans (Roxb.) Seem	Kensseru	Araliaceae	Tree	23.80	15.71	9.95	0.09	Food plant
Lagerstroemia parviflora (L.) Pers.	Ajhar	Lythraceae	Tree	42.86	20.48	17.53	0.1	Food plant
Litsea monopetala (Roxb.) Pers.	Hengalu	Lauraceae	Tree	3.8	3.8	2.50	0.26	Moutange
Mallotus philippensis (Lam.) Mull. Arg.	Henduria	Euphorbiaceae	Tree	5.23	4.76	2.61	0.23	Moutange
Manihot esculenta Crantz	Simolualu	Euphorbiaceae	Shrub	85.71	5.24	14.39	0.78	Food plant
Musa balbisiana Colla.	Athiakol	Musaceae	Herb	27.14	9.05	10.17	0.33	Moutange
Musa champa Hort.	Senikol	Musaceae	Herb	28.57	8.09	8.44	0.43	Moutange
Musa chinensis sweet	Jahajikol	Musaceae	Herb	18.57	6.67	5.98	0.42	Moutange
Musa sapientum L.	Monuhorkol	Musaceae	Herb	9.05	2.38	3.39	1.59	Moutange
Persea bombycina (King ex hook. f) Kosterm.	Soom	Lauraceae	Tree	3.8	3.8	2.08	0.26	Moutange
Ricinus communis L.	Enera	Euphorbiaceae	Shrub	175.23	8.57	27.47	0.59	Food plant

Table 2 : Activity calendar related to food plant management in Eri culture

Species	Activities	Months											
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Heteropanax fragrans (Roxb.) Seem	Land preparation												
	Plantation												
	Pruning												
	Leaf harvesting												
Ricinus communis L.	Land preparation												
	Plantation												
	Weeding												
	Leave harvesting												
Gmelina arborea (Roxb.)	Land preparation												
	Plantation												
	Maintenance												
	Leave harvesting												
Lagerstroemia parviflora (L.) Pers.	Land preparation												
	Plantation												
	Maintenance												
	Leaf harvesting												
Manihot esculenta Crantz	Land preparation												
	Plantation												
	Maintenance												
	Leaf harvesting												
Carica papaya L.	Land preparation												
	Plantation												
	Maintenance												
	Leaf harvesting												

plant species in the homegardens may be the result of selection of species by the ethnic communities based on the utility of specific products, thereby, providing a wider choice of plant materials. The dominant plant species observed in the studied homegardens were *Areca catechu* L. (IVI 64.14), *Lagerstroemia speciosa* (L.) Pers. (IVI 17.51), *Ehretia acuminata* R.Br. (IVI 16.52), *Gmelina arborea* Roxb. (IVI 11.59) and *Heteropanax fragrans* Seem (IVI 9.95). *Ricinus communis* (IVI 27.47) was the dominant shrub in the homegardens maintained by the Mishing tribe.

The Eri silkworm, *S. cynthia ricini* is polyphagous and has been reported to feed on a variety of food plants (Manjunatha and Murthy, 2013). A total of six plant species belonging to five families *viz. Carica papaya* L. (Caricaceae), *Gmelina arborea* Roxb. (Lamiaceae), *Heteropanax fragrans* (Roxb.) Seem (Araliaceae), *Lagerstroemia parviflora* (L.) Pers. (Lythraceae) and *Ricinus communis* L. and *Manihot esculenta* Crantz (Euphorbiaceae) were recorded as food plant for Eri silkworm of which four species were trees and other two were shrubs (Table.1). However, Meth and Gogoi (2016) during their study in Arunachal Pradesh reported only two food plant species for the Eri silkworms. Bindroo *et al.* (2007) reported 24 plant species as host of Eri silkworm. *Heteropanax fragrans* Seem and *Ricinus communis* L. were the primary food plants, which was also reported by Chowdhury (2006). *Gmelina arborea, Lagerstroemia parviflora, Manihot esculenta* and *Carica papaya* were recorded as secondary food plants of Eri silkworm which is also reported in other studies (Arora and Gupta, 1979). Sengupta and Singh (1974) also reported the use of *Ricinus communis, Manihot utilissima, Heteropanax fragrans, Carica papaya*, *Evodia fraxinifolia, Sapiumeugeniifolium, Jatropa curcas* and *Gmelina arborea* as food plants for the rearing of Eri silkworm, among which *Ricinus communis* was found to be the most promising one, while the others were used as secondary food plants. Patil (2004) and Patil *et al.* (2008) reported three new host plant namely, *Michelia champaka, Spathodea campanulata* and *Terminalia paniculata.* In the present study, *Heteropanax fragrans* was planted only for rearing of Eri silkworm by the Mishing tribe and it featured majority of sampled homegardens.

A total of 10 species were recorded to be used for the construction of mountage in the present study. The dry leaves and twigs of plants locally known as *Ajhar, Hinduria* and *Jaligos* were used by the community for the preparation of mountage (Table 1). Meth and Gogoi (2016) reported the use of dried leaves of banana, jackfruit and bamboo for the construction of mountage. However, in case of Muga silkworm, dried leaves and twigs of *Lagerstroemia parviflora*, *Mesua ferrea* and *Persea bombycina* were reported to have been used for the construction of mountage (Mech *et al.* 2015). Chakravorty *et al.* (2015) reported the use of

Table 3: Traditional practices for the management of food plants of Eri silkworm

Status of food plants	Name	Traditional practices				Other uses
		Land preparation	Plantation	Maintenance of seedling	Harvest	
Primary	*Heteropanax fragrans* (Roxb.) Seem	Land is pulverised repeatedly and kept for 5 to 7 days before planting of seedling.	The matured seed on plants retained for the feeding of birds because they believe that better germination and quality planting material is obtained from the seeds found in the excreta of the birds. Later they collect the seedling from that site and transplant it at a space of 3 m to 5 m along the periphery of their homegardens. Sometimes vegetative propagation method is also followed.	The leaf of Kesseru plant is cut every year when they plan to rear Eri silkworm. They prune the plant usually during the month of September to November when it attains a height of 2 m to 3 m from the point where branching starts.	The leaf is mainly harvested by the male members of the family. It is only when tender leaf starts appearing after pruning that they start collecting the leaves. From one plant, they get more than 2 kg of Eri leaves. From a single plant they can harvest leaves upto 2 to 3 times a year.	
	Ricinus communis L.	They plough the land 2-3 times before sowing the seed of castor.	The matured seed of castor plant from the previous year is preserved. They collect the matured seed during sunny days because they believe that the seed will be good during that period. To protect the seed from insect attack they keep it above the place of regular fire place for 2 to 3 month after collection. They usually sow it near the vegetable garden during the winter season.	Weeding is carried out as and when required. Females are mainly involved in this activity.	After 60 to 70 days from the date of sowing they harvest the leaf of castor plant. They pluck tender leaves for young worm and mature leaves for the 4th and 5th phase of worm.	Leaf are used as pain reliever and branch are used as toothbrush

Continued

Secondary	*Gmelina arborea* Roxb.	Land is pulverised with the help of spade	In case of *Gmelina arborea*, they tie their goat under the tree during the time of maturation of fruit as they believe that it ensures good germination once it is taken by the goat.	Weeding and watering is carried out upto 3 to 7 month.	Plucking of the tender leaf is done with the help of knife and bamboo stick and is mainly carried out by the male member of the family.	Timber, fuelwood, fodder
	Lagerstroemia parviflora (L.) Pers	Land is pulverised with the help of spade	It is commonly propagated from seedling by collecting the seeds from wild grown areas. Depending on the rainfall planting is done from February to May	Weeding is carried out as and when required.	Plucking of tender leaves is done with the help of knife and bamboo stick by the male members of the family.	Timber, fuelwood
	Manihot esculenta Crantz	Land is pulverised 2 to 3 times with the help of spade.	Generally, they plant this species during the month of April to May. After planting, people dig up the upper layer of its surrounding soil and place the soil at the base of the seedling by spade. In this way soil is amassed upto a height of about 15 cm to 30 cm at the bottom of the planted seedling.	Weeding is carried out at an interval of 5 to 7 days up to the age of 2 to 3 month.	This plant is used during the time of scarcity of the primary host plant. Usually, the women are involved in this activity. They harvest the tender leaf of this plant.	Tubers and tender leaf are eaten
	Carica papaya L.	Land is pulverised upto 2 to 3 times in the preparation of nursery. During plantation, they dig the upper layer of soil upto 15 to 30 cm.	Seeds of ripe papaya are squeezed out by hand. A spacing of 5-10 cm is maintainedfor each seed when they sow in previously prepared nursery bed. Seedling are transplanted to the selected site when it attain 2 to 3 ft height.	Sprinkling of water is carried out after sowing which is continued at 3 to 4 days interval.	Young plants are watered during winter time. Weeding is carried out as and when required.	Fruit, vegetable, medicine

dry leaves of *Mesua ferrea, Castanopsis* sp., *Lagerstroemia speciosa, Celastrus monospermus* and *Mangifera indica* for the construction of mountage in the rearing of Muga silkworm. The importance value index of tree species related to Eri culture showed that it contributed around 37.47% to the total importance value index of all the tree species in the studied homegardens. *Bambusa tulda* was the dominant species (IVI 21.90) among the plant species used for Eri culture with a density of 132.50

individuals ha^{-1} followed by *Lagerstroemia parviflora* (IVI 17.53 and density 42.86 individuals ha^{-1}), *Gmelina arborea* (IVI 11.59 and density 13.33 individual ha^{-1}), *Musa balbisiana,* (IVI 10.17 and density 27.14 individual ha^{-1}), and *Heteropanax fragrans* (IVI 9.95 and density 23.80 individual ha^{-1}). Plants are maintained in the homegardens for varied reasons (Blanckaert *el al.,* 2004). It was observed that all the plant species used for rearing Eri silkworm were distributed contagiously (Table 2). Occurrence of *Bambusa tulda* were common and was recorded from majority of the sampled homegardens as it had many other uses, apart from its use in Eri culture.

The activities slated for the management of food plants in rearing of Eri silkworm varied for different species (Table. 2) women have a significant role to play in the management of plant species in the homegardens. Land preparation, planting and pruning is mainly done by male members of the family, while women of the community are mainly involved in weeding and harvesting activity. The role of women in the management of food plants in the homegardens include seed storage, growing vegetables, harvesting products and collecting the by-products (Bargali and Vibhuti, 2019). Land preparation is carried out during the month of October to November for the plantation of *Ricinus communis,* however in case of *Heteropanax fragrans*, *Lagerstroemia parviflora*, *Manihot esculenta* and *Carica papaya,* land preparation is carried out during December to February (Table 2). Seeds of *Ricinus communis* were sown during the months of November and December. Pruning is one of the main activities carried out for the management of *Heteropanax fragrans,* which is usually carried out during September to October.

The females of the Mishing community are mainly involved in weeding activities which is done directly by hand or using simple equipment's such as hand held knife and a long knife attached to a wooden handle locally called *'Kotari'*. Harvesting of plant is done in different period for different species. *Heteropanax fragrans* is harvested for a period of about seven months from January to April and then again from October to December. However, harvesting of *Ricinus communis* is generally done during March to June and again from October to December (Table 2). Peyre *et al.* (2006) observed that activities such as sanitary pruning, rejuvenation pruning, canopy pruning to increase light penetration and cutting low branches were seldom whereas weeding, fertilization and crop spacing were the common activities for the traditional management of plant species evident from different homegarden types of Kerala. For most of the species, assisted natural regeneration was practiced. The common planting material for food plants were seeds followed by vegetative propagates. Food plants have an important role in sericultural operations because leaves are the only nutritive source that help in the production of high value commercial silk. Selection of food plants depend on three major factors viz., survival rate, silk production in terms of quality and quantity and fecundity. The Mishing community have established, evolved and nurtured a variety of practices associated with the management of food plants for rearing of Eri silkworm.

There is a strict adherence to the time and process of sowing or planting, weeding and harvesting by the Mishing people in the management of food and host plant in eri culture (Table 3). Differently matured leaves are fed during different stages of maturity of the worms as tender leaves are generally fed to the younger worms while matured leaves are given to older worms. Some of the plants used in eri culture also find multiple uses as food, timber and medicines, thereby increasing its importance (Table 3). They have a long tradition of natural resource conservation based on customs and religious beliefs which have percolated from one generation to another. They have evolved various rituals and taboos related to the harvesting and consumption of plants. During menstruation, women desist from harvesting food plants and avoids entering the rearing room as the belief exists it can incur death to silkworms. They do not harvest bamboo species on Tuesday and Saturday as they believe that production of bamboo will be hampered if they harvest during that day. In case of papaya, if the fruits are formed lately they wrap a *"Mekhela"* (traditional cloth for women) on the trunk of papaya plant.

The rich diversity of plant species mixed with cultural practices make the traditional homegardens in the region a sustainable and economically feasible agroforestry system. The Eri silkworm rearing practice provides direct and indirect economic benefit to the people through income generation. Due to the scarcity of time, lack of food plants, low return, marketing knowledge and training, non availability of governmental and non-governmental institutions, the indigenous knowledge and traditional practices pertaining to the rearing Eri silkworm are taking a back stage in the present day scenario. There is an immediate need for the conservation and management of these food and host plants by the local community ably aided by the central and state government authorities which will help in rejuvenating this unique practice of Eri culture.

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