

ERI SILKWORM REARING

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Introduction

Eri is the widely spreading most popular silkworm species among commercially exploited *Vanya* silkworms. North East India is considered as the centre of origin for eri silkworm, *Samia ricini* (Donovan). Eri culture is an age old agro-based small scale industry of the region.

Moreover, eri pupae are popular as delicacy among the tribal people of this region. Around 1.32 lakhs families of Assam are involved in eri culture.

A total 5 comprehensive Practices in eri sector has been developed through intensive research as follows.

1. Practices of castor cultivation and its management.
2. Practices of raising the Kesseru nursery.
3. Practices of Kesseru cultivation and its management.
4. Practices of Eri Seed Production.
5. Practices of early and late age eri silkworm rearing.

1. PRACTICES OF CASTOR CULTIVATION AND ITS MANAGEMENT.

The Eri silkworm is multivoltine and polyphagous in nature, feeding on several host plants. Castor (*Ricinus communis*) is the primary food plant of Eri silkworm. For basic seed production and to get the highest potential yield, rearing on castor is must.

Season and climate

The ideal period for plantation is March- April in North Eastern region of India. September-October is another suitable season for raising castor. Castor is a warm season crop. However, it grows under diverse climatic conditions.

Soil

Flat and sloppy soil either acidic or alkaline is suitable. Water stagnation is to be avoided by adopting proper drainage system in the planting area.

Varieties

A non-bloomy red variety of castor, NBR-1 is recommended for eri silkworm rearing in North Eastern region of India (Sarmah et al., 2002). Recently, two more productive accessions Acc 003 and Acc 004 have been developed with more than 13 MT leaf yield/ha/year (Sarmah et al., 2011 and Sarmah et al., 2013)) and later named as NBR-2 and NBR-3 (Sarmah and Gogoi, 2012).

Besides, high oil yielding varieties like Jyothi, GCH-5, GCH-4, DCH-519, DCH-177, CO₁, Aruna etc. are being utilized for eri silkworm rearing in non-traditional states of India among which Jyothi, DCH-519 and DCH-177 showed encouraging performance in Assam condition(Sarmah, 2006).



NBR-1



NBR- 2



NBR- 3



Jyothi



DCH-519



DCH-177

Spacing

Pit system of plantation is followed for raising castor for eri silkworm rearing. For sowing of seeds, 20 x 25 x 25cm (Length x Breadth x Depth) size pits are to be prepared maintaining 1x1m spacing. In each pit, 1 kg FYM along with Urea 13 g, SSP 25 g and MOP 3 g are to be added as basal dose and covered with soil. For perennial castor cultivation 1.0x 1.5 m spacing is recommended and pruning at 1m height during March (Sarmah *et al.*, 2008).

Spacing in castor plants



Seed collection and treatment

Mature capsule of seeds are to be collected during sunny day. Capsules are to be sun dried well and seeds to be removed. Before sowing the seeds, it is necessary to treat the matured and healthy seeds with Bavistin 2 g / kg to check seed borne diseases.

Sowing

Two seeds per pit at a depth of 2.5–3.0 cm are to be sown. Germination takes place after 7-10 days. Only one healthy seedling per pit is to be allowed for vigorous growth after germination.

Application of fertilizer

In addition to organic manure (FYM), chemical fertilizer is important for better growth and leaf yield in castor. NPK @ 60:40:20 kg /hectare as basal dose at pit or after one month of germination and 30 kg nitrogen/ha as 2nd dose should be applied after attaining the age of three months by ring digging method. In case of fertile land chemical fertilizer may be avoided.

Harvesting of crop

Four leaf harvests can be made in North East region from a single plant in a year during May-June, July-August, September-October and November-January.

Crop	Leaf yield/acre/year (kg)
May-June	1400
July-August	1200
September-October	1200
November-January	1000

Kesseru Cultivation

Kesseru is widely used as a best perennial food plant for eri silkworm rearing. It belongs to family Araliaceae is ranked second among all the food plants of eri silkworm next to castor. It is widely distributed in the North Eastern region of India, both in wild and cultivated conditions. Taking the advantage of its perennial nature, Kesseru is being utilized in various developmental schemes of Central Silk Board, Govt. of India

Eri Grainage house

A Grainage room having a working area of 34 feet length x 18 feet breadth x 12 feet height all round verandah of 5 feet x 6 feet is required to produce 5,000 dfls per crop.

The preferable temperature and humidity is 25 ± 2 °C and relative humidity of 75 ± 5 %. The room should be preferably east facing with provision for proper ventilation. The plinth of the grainage room should be elevated, dry and damp free



Appliances and Chemicals for Commercial Grainage operation

To carryout the grainage operation, following equipment and appliances are required for production of 25, 000 dfls per year in 5 grainage operations.

Sl.N o.	Items	Size/specification	Quantity
	Wooden racks	3.5 m x 0.5 m with 3 selves.	6 nos.
	Cocoon preservation cages	1.0 m x 0.5 m with bamboo or wire mesh.	54 nos.
	Kharikas	Thatch grass/ tree twig make	10,000 nos.
	Cotton threads	Soft cotton	40 nos.
	Eye protecting glasses	Standard	6 pairs
	Weighing balance	Electronic 0.1 g to 500 g	1 no.
	Musk	Plastic	6 nos.
	Bucket	20 litres capacity	5 nos
	Bleaching powder	30 % Chlorinated	20 kg
	Lime powder	Slaked	40 kg
.	Max. & Min. thermometer	Digital/manual	1 set
.	Hygrometer	Digital/manual	1 set
.	Hand gloves	Rubber	6 pairs

.	Sieve	Steel with 30 cm diameter	2 nos.
.	Moth crushing set	Brass made 20 hole set	3 sets
.	Microscope	Compound	2 nos.
.	Sprayer	Foot/hand sprayer	1 no.
.	Scissor	Steel	4 nos.
.	Bloating paper	Standard	50 sheets
.	Formalin	Commercial	2 litres
.	Slide and cover slip	Standard	20 packets
.	Examination table	Wooden 2 m length x 1.0 m breadth x 1 m height	1 no.
.	Stool	Wooden/steel	4 nos.
.	Potassium hydroxide / carbonate	Laboratory grade. 500 g.	4 bottles

Disinfection of Grainage room and appliances

Disinfection is the act of destruction of disease causing pathogens. A disinfectant is an agent that has the capacity to destroy germs or harmful microorganism

Moth emergence:

Generally, eri moths start emerge early in the morning and at evening and the emergence of moths from cocoons take place after 18/19 days after spinning at 24 – 25 °C. However, after the cocoon formation, the pupae undergo metamorphosis for 14 -15 days and develop into moth. The development and metamorphosis process differ in summer and winter seasons. The freshly emerged moths are moist, the scaly hair on the soft bodied flexible, wings are small and curled. These moths stay motionless for one hour near the cocoon or wall of the moth cage from which the moth emerges.



Moth sorting and picking

The purpose of moth sorting is to eliminate diseased and unhealthy moths, abnormal or underdeveloped wings, scaly hairs dropped and inert, inactive and incapable of copulation to improve the quality of eggs. The healthy moth with bright body, profound wings and large abdomen is considered for pairing and egg production.



Moth emergence and wing spreading takes some time, after proper spreading the wings, the male and female moths must be gathered separately to prevent injuries each other. By the time deformed and weak moths should be rejected. Within a batch of cocoons, a small quantity of exceptionally early or late emerging moths should be eliminated and not included for mating. Healthy male and female moths should be collected in the morning and kept 50:50 ratio of male : female in coupling cages.

MATING OF MOTHS

Eri moths have good coupling aptitude in natural condition, mechanical coupling is not required. The optimum temperature and humidity for mating is about 23-24 °C and 75-80 %. Generally, mating takes place after one hour of emergence ensuring 8-10 hours coupling and decoupling is required in the afternoon. Male and females moth that emerge in the evening should be kept in pairing cage whole night and collected in the morning for tying.

MATING OF MOTHS



Picking up and tying of mated female moths

Within an hour, more than 2/3rd of emerged moths mate naturally. While picking up the mated moths, the base of fore wing of mated female moths is held with thumb and tied it on the *khorika* (small bundles of straw or a split stick 30 cm long with a hook or cut branches of trees having one hook like projection).



While tying the female moth should be on the upper side and male on the down

side. The *kharikas* should be hanged evenly on the string; not to be too closed to make easy separation of mated moths. There should be no sound, strenuous vibrations and bright light free in the room. The room should have proper aeration with suitable temperature 24 to 26 °C and 70-80 % relative humidity inside the room and semi dark condition.

Decoupling

Optimum pairing of male and female eri moth is most essential to obtaining the good quality eri seed. Mating for 6-8 hours is sufficient to ensure full fertility



Oviposition

Eri moths always lay egg comfortably in the vertical position on *kharika* or branch of the tree, where the number of the eggs found more than other oviposition device. The suitable temperature and humidity for egg laying is 25-26 °C and 80-90 % in the semi dark condition.



Eri moths do not properly oviposit in the plain surface or cellule like mulberry silkworm, If eri moth do not get suitable egg laying device, then number of eggs remain inside the abdomen and the period of egg laying increase. They are allowed to lay eggs for a maximum period of 2-3 days.

The number of eggs laid by one female moth is usually 300 – 350

Numbers, but sometimes the number of eggs are found 400 – 450 in the spring and autumn season when worms are fed with primary food plants (*Castor*, *Ricinus communis* Linn).



Collection of female moths after oviposition

After 2-3 days of egg laying, the female moths are collected in morning hours and separated date wise for microscopic examination of mother moths. The poor layings and unlaidd female moths are discarded with the *kharika*. Eri moth lay 90 % eggs within 2-3 days in the suitable environmental condition. The life span of the eri moth is 5-8 days depending upon the season. The eggs laid after the 3-4 days are not suitable for rearing.



Collection of female moths after oviposition

Mother moth examination

In order to produce disease free laying (DFL) and to determine the presence of pebrine spores, mother moths are subjected to microscopic examination. Procurement of healthy or pebrine free seed is paramount importance in eri culture.



It is observed that bacterial, fungal and pebrine diseases are common in eri silkworm. Bacterial or fungal disease can be controlled by surface disinfection and maintaining hygiene condition. But the pebrine is the protozoan disease which infect generation to generation through mother moth. For tackling the problem of pebrine disease, mother moth is examined following individual mother moth examination and mass mother moth examination.

Requirement of equipments/materials:

For the improved centrifugal mother moth examination, following equipments / materials are required for detection of pathogen.

- 1) Mixie with medium size Jars: 1 no.
- 2) Pastel with grinder: 4 sets
- 3) Centrifuge (1000 - 5000 rpm) : 1 no
- 4) Centrifuge tube (50/100 ml): 36 nos.
- 5) Cyclomixer: 1 no.
- 6) Plastic beakers: 36 nos.
- 7) Funnels (10 cm diameter): 36 nos.
- 8) Scissors: 4 nos
- 9) Measuring cylinder (500 ml): 2 nos.
- 10) Muslin cloth: 2 mters
- 11) Thin glass rod: 5 nos.
- 12) Micro slide with cover slip: 5 packets
- 13) Compound microscope: 1 no.
- 14) Moth examination table and stool: 1 pair
- 15) Potassium carbonate: 500 g
- 16) Potassium hydroxide: 500 g
- 17) Bleaching powder: 5 kg
- 18) Cotton: 2 roll

PACKAGE OF PRACTICES OF IMPROVED ERI SILKWORM REARING AND ITS MANAGEMENT.

Availability of food plant:

A rearer has to decide the size of the rearing to be conducted after estimating the availability of eri food plants. The most common eri food plants are castor, kesseru, tapioca and payam, which are abundantly found in North Eastern region of India. Another perennial food plant Borpat, *Ailanthus grandis* is a promising eri food plant. Out of these, castor is the most preferred food plant of eri silkworm and it can be utilized throughout the year.

Rearing House:

Eri silkworms are reared indoors. The plinth area of 10 m x 5 m size rearing house having tin or thatch roofing with 1.5 m verandah all around is ideal for accommodating 100 dfls for commercial and 50 dfls for cellular stock maintenance of eri silkworm rearing per crop. The rearing houses are to be built with adequate number of windows for maintenance of a good environment and ventilators which are also to be fitted with nylon nets to stop entry of uzi flies

Requirement of rearing appliances:

All the required appliances and materials for rearing should be made available prior to rearing. These materials should be kept clean and disinfected properly. The following major items are required for rearing 100 dfls of eri silkworm

Sl. No.	Name of the items	Specifications	Quantity
1	Hand sprayer	Plastic	1
2	Rearing stand (wooden)	2 m x 1.8 m x 0.50 m with 5 shelves	10
3	Feeding stand (Wooden)	1.0 m height	10
4	Rearing tray (Bamboo)	1.0 m diameter	100
5	Chandrika (Bamboo)	1.0 m x 1.0 m	100
6	Ant wells (Aluminum)	15 cm diameter	40
7	Disinfection mask	Standard	3
8	Leaf preservation chamber (Wooden)	1.5 m x 1.0 m x 0.75 m	2
9	Egg hatching box (Plastic)	0.60 m x 1.0 m	100
10	Bucket	20 lit capacity	2
11	Wash basin	Standard	2
12	Wash Basin stand	1.0 m height	2
13	Plastic mug	1.0 lit	2
14	Hygrometer	Digital or wet & dry bulb	2
15	Max-min thermometer	Standard	1
16	Foam pad	40 cm x 60 cm	2
17	Measuring cylinder	1lt	1
18	Basket (Bamboo)-	--	1
19	Old news paper	--	5 kg
20	Bleaching powder	--	5 kg
21	Bird feathers	--	10
22	Slaked lime	--	5 Kg

Silkworm Rearing Management

The domesticated variety of eri silkworm, *Samia ricini* (Donovan) is multivoltine in nature. The structure of the genitalia, wing pattern and chromosome number demonstrates that *Samia ricini* (Donovan) is derived from its wild form, *Samia canningi* (Hutton).

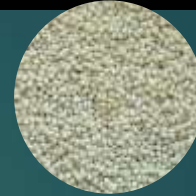
Several eco-races like Borduar, Titabar, Khanapara, Nongpoh, Mendipathar, Dhanubhanga, Sille, Kokrajhar, Diphu, Genung etc. (Chakravorty *et al.*, 2008). of eri silkworm are available in North Eastern region of India. Depending upon larval colours and markings, six pure line strains were isolated from Borduar and Titabar eco races like Yellow Plain, Yellow Spotted, Yellow Zebra, Greenish Blue Plain, Greenish Blue Spotted and Greenish Blue Zebra. Eri silk is unique among other silks for its typical quality of white soft yarn possessing thermal properties.



Moth Emergence



Adult Moths



Eggs



1st INSTAR LARVA



2nd INSTAR LARVA



3rd INSTAR LARVA



4th INSTAR LARVA



5th INSTAR LARVA



COCOON & PUPA



COCOON

Life Cycle of Eri Silkworm

Selection of races and season:

So far, 25 eco-races of eri silkworm are characterized collected from different parts of North Eastern region of India,

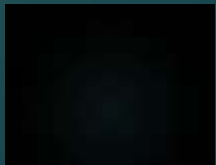


In addition, six strains are isolated and maintained in the germplasm bank of Regional Eri Research Station, Mendipathar in Meghalaya and Central Muga Eri Research and Training Institute, Lahdoigarh. These include yellow – plain, yellow – spotted, yellow – zebra, greenish – blue plain, greenish – blue spotted and greenish – blue zebra (Debaraj, *et al.*, 2001). Borduar and Titabar eco-races are better yielder among the eco-races of North Eastern region of India (Sarkar *et al.*, 2012).

The best season for eri silkworm rearing is June-October during which the rearing performance is found better (Sarmah et al., 2012). . The new eri breed C2 has been developed by hybridization of two potential parents SRI-018 (Genung) and SRI-001 (Borduar) through exerting directional selection at Regional Eri Research Station, Mendipathar, under Central Muga Eri Research and Training Institute, Lahdoigarh, Assam. (Singha, 2010). C2 breed shows best performance on feeding of non-bloomy red variety of castor (NBR-1).

However, it can be reared on Kesseru (*Heterpanax fragrans*), Borpat (*Ailanthus grandis*) and Borkesseru (*A. excelsa*).

The prevailing climatic conditions of the North Eastern region of India are congenial for eri culture and eri silkworms can be reared in 4 – 5 overlapping crops in a year.



Egg incubation and hatching:

The disease free layings (dfls) of eri silkworms are kept in the egg boxes for hatching. The dfls are kept in the paper boxes or plastic egg hatching box for uniform hatching. Incubation of eggs at optimum conditions of temperature and humidity is essential for uniform embryonic development and good hatching. Eggs should be incubated in a well-maintained room or incubator at 24-26 °C temperature and 80-85 % relative humidity.

The colour of the egg changes to a dark bluish before two days of hatching.

Eggs should be exposed to light in the early morning hours (6 – 8 AM) on the expected day of hatching to get uniform hatching simultaneously. Eggs generally hatch on 9 to 10th day in summer-autumn seasons and 15 to 20th day in winter. During incubation, the eggs are kept and spread uniformly in a thin layer in the box to facilitate good hatching.

Brushing of worms:

Brushing is the transfer of newly hatched larvae from eggs to the rearing bed. The larvae hatch out in the early morning hours and continue up to 9-10 AM. On the first day of hatching, tender leaves are put inside the egg box in the early morning. The

newly hatched larvae crawl onto the leaf and start feeding. The leaves along with the larvae are transferred to the rearing tray with new fresh leaves.



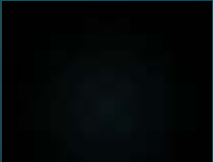
larvae inside the box are gently transferred to the tray with the help of fine and soft brush or bird's feather.



The worms hatched in the first two days (48 hours) show more healthy, good vigour and growth; and they are considered for stock maintenance of races

Methods of rearing:

There are three methods of eri silkworm rearing, *i.e.*, traditional bunch-rearing, improved tray and platform rearing. The farmers of the North Eastern region generally employ bunch rearing method



Bunch rearing:

In bunch rearing method, about 10-12 leaves of castor or branches of kesseru are tied together to make a bundle and hung vertically on a horizontal bamboo/wire/string support. Then the worms are allowed to feed on the tied leaves

The foliage is changed by keeping fresh bunch near the exhausted one and the worms crawl over the new one. Just below the hanging bunches bamboo mat or tray is kept on the floor so that the worms which fall down are not contaminated with dust on the floor.



Bunch rearing



Tray rearing

Tray rearing:

In tray rearing method, the worms are reared providing the leaves on the tray. Trays are made up of either bamboo or wooden in different shapes and sizes. The shapes are round (bamboo made), square and rectangular (wooden). The young age (I-III instars) silkworm rearing is conducted either in the wooden trays of 50 x 60 x 5 cm size or in bamboo tray (1.0 m diameter).

However, bamboo trays of size 1.0 m diameter is more convenient to rear 10-15 dfls until 2nd / 3rd instar; while 600-700 worms can be reared up to 4th instar and 300 worms in the final instar which also provides sufficient space.



Platform rearing technique: This is new innovative rearing method of eri silkworm (Debaraj *et al.*, 2003). The model platform rearing device for eri silkworm rearing consists of 3 nos. platforms each of 1 x 2 m size and made up of bamboo strips with sieve size of 1sq cm. Platforms are placed in 3 tier in bamboo rack of size 1



2.2 x b 0.75 x h
1.60 m. Two nos. of such racks can be placed in a room
floor area of 5.4 sqm. (1.2 x 4.5 m).

Maximum of 1200 eri silkworms at 5th instar can be reared in each platform to accommodate 7200 silkworms by brushing 25- 30 dlfs.. To collect litters of silkworm, gunny cloth is to be fitted below each tier. The technology is found to be advantageous to accommodate almost double quantity of silkworms per unit against the traditional round bamboo try (1m diameter with capacity of 300 nos. 5th instar worms) rearing system.

Silkworm rearing:

In general, silkworm rearing divided into two main phases, viz., i) Young age silkworm rearing and ii) Late age silkworm rearing depending upon the nutritional requirements and environmental conditions to be maintained during rearing. In both the phases of rearing, the requirements are different and the techniques of rearing are also quite distinct. The first to third instar worms form the young age and the remaining two instars (fourth and fifth) form the late age worms

Young age silkworm rearing:

Young age silkworm rearing is also known as “Chawki rearing.” A good cocoon crop at the end of successful rearing is greatly influenced by the conditions of young worms rearing. Therefore, young age worms should be reared under good rearing conditions providing them with suitable and good quality leaves. Temperature of 26-28 °C and relative humidity of 85-90 % are ideal conditions for young age rearing. Sufficient tender (glossy) and fresh leaves should be provided to young age larvae



Late age silkworm rearing:

Late age worms consist of fourth and fifth instars which need preferably lower temperature and humidity during rearing conditions. These stages consume more quantum of food than the young age worms because the worm has not only to develop silk glands and to increase growth rate, but also has to store up the reserve food materials for the future stages like pupa and imago. Therefore, these stages should be provided as much as quality food they require. The late age worms consume 80-85 % leaves supplied during the entire larval period.

The environmental and nutritional conditions required in late rearing are different from that of young age. The ideal temperature range 24-26 °C and relative humidity range 70-80 % should be maintained during the rearing of late age worms. These stages should be provided with semi-matured leaves. The feeding of dried, yellow and diseased leaves deteriorates the health of the worms and even death due to diseases. Since 80-85 % of leaves are consumed by these stages, ensure continuous supply of quality leaves after preservation in the leaf chamber.

Maintenance of larvae:

During the entire rearing period, the stage wise general maintenance of the larvae is required considering the following aspects, a) Feeding and its frequency, b) Bed cleaning, c) Spacing of worms, d) Handling of moulting worms and care, e) Collection and destruction of weak, diseased and undernourished larvae.

Collection and destruction of weak, diseased and undernourished larvae:

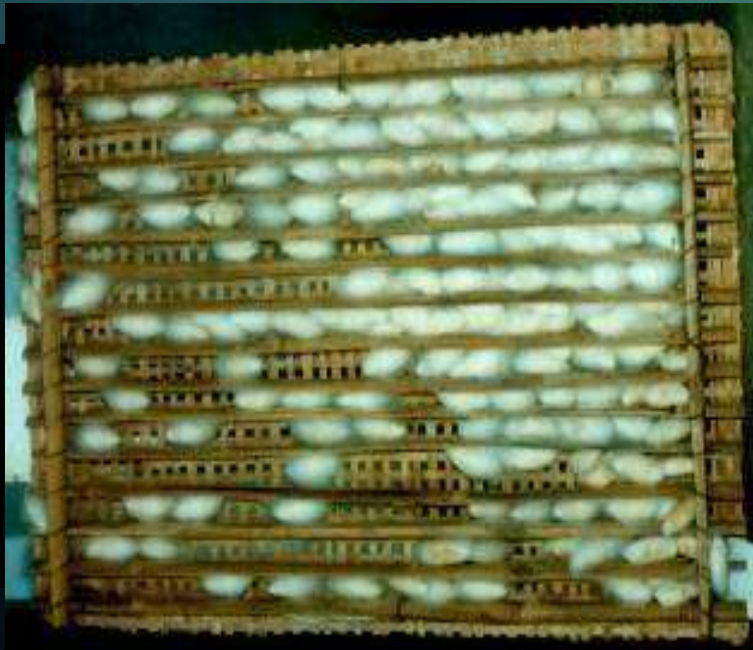
During rearing, the weak, injured, diseased and irregular worms should be collected immediately and put in 2 per cent formalin solution. Such worms should be buried or burnt carefully to prevent spread of diseases. If rearing continues mixing with these worms, the loss due to contamination and disease spread will be more; even crop failure may take place.

Matured worm collection and mounting:

After completion of larval life span, the matured 5th stage larvae discard complete excreta consisting of liquid and semi-solid substances and ready for spinning cocoons. Before spinning, the worms stop feeding and become restlessly moving here and there in search of a suitable place for cocooning. The matured worms produce a hollow sound when it is rubbed gently between fingers. This is the time for picking the ripe worms and putting them on mountages.



Before mounting process, the required number of mountages should be kept ready well in time. The worms should be collected carefully for mounting



Bamboo strip type moutage



Wooden strip type moutage

Harvesting and assessment of cocoons:

After completion of spinning, the larval skin is cast off and pupation takes place. The pupa has a thin cuticular skin which is soft and may get ruptured easily, if disturbed. The last and important step is harvesting of cocoons from the mountage in time. Cocoons should be harvested after 5-6 days of spinning in summer and 8-9 days in winter.

Economics of Ericulture

Castor based ericulture

Establishment cost of Castor plantation (Unit: 1 acre)

Sl.No.	Activities	Quantity	Rate (Rs)	Amount (Rs)
Recurring cost for inputs				
1	FYM	400 cft	7	2800.00
2	Urea, SSP and MOP	80,100 &13 kg	8	1544.00
2	Castor seeds	4 kg	20	80.00
3	Insecticide/pesticide	L/S		200.00
4	Green Fencing	L/S		2000.00
Total (A)				6624.00

Employment generation through engagement of manpower (MD)

1	Land preparation	20 MD	100	2000.00
2	Pit digging	20 MD	100	2000.00
3	FYM application and Seed sowing	4 MD	100	400.00
4	Cultural application (3 times)	15 MD	100	1500.00
5	NPK application	20 MD	100	2000.00
Total (B)		79 MD		7900.00
Total establishment cost of plantation (A+B) = (Ai)				14524.00

1	Rearing house (thatch house)	1	50000	50000.00
2	Platform with stand	4	300	1200.00
3	Mountage	20	60	1200.00
4	Sprayer	1	1200	1200.00
				53600.00
Total (A): Depreciated cost (10 years)				5360.00

Recurring cost				
1	Cost of dfls (for 4 crops)	400	2.00	800.00
2	Cost of disinfectants	L/S		200.00
Total (B)				1000.00
Employment generation through engagement of manpower				
1	Disinfection of rearing house (4 crops)	4	100	400.00
2	Rearing of eri silkworm (@35MD/100 dfls)	140	100	14000.00
3	Removal of pupa (2500/MD)	32	100	3200.00
Total (C)				17600.00
Total cost of rearing (A+B+C)= (B ii)				23760.00

(a) Total investment (A i + B ii)=Rs.38484.00

Return from ericulture

Sl.No.	Activities	Quantity	Rate (Rs)	Amount (Rs)
1	Sale proceed of cocoon (@8kg/100dfis)	32	300	9600.00
2	Sale proceed of pupa (@62kg/100dfis)	248	200	49600.00
	(b)Total return			59200.00

**Net profit through rearing in Castor based ericulture: (b-a)=
Rs.20716.00**

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THANK YOU