Manual on

Mountages, Mounting and Harvesting Technology for Quality Cocoon Production

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Preface

There is a demand for quality bivoltine silk in domestic and international markets. India, inspite of being the second largest producer of silk in the world, has been striving hard to meet the demand of quality silk as more than 90% of its production comprises of ungraded silk. Of late the bivoltine sericulture technologies were stabilised and the country first time could cross 1000 MT mark in bivoltine raw silk production recently. Though there has been perceptible improvement in cocoon productivity and reduction in crop losses due to new sericulture technologies developed by CSRTI, Mysore and others. However the renditta of bivoltine cocoon has been sharply rising due to decline in cocoon quality these days. Quality of mountages, types of mountages, mounting methods, regulation of environmental conditions and harvesting technology of cocoons plays the vital role in production of quality cocoons. The final activity of silkworm rearing is mounting. Lack of knowledge in identification of mature larvae, mounting time , mounting methods and mountages may lead to production of inferior quality of cocoons. Mounting is time bound and labour intensive activity. Therefore awareness and popularisation of this aspect of silkworm rearing technologies are essential for producing quality cocoons and this compilation entitled "Manual on Mountages, Mounting and Harvesting Technology for Quality Cocoon Production" is one such attempt which will help all stake holders in production of quality cocoon and in turn raw silk.

We are grateful to all the scientists of CSRTI, Mysore particularly RTI and SED divisions who have directly and indirectly helped in the preparation of this booklet. Special thanks are due to Dr. Nirmal Kumar, Scientist - D, Chief, Sericulture Division for his help in critically going through the text and suggesting inprovement therein .

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1. Introduction

The life cycle of silkworm can be broadly divided into egg, larvae, pupa and moth which is completed in about 45-50 days in case of multivoltine type while bivoltine type take 50-55 days. Eggs provided with conducive atmosphere hatche into larvae in about 10 - 11 days. Larval period is the only feeding period which lasts for 23 - 25 days. Silkworm after passing through feeding and moulting phase, attains maturity and starts searching suitable place for spinning a cocoon around its body to pass into pupal stage of metamorphosis within 5 - 6 days which in turn transforms into moth within next 6 - 7 days. The mounting of mature larvae is the last activity in silkworm rearing in which the efforts put in for rearing larvae are realised in the form of a saleable product, the 'cocoon'. The mature silkworm larvae are then transferred to a suitable frame with proper anchor for spinning cocoons, called as mountages and the process of transferring the mature larvae is called mounting.

1.1 What is quality cocoon ?

The cocoons in a lot with maximum live pupae, minimum defective cocoons, uniform size and shape with higher shell content with good relability are reffered to as quality cocoons.

1.2 What is defective cocoon ?

The cocoons which can not be reeled or difficult to reel are called defective cocoons. Inadequate mounting care, poor quality of mountages, silkworm diseases and pest lead higher number of defective cocoons (Fig : 1).

1.3 Types of defective cocoons :

1. Stained / Soiled cocoons: Soiled / stained cocoons are formed due to the urination or staining or due to liquid coming out from dead larvae. The reasons are high humidity and disease infestation.

2. Melted cocoons: The main reason is late age infestation which leads to the death of pupae inside the cocoon and they are not fit for reeling.

3. Thin end cocoons: Either one end or both the ends of the cocoon shell layer becomes extremely thin and such cocoons are not suitable for reeling. Low temperature and high humidity during rearing and low temperature and dry conditions during spinning may lead to occurrence of this type of cocoons.

4. Deformed cocoons : Cocoons which are swollen or differ from the normal shape and size are called deformed cocoons which can not be reeled. These types of cocoons are formed when larval health is poor or for irregular space in cocooning frame.

5. Pierced cocoons: Due to penetration of uzi maggots, cocoons are pierced and are not fit for reeling.

6. Flimsy cocoons: These cocoons are having very thin shell (jelly type) and are not fit for reeling. These cocoons are formed by the weak larvae due to the occurrence of diseases.

7. Double cocoon: These cocoons formed by two mature silkworms together are large in size, deformed and with thick shell and has coarse wrinkles. They can not be reeled to get uniform yarn. The double cocoons are also formed due to congested space during spinning. Hereditary factors also influence the formation of such cocoons.

8. Printed / Pressed cocoons: Some portion of cocoon adhere to the cocooning frame and leave a print on cocoon. This is due to the poor quality of mountages, mounting of immature worms and over crowding of the worms.

9. Loose shell cocoons: Shell of the cocoons is very loose and not fit for reeling. It is due to race or non maintenance of environmental condition during spinning.

1.4 Causes of defective cocoons :

In the sericulturally advanced countries the occurrence of defective cocoons is less than five percent, while in India it goes even up to 15 % or more at some farmer's level. Due to occurrence of more defective cocoons (shape, size, deformed and double cocoons) reeling performance is affected leading to higher renditta and economic loss to the reeler. Causes for formation of defective cocoons are :

- Secondary contamination at late age rearing
- High temperature and high humidity during late age rearing and mounting
- Improper maintenance of hygienic conditions during rearing
- Bad quality of mountages
- Overcrowding of worms on mountages
- Unsuitable materials used for making mountages
- High humidity and lack of air current during mounting

The percentage of defective cocoons normally should not exceed more than 5 % if mature silkworms are picked up timely, good mountage and proper mounting methods are followed. A survey was conducted of 20 farmers of one hectare of mulberry garden land holding in Karnataka showed 12.73 defective cocoon percentage (Table 1).

Table 1 : Defective cocoons from 1 hectare of mulberry

Sl. no.	Particulars	
1	Unit area of mulberry	One hectare
2	Number of farmers covered (numbers)	20
3	Total area covered for survey (hectares)	9.5
4	Average dfls reared / year / hectare (numbers)	2500 dfls
5	Cocoon produced / hectare / year (kg) @ 65 kg /100 dfls	1625.00
6	Mountages used	Bamboo/Plastic
7	Quantity of defective cocoons / hectare / yr (kg)	206.00
8	Good cocoons obtained / hectare / yr (kg)	1419.00
9	Cocoon produced for 9.5 hectare / year (kg)	15437.00
10	Quantity of defective cocoons / 9.5 hectare / yr (kg)	1957.00
11	Defective cocoons obtained / hectare / yr (%)	12.73

Source : The 20th Congress of the International Sericulture Commission, France, 2005

2. Symptoms of spinning silkworm :

Depending on the breed, a mature worm require around 48 to 72 hours at 25° C ± 1 ° C to make cocoon from beginning to an end. The mature silkworm looses its appetite, stops feeding, the faeces becomes softer, the front portion of body becomes semitransparent due to growth of silk gland which occupies all the body cavity. Mature larvae reduces in size and starts searching for suitable space to build the cocoon with head and thorax always try to climb vertically (Fig : 2). The mature larvae have the tendency to climb above the leaves hence can be easily picked up (Apogeotropism). The spinning larvae start spinning the silk through spinneret which is situated below the mouth. Mature larvae (50 dfls or 20,000 larvae) discharge 46 litres urine during the entire spinning period. (Table 2).

Table 2 : Water released by mature silkworm during the spinning (50 dfls or 20,000 larvae)

Contents		Water discharge (litre)	Percentage of water discharge
Water	Urine	7.8	16.96
	Water in faeces	4.5	09.78
Total		**12.3**	**26.74**
Water vapour	Solidification of liquid silk	23.0	50.00
	Respiration	10.7	23.26
Total		**33.7**	**73.26**
Grand Total		**46.0**	**100**

Source : AICAF, Japan, Publication, 1995

Moisture thus accumulated should be removed from the mounting place as early as possible by providing good ventilation with sufficient number of windows and ventilators. Therefore farmer keep mountages generally in the verandah for better aeration and loss of moisture. Silk filament dries as soon as it comes in contact with air. The drying becomes slow if environment is humid and results in formation of soft cocoons with poor reelability. The urine and faeces must be removed 8 - 12 hours after mounting. Moisture released by the respiration and solidification of liquid silk is invisible and often remains un-noticed which needs to be removed.

3. Cocoon formation :

The length of mature larva is about 4 to 5 cm and it can further stretch its body. Mature larvae crawl on the mountages with the abdominal legs and move the head from one end to another end forming the outline of cocoon shape. After this larva stretches the caudal end and discharges the urine which is about 0.5 ml / larva in the form of drops with semi solid faeces. It anchors itself first to the mountages by oozing out a tiny droplet of silk fluid which immediately hardens and stick to the mountage. Then, mature larva spins the cocoon in 8 or S shape without any definite direction by swinging the anterior part of body continuously and can spin around 600 to 2000 m of silk filament depending upon the breed. The spinning silkworm spin loose hammock which provides necessary foothold to start spinning. The process of cocoon making is temperature and humidity dependent and under ideal temperature and relative humidity condition it takes 60 to 72 hours. Inside the cocoons larvae

metamorphose into pupa after spinning is completed and body shrinks to half. If mounting is delayed by more than 12 to 18 hours flimsy and defective cocoons are produced. With the increase in temperature, the spinning process can be enhanced but it is not advisable as it affect reeling characters and filament length recovery is reduced. If humidity is more during the spinning process, it will enhance the breaks during reeling and deteriorate the quality of yarn. Spinning of cocoon will take about 3 days and during spinning later half part of spinning is very much important to determine the quality. Hence, to obtain the quality silk recommended temperature (24 -25 ° C) and humidity (60-70 %) is required to be maintained with proper air current.

Mature larvae normally waste 2-3 % silk for footage and it may be more if mountage is not proper. In addition, the mountage also affect the shape and size of the cocoons and also silk content in cocoon shell, compactness of shell, filament length, denier and silk ratio. The above mentioned characters will affect drastically if the environment changes during spinning.

4. Environmental conditions for spinning and their management :

Environmental conditions like temperature, humidity and air flow play key role during formation of cocoons and affect the silk filament, especially the reeling characters. The silkworm builds quality cocoon at an ideal temperature of 25° C, 60 to 70 % relative humidity and an air current speed of 0.5 to 1.0 m per second. The spinning worms prefer dim or moderate light with an intensity of 15 to 30 lux. Spinning larvae avoid bright light. It is observed that:

- Temperature above the optimum requirement reduces cocoon quality. Low temperature enhance the pupation duration. With increased or decreased temperature than recommended, cocoon characters i.e., shell weight, shell ratio and cocoon yield are affected.
- With the increased humidity (> 70 %) during spinning reeling character i. e., reelability , non breakable filament and other associated characters are adversely affected.
- Depending upon the environmental conditions air current is required to build quality cocoons. During rainy season more than recommended air current is a must to remove the accumulated humidity in the mounting hall and vice versa during summer and winter.

Larvae prefer dim light of 15-30 lux. It is better to avoid to keep the cocooning frames in strong and bright light. Due to the lack of space, farmers are keeping the mountages under the tree but they are advised to avoid the direct sun light.

The temperature, relative humidity and air flow since affect the reelability of the cocoons in a mutually interactive manner, they should be maintained suitably for better cocoon quality. However among the above factors, the relative humidity and airflow have a strong effect on reelability of cocoons (Table 3).

Table 3 : Combined effect of temperature, relative humidity and airflow during cocooning on reelability of cocoons.

Temperature ° C	Relative humidity (%)	Reelability (%) in relation to air flow	
		0 cm / s	50 cm / s
23	65	92	96
	90	54	91
30	65	85	94
	90	28	83

Source : AICAF, Japan, Publication, 1995

5. Management of mounting :

Transferring the mature larvae on to the cocooning frame for spinning is referred as mounting. Larvae get matured within 4 to 6 hours after the sample larva is seen in the bed hence mounting of the matured larvae on cocooning frame requires well planning. Mounting operation is time bound , quick and labour intensive activity in silkworm rearing. The mounting should not be delayed when larvae are matured, as delayed mounting and prolonged mounting results in loss of silk besides production of poor quality cocoons and silk yarn leading to lower income.

6. Mounting methods:

There are three different types of mounting methods to mount the spinning worms on the cocooning frames. Mounting methods are also depend on the type of mountages are used. In the entire rearing operations, mounting process is the most labourious and time bound work. If mounting process is not planned properly and mounting method is wrong, it will affect the quality of cocoons and silk yarn. The most common mounting methods are detailed below :

6.1. Pickup method
6.2. Self mounting method
6.3. Shoot shaking (Jobarai) method

6.1. Pickup method:

The most commonly used method by south Indian farmers is picking of individual matured larvae by hand and mounting on the mounting frames. When 30 % of worms attain maturity, all the worms will be picked and mounted on the mountages to spin the cocoons (Fig : 3). However, this method is more effective only when worms attain uniform growth and maturation. Care has to be taken to remove extra worms on the mountages after 6 to 8 hours and remounted on separate mountages. In this method silkworms are mounted in right time and will produce good quality of cocoons. This method is highly time and labour consuming.

6.2. Self mounting method :

To let mature silkworm up into the cocooning frames placed on the rearing bed is called self mounting or natural mounting. While adopting this method it is necessary to have uniform growth speed of silkworm for maturing at the same time, while rearing bed also need to keep plain in advance when cocooning frame are put on it. To make rearing bed plain , entire leaf can be fed after bed cleaning in the previous morning or otherwise also. In this method the cocoon frames i.e., bottle brush , plastic collapsible, mulberry twigs, grasses and paddy straw etc., are kept on the rearing bed when more than 30 % worms are mature. Cocooning frames are left on the bed for 4 - 6 hours and mature worms are allowed to crawl up on the mountages due its negative geotropic nature (Fig : 4). Fully matured larvae only will crawl on the mountages. This process needs to be repeated 2 times. When more than 80 % worms crawled up, the mountages can be removed and placed on different place or hanged. Remaining 10 - 20 % left over mature silkworms can be hand picked and mounted in the mounting frames. In this method silkworm waste lot of silk and floss percentage increases.

6.2.1 Maturation and acceleration of spinning :

In sericulture, both silkworm rearing and synchronised spinning plays vital role. Usually, all the silkworms do not get uniform maturation and this process lasts for 2 to 3 days. In winter season it extends further due to low temperature. Because of this farmers have to pick the ripe worms continuously thereby incurring extra expenditure and time. Silkworm those are below and at fag end of eating phase will spin the cocoons in the rearing bed. Hence, crawling up of mature silkworms need to

be accelerated by scattering of chaffs with cresol (one part of 300 times solution of cresol soap mixed with 10 part of chaffs in volume) is effective. Applying fresh saw dust with strong smell or lime dusting , 3 - 4 hour before spreading the mountages will enhance crawling up speed.

6.2.2 Syncronisation of spinning :

Sampoorna is a spinning hormone of plant origin which contains β - ecdysone. Application of this hormone (20 ml in 4 liters water on the onset of spinning when 3 - 5 % mature worms are noticed in a batch is required for 100 dfls) on the last feed will hasten the maturation process and induces synchronised spinning. It reduces mounting period by 18 - 40 hours. This technique additionally helps to overcome unforeseen shortage of mulberry leaf if any in the final instar and out break of diseases in the fifth instar.

6.2.3 Shoot shaking (Jobarai) method:

In this method, when more than 30 % worms are matured, 10 to 12 mulberry shoots with mature silkworm from the shoot rack can be taken out and held together and shaken so that all the ripened larvae fall down on the polythene sheet which is spread on the floor. Silkworms can be separated by keeping the shoot on the vibrating (manually or electrically operated) machine (Fig : 5). Extra leaves, faeces etc. removed by hand and worms be mounted on the cocooning frames. This method saves time and labour without affecting the cocoon quality.

In this method lime dusting is done to accelerate the crawling of worms on to the rearing bed. To get uniform matured larvae, nets can be spread on the rearing beds and last feed is given and these nets along with larvae are transferred to vibrating mechine and separated larvae are mounted on to the mountages.

Among the above discribed methods, pick up method of mounting is found to be ideal. The quality of cocoons obtained is better compared to self mounting method, as the silkworms are picked at right time. However, this method needs more space and requires additional workers and hence costly.

7. Mountages :

Mountages play a vital role in quality cocoon production. Farmers depending upon their resources use different types of materials available locally for making mountages. Types of material used, finishing of mountages, space available for spinning worms in mountage etc., will decide the quality of cocoon. Narrow space affects

ventilation and results in poor reelability of cocoons. Similarly more space results in wastage of silk in the form of floss. Therefore, adoption of proper mounting technology and spacing provided to larvae contribute significantly for better cocoon formation. Lack of care during mounting of mature worms and adoption of wrong mounting technology results in formation of defective cocoons, which affects the reeling performance as also production of quality silk, besides fetching lower price of cocoons. Even though the silkworm larvae are healthy, it is estimated that the farmers loose about 12 - 15 % of crop due to defective cocooning which is attributed to inadequate mountages, poor quality of mountages, shortage of time, lack of space, mounting care and non management of environmental conditions.

7.1 Quality of mountages :

The mounting frames or mountages should provide sufficient and uniform space for the spinning larvae to form cocoons. The basic concept of mountage is to provide an angular uniform space for spinning silkworm so that cocoon formation is easy. Different countries use different types of mountages. The fabrication and types of mountages depend on the locally available and cheap materials in the respective places. If the material and structure of the mountages are not proper, it will affect the shape and size of cocoons, besides increasing the double, deformed and soiled cocoons thereby wastage of silk in the form of floss. A good mountage should possess following qualities :

- It should be convenient for mounting with sufficient and uniform cocooning space.
- Material used should absorb moisture caused due to excretion of urine.
- Material should be cheap, durable and easily available locally.
- It should be amenable for disinfection.
- Easy for cleaning and storage after use.
- Cocoon harvesting should be easy.

7.2. Types of mountages :

Depending upon the locally available materials, sericulturists use different types of mountages in different parts of India and in different countries. An account of the same is given in Table 4.

Table 4 : Different types of mountages used in different countries .

Types of mountages	Mechanism	Country	Spacefor spinning
Rotary	Rotation and hanging, made of card board	Japan	Individual cell
Folded straw	Fixed, wave shaped	Japan	Common
Centipede mountage (Cylindrical or dome shaped)	Fixed, hanging vertically or horizontally, made out of bamboo,cocoonut, plastic with rope and iron	China, Thailand, Vietnam, Nepal, Uzbekistan, India	Common
Twigs (Mulberry, Red gram, Cotton)	Fixed, standing vertically, made out of brush wood	France, India	Common
Plastic collapsible mountages (wave shaped)	Fixed, standing vertically or horizontal in use	India, China, Japan	Common
Eucalyptus / Mango leaves	Fixed standing vertically or horizontal in use and can be hanged	India	Common
Chandrike	Fixed, standing in use, made out of bamboo	India	Common

Source : AICAF , Japan Publication, 1995 : Indian Silk, 43, 2004

A brief description of different types of mountages used in India those are widely used and popular among the farmers is given as under :

7.2.1 Traditional Bamboo mountages

7.2.2 Plastic collapsible mountages

7.2.3 Rotary mountage

7.2.4 Bottle brush mountages

7.2.5 Bamboo spiral mountages

7.2.6 Mulberry twigs / grasses / straw

7.2.7 Modified (hybrid) mountages

7.2.7.1 Vertical fixed type of mountages

7.2.7.2 Shoot rearing rack rotary type of mountages

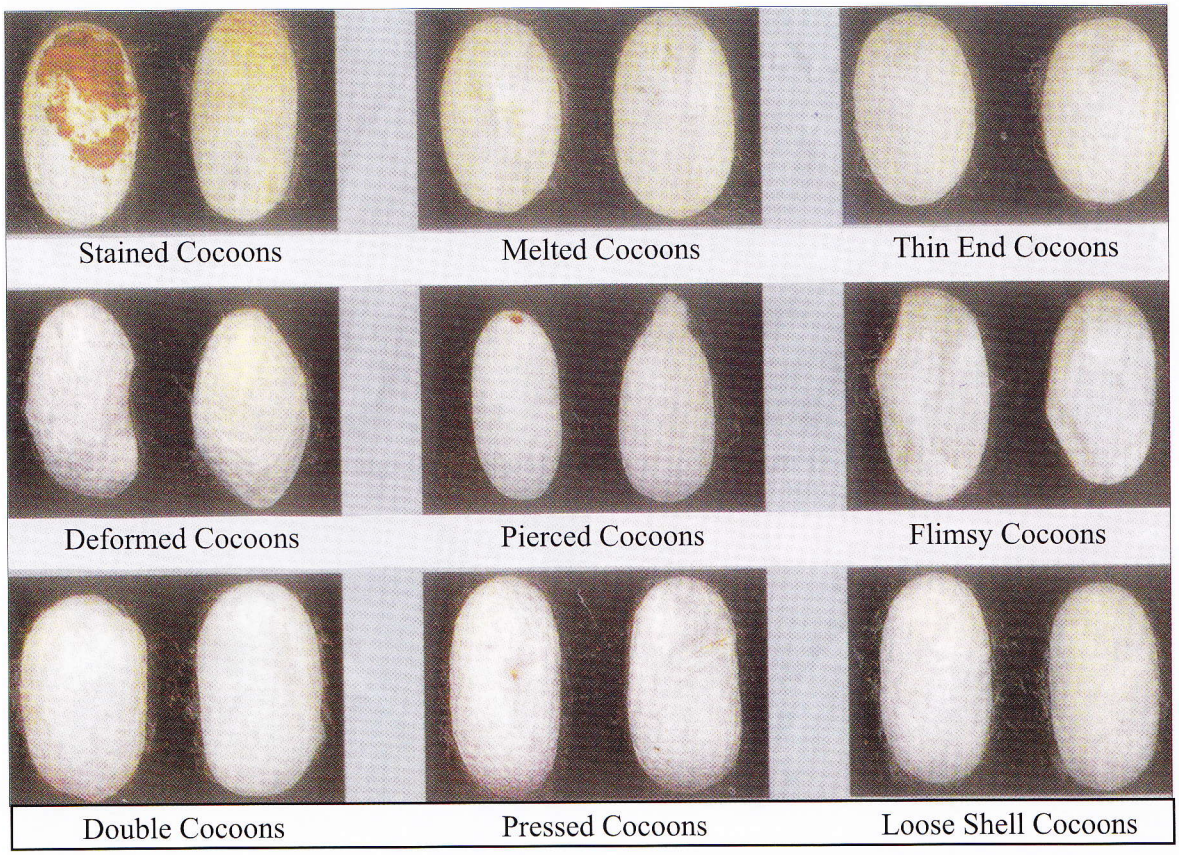

Fig 1 : Different types of defective cocoons

Fig 2 : Mature larva

Fig 3 : Picking of mature larvae

Fig 4 : Self mounting method (collapsilble mountages)

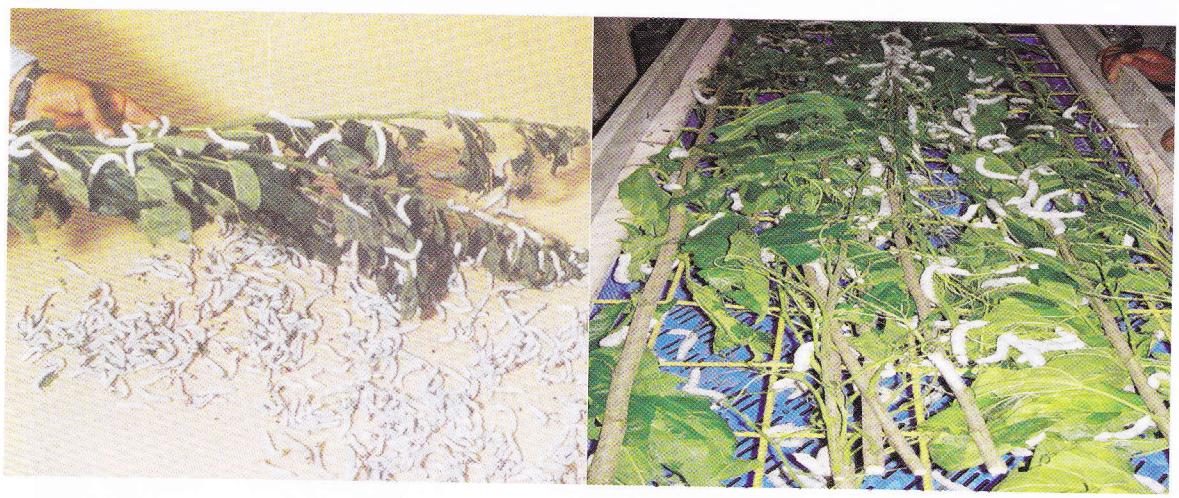

Fig 5 : Jobarai (by hand and mechanised shoot shaking) method

Fig 6 : Bamboo mountages

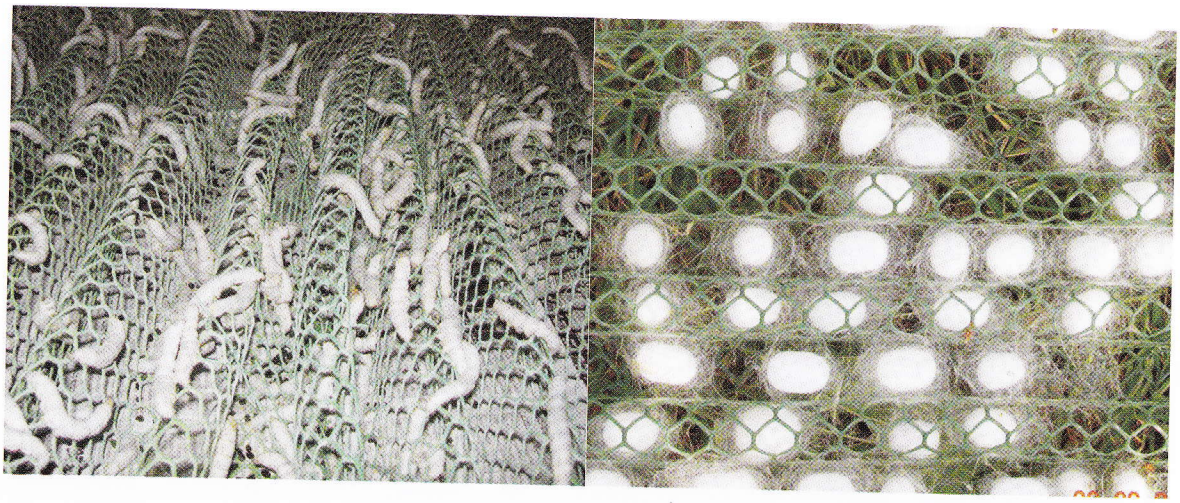

Fig 7 : Plastic collapsible mountages

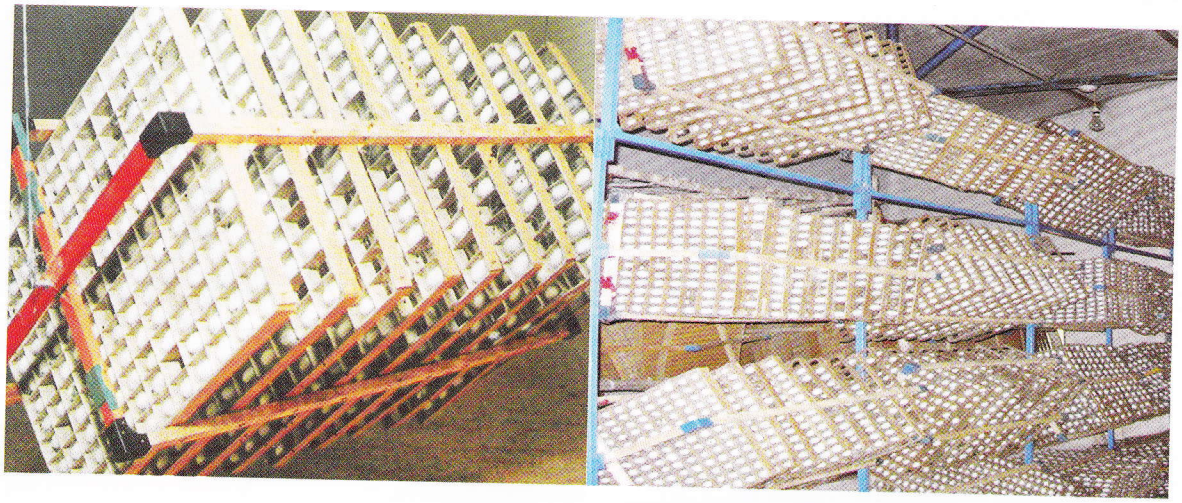

Fig 8 : Rotary mountages

Fig 9 : Bottle brush mountage

Fig 10 : Vertical fixed type of mountages

Fig 11 : Shoot rearing rack rotary type mountages

Fig 12 : Cocoon harvester (hand operated)

Fig 13 : Cocoon harvester (pedal operated)

Fig 14 : Sorting of defective cocoons

Fig 15 : Deflossing of cocoons

Fig 16 : Packing of quality cocoons

7.2.1 Traditional Bamboo mountages (Chandrike) :

Indian farmers use cocooning frame made of bamboo called chandrike. Chandrikes are made of spirally woven bamboo stripes with some holes on a bamboo mat to which two bamboo stick support on the backside. Each mountage is of 6 feet length and 4 feet width and can accommodate 900 to 1000 mature worms depending upon the race. Mature silkworms are collected and spread on the cleaned and disinfected chandrikes at the rate of 40 to 50 worms per sq ft. Chandrikes mounted with mature larvae are kept at an angle of 45 ° to allow urine to fall on the ground and to prevent staining of cocoons (Fig : 6). Mountages with mounted mature larvae are kept under shed and sometimes piled up one above the other. Mountages are turned upside down after 8 - 12 hours for equal distribution of larvae. Though, chandrikes are popular among the farmers and used extensively particularly in southern part of India, they have many disadvantages. Cocoon characters and economics of the mountages are given in Table 5 and 6.

Demerits :

- Falling of urine, flimsy, diseased and dead larvae on the floor leads to contamination.
- Separate space is required for mounting and keeping the chandrikes which is not available with most of the farmers.
- Due to sagging of spirals, uneven space created in mountages affects the shape and size of cocoons which leads to poor reelability.
- More space is required for storage while not in use.
- Mounting needs more time and labour.
- Traditional chandrikes are bigger in size thus their handling is difficult.
- Life span of chandrikes is about 3 - 4 years normally.

7.2.2. Plastic collapsible mountages :

Plastic collapsible mountage is made of plastic mesh of (8 cm long and 6 cm wide) having 11 folds of 6 cm height with length of 3 ft and 2 ft and provide space for 300 to 350 larvae to spin cocoons (Fig : 7). Old news paper thin strips , dry grass or paddy straw are sprinkled on the mountages before and after mounting for better grip and easy anchorage of the spinning larvae. In self mounting system, plastic collapsible mountages are kept directly on the bed with the uniformly arranged folds when silkworms attain maturity. Mature larvae crawl up and spin the cocoons. Dusting of lime hastens the crawling of the worms on to the mountages. In pick up method, arrange the mountages uniformly on the old news paper spread on the rearing bed and transfer the picked up worms on the plastic collapsible mountages uniformly at the

rate of 45-50 worms / Sq ft. Collapsible mountages can be spread on the iron frames of 3 ft and 2 ft size and picked up mature silkworms can be mounted. These collapsible mountages can be kept horizontally on the rearing beds, stands and can be arranged vertically. Extra worms on the mountages are removed after 6 - 8 hours and transferred them on the separate mountages. These mountages are very light in weight, less space is required for storage due to its collapsible nature, easy for handling and disinfection. Due to frequent handling and stretching of collapsible mountages for the harvesting of cocoons it looses it shape, size, peak and corrugation and to retain its originality, 10 collapsible mountages are pressed at a time in pressing tool for some time and tied before storage. Cocoon characters and economics of the mountages are given in Table 5 and 6.

Demerits :

- Due to repeated use it looses it shape, size, peak and corrugation.
- It can be damaged by rodents easily.

7.2.3 Rotary mountages :

Rotary mountages are used in Japan and each mountage set comprises of 10 card board frames of 55 cm x 40 cm size. Each card board has 156 cells or sections (13 rows x 12 sections) and each cell or section dimension is 4.5 cm x 3 cm x 3 cm. The card board frame can be folded completely when it is not in use. A set of card board frames are accommodated in a wooden frame of 120 cm x 58 cm x 48 cm dimension with plastic stoppers to hold each card board with an interval of 8 cm. There are two hooks on both the sides of the wooden frame to suspend the mountages from ceiling for free rotation (Fig : 8). The capacity of rotary mountages is 1560 larvae and about 80 % larvae i.e., 1200 larvae can be mounted. In this type of mountages, the individual cell provides uniform space for individual worm for spinning cocoon and hence cocoons formed is of uniform shape and size. There is no chance for formation of double cocoon, soiling of cocoons by dead worms and loss of silk thread in the form of floss.

Method of use :

Old news papers are spread on floor and rotary mountages frame are arranged horizontally. About 1200 mature silkworms are collected into a plastic basin for each frame by measurement and then transferred to the frame by using comb or spreading directly. Mature silkworms are allowed for 4 to 6 hours to climb on to the mountages. Entire frame is lifted and suspended from the ceiling with the hooks and iron rods in such a way that the cardboard should not touch otherwise it will restrict rotation. Depending upon the height of the wall 3 or 4 sets can be hanged one after another. Urine bag is tied below the lower mountages for easy collection of urine, faeces and to

avoid contamination. Old news paper or vinyl sheet or collapsible mountages are kept below the frames to collect the dropped worms . Mountages are rotated to 180 degree for uniform distribution of larvae, when all worms starts spinning. Mountage are prevented from rotation after a day by locking to prevent breaking of filament. In rotary mountages all the mature silkworms get separate space for spinning the cocoons. Good ventilation helps in drying silk filament quickly and improving the reeling characters. Harvest of cocoons is easier in rotary mountages and labour saving. Disinfection is also easy and storage of cardboards is convenient as they can be folded and require less space. Undoubtedly, rotary mountages are best for the production of quality cocoons. The cocoon characters and economics of these mountages are given in Table 5 and 6. However there are a few demirit of these mountages as given under :

Demerits :

- Initial investment is higher hence most of the farmers can not afford.
- Require separate space for mounting.
- Though it is very good but not readily available as manufacturers are only a few.

7.2.4. Bottle brush mountage :

Eight branches of 15 cm length bamboo thin strips or coconut leaf veins are inserted into coir rope at distance of 3 cm with 24 cm circumference in groups to make them as bamboo bottle brush mountages. Plastic bottle brush mountages are made of plastic and are machine made. Structure of this type of mountages are as bamboo bottle brushed mountages. In this type of mountage, 50 pieces of similar shape, size and circumferences are joint together by an iron rod of one meter with an iron stopper at the end (Fig : 9). For harvesting the cocoons, stopper is removed and in the same way the bamboo thin strips are removed and cocoons can be harvested easily. All these mountages can be used for self mounting, when the 30 % larvae are matured. As soon as the worms mature, bottle brush mountages are lined up on the rearing bed The mountage can be lifted up after 4 to 6 hours and hung vertically from roof or between the two ropes or two wires stretched horizontally in the space above the rearing bed or tied between two walls. Worms left on the rearing bed can be picked up by hand and mounted or another bottle brush mountages can be spread. One meter of mountage accommodates 450 to 500 mature silkworms to spin the cocoons. Life span for bamboo bottle brush mountages are 3 - 4 years and for plastic bottle brush mountages it is 10 years. Urinated cocoons are minimum and reelability improved due to good aeration during the cocooning period. Disinfection, mounting and harvesting operations are also easy in this type of mountages.

Demerits :

- Initial investment is more.
- Not popular among farmers due to high cost and also not manufactured locally.

7.2.5. Bamboo spiral round mountages (Dalla) :

In this type of mountages, bamboo net is woven as tapes spirally at a distance of 5 cm. It has two bamboo rippers as supports of 150 - 150 cm length. These types of mountages are inserted on the rearing trays where old news papers are spread. After picking up all the mature larvae, they are mounted on the bamboo spiral mountages as done in the bamboo mountages. About 300 or 400 larvae are mounted in tray depending upon the size of the tray i. e., 3 or 4 ft. diameter for quality cocoon production. This type of mountages are very common in West Bengal.

7.2.6. Twigs / grass / straw :

Mulberry, mango and red gram twigs are spread on the rearing bed in three dimensional direction. Paddy straw, dried grass and other similar material are spread on the rearing bed when all the worms are matured to facilitate the spinning. It is a cheap , less labour intensive and time saving but shape and size of the cocoons can not be maintained. Chances of double cocoons and other types of defective cocoons formation are more, silk wasted as floss formation is more hence not recommended for commercial cocoons. However, these types of mountages can be used for pure race mounting.

7.2.7. Modified (hybrid) mountages :

To obtain the good quality of cocoons without losing the characters and quality with affordable price, new improved types of mountages were introduced by CSRTI, Mysore. These are designed using card board frames with basic concept of providing separate and uniform space for individual worms. Each card board frame consists of 13 rows and 12 columns of rectangular cells with total156 cubicles. Each cube is of 4.5 cm length x 3 cm breadth. Two new models of such mountages (modified hybrid mountages) developed as detailed below :

7.2.7.1 Vertical fixed type of mountage.

7.2.7.2 Shoot rearing rack rotary type mountage

7.2.7.1 Vertical fixed type of mountages :

One model of modified (hybrid) mountages is vertical fixed type of mountage. This mountage is made out of bamboo mat and card board frames. A loosely woven bamboo mat of size 1.8 x 1.2 m is supported with bamboo sticks on either side. Small holes are left on the mat to provide ventilation. Eight partitions are made on the mat

by fixing split bamboo sticks to accommodate eight cardboard frames of 54 cm x 40 cm size providing 156 cubical in each frame (Fig : 10). This mountage can accommodate 1248 mature worms and 80 % larvae can be mounted and enables to produce about 1.75 to 2.0 kg cocoons.

Method of using:

The mountage can be used by placing the bamboo mat frame on the floor and eight card board frames are placed on eight partition of the mat. The mature worms are mounted to the card board frame @ 130-150 larvae / frame similar to traditional bamboo mountages. A total 1248 worms can be mounted on eight frames fixed on each mountage. The mountages with worms are left on floor for 30-60 minutes and later kept in slanting position for 3 to 4 hours. When worms starts spinning, the frame get fixed to the bamboo mat due to silk thread woven by worms. The mountage are turned up side down one or two times to facilitate uniform distribution of worms to all cells of the frames. Care should be taken to remove the extra worms on the mountage after 6 to 8 hours and remounting them in a separate mountage to get desired quality of cocoons. The mountages may be kept in well ventilated room to facilitate evaporation of urine.

Requirement of mountages:

The requirement of mountages for 100 dfls is decided on the number of larvae brushed. Usually 45 to 50 worms are mounted per square feet and about 1000 mature worms can be accommodated hence about 40 mountages are required for 100 dfls larvae. Requirement of mountages for 1 acre and 2 acre land holding farmers as shown in Table 7.

Advantages of the mountage :

These type of mountages have provision of individual space for each mature larvae to spin cocoon, no double cocoon formation, keeping away from urination and soiling by dead worms, minimum appearance of defective cocoons with low melting besides uniformity in cocoon shape and size. The harvesting of cocoons is easier and cost involved is relatively less compared to all other traditional or improved mountages.

The bamboo mats are commonly available and are cheap, with durability of about 3 to 4 years. While card board frames can be made by locally trained persons. The assembly and disinfection of mountages is easier. The burner or flame gun is ideal for cleaning and then all frames can be packed and piled up for next use, hence storage is easier and require less space. The demerit is the requirement of comparatively

more space during mounting. This mountage is more suitable for the farmers who are traditional users of bamboo mountages. However, the quality of cocoons harvested from this mountage is better than the bamboo mountages. Cocoon characters , economics and requirement of mountages are given in Table.5 , 6 and 7 .

7.2.7.2 Shoot rearing rack rotary type mountage :

Another model of modified (hybrid) mountages is shoot rearing rack rotary type mountage. In shoot rearing, the sericulturists generally opt for self mounting, where plastic collapsible mountages are placed on the bed in the shoot rearing racks and ripened worms are allowed to crawl on to the mountages. When expected number of mature worms crawl up, the mountages will be shifted to other rearing bed already spread with old news paper or the worms will be allowed to spin cocoons on the same rearing bed itself to save the labour. In this mounting practices, worms waste considerable amount of silk as floss.

Keeping in view of the above demerits of collapsible plastic mountages through self mounting system and to improve the quality of cocoons, a new rotary type mountage was developed with the facility to accommodate the mountages within the shoot rearing rack itself.

Preparation of mountage :

Two or three rotary card board frames (156 cubicles in each frame) are fixed on a wooden rectangular frame of length 115 cm (172 cm for three card board frames), width 44 cm, 2.5 cm height and frame thickness of 2.0 cm and rotary card frames are tied with plastic thread to avoid falling. Two pins are provided on the both sides of the wooden frame to facilitate easy rotation of mountage (Fig : 11). Both mounting methods i.e., self mounting and pick up method can be practiced for this type of mountages

Self mounting :

The shoot rearing rack rotary type mountages (2 or 3 card board frames) have to be kept on rearing bed when more than 30 % of worms are matured. After 1 - 2 hours, the frames with crawled worms will be lifted and hanged in between shoot rearing racks where worms are already removed by pick up method. However, this method is more effective only when worms attain uniform growth and maturation. Care has to be taken to remove extra worms on the mountages after 6 to 8 hours and remounted on the separate mountages.

Pick up method :

This method is more convenient as it helps in getting uniform quality of cocoons as fully mature silkworms are picked up and mounted. In this method, old news papers are spread on the shoot rearing rack where worms are removed by pick up method and frames are kept on these old news paper. About 250 - 300 worms are kept in two or three heaps or mounted on the mountage, kept horizontally. The use of old news paper at the bottom prevents worms re-entering into rearing bed and facilitates easy crawling and distribution of worms into cells of the frames.

The shoot rearing rack rotary type mountage along with mature worms are hanged to the racks of shoot rearing stand by fixing thread or hooks for easy rotation of mountage and then the news paper can be removed from the bed. The mountage starts rotating due to weight of the crawling worms which facilitates uniform distribution of worms into cells. Care should be taken to tie the mountage at distance of one or two inches gap between top and bottom of rack and gap between each mountage should be maintained equally to facilitate easy rotation. It is preferable to remove extra worms on the mountages after 6 to 8 hours and remounted to new mountages.

Requirement of mountage :

Each mountage provided with two card board frames which can accommodate 250 to 300 larvae and if it is three card board frames about 400 to 450 larvae can be mounted on the such type of mountages. One hundred fifty 2 card board frame and 100 three card board frames are required for 100 dfls (40000 larvae). Requirement of mountages for 1 and 2 acre land holding farmers is given in Table 7.

Advantages of new mountage :

While using shoot rearing rack rotary type, for mounting of worms do not require separate mounting hall. Extra space and labour can be saved upto 75 and 25 % respectively compared to traditional type of bamboo mountage. This mountage provides space for individual mature worms to spin cocoon and the rotation of mountage helps in uniform distribution of the worms to all cells. The wastage in the form of floss is minimum, double cocoon are not formed and cocoons are kept away from urination and soiling by dead worms as urine and litter falls into rearing bed enabling mounting environment clean and hygienic. Humidity is not increased in rearing bed as observed commonly in self mounting system by use of plastic mountages. No injury to the falling worms from mountage due to cushioning effect of rearing bed compared to rotary and other mountages where estimated loss is 1.5 to 2.0 %. In self mounting system of plastic collapsible mountages, the formation of bed cocoons are more and soiling of cocoons is common due to re - entry of larvae into rearing bed. However, in new mountage cocoon bed cocoon formation is minimum. The harvesting of cocoons

is easier and cost involved is relatively less compared to all other traditional types of mountages. The disinfection of mountage is easier and storing also require minimum space compared to other mountages. Cocoon shape in these mountage is uniform unlike in plastic and traditional mountages. The quality of cocoons harvested from these mountages is better than all other traditional mounting system and mountages, these cocoons fetch Rs.10 to 15 / kg higher price (Table 5 and 6).

7.3 Mounting density :

Mounting density plays a very significant role in determining the cocoon production quality despite the healthy silkworm larvae are mounted. In India, maximum used mountages are bamboo made chandrike follwed by collapsible mountages. Other types of cocooning frames are not much in use . About 40 to 50 mature silkworm larvae can be mounted per square feet in the widely used chandrikes and plastic collapsialble mountages while 450 to 500 mature silkworm can be mounted in bottle brushed mountages of one metre length. The rotary card board mountages has 1560 cubicles but 1200 mature silkworm larvae (80 %) are mounted. The modified (hybrid) mountages i. e., vertical fixed type of mountage can accommodate 1248 but about 1000 - 1100 (80 %) mature silkworm larvae are mounted. While in shoot rearing rack rotary type of mountages if it is two card board frame mountages, 250-300 mature larvae and in case of three card board frame 400-450 mature larvae can be mounted. Bamboo spiral round mountages (dalla) has capacity to accommodate 300 to 400 mature silkworm depend upon the size of the tray 3 or 4 ft diameter. If the mature silkworms are mounted more than the optimum number, defective cocoon percentage (double cocoons and soiled cocoons etc.,) will be increased and cocoon quality will be inferior and if the number is less than the optimum , number of cocooning frames require will be more which become labourious, uneconomical and also require more space for mounting .

8. Disinfection of cocooning frames :

The mountages are the chief source of contamination and pupal death if used without proper disinfection. Most of the farmers use mountages without disinfection which leads to crop losses and increased pupal mortality. Mountages should be cleaned and made free from floss, litter, dust and then thoroughly disinfected for producing quality cocoons. The mountages can be disinfected by 0.3 % spraying slaked lime or 2 % formalin or by 2% bleaching powder . Different type of mountages including bamboo mountages can be cleaned by burning the floss to destroy the pathogens using a flame gun. The mountages should be used 6 to 8 hours after the disinfection. Mountages made up of plastic (collapsible mountages and plastic bottle brush mountages) can be submerged in the disinfectant solutions for 12 hours. The card board mountages can be pooled together on vinyl sheet after floss removal and 10 %

Late harvest of cocoons will lead in reduction in weight of cocoons due to driage and reduce income.

10. Sorting of cocoons :

After the cocoons are harvested, defective cocoons need to be removed to get good price. For this purpose, defective cocoons i.e., flimsy, double, melted, thin end, stained and pierced cocoons should be sorted out before transacting the cocoon lot in the cocoon market (Fig : 14). The general practice of farmers is to remove all the cocoons from the mountages en mass and try to market them together which increases the scope for damaging the reeling quality of cocoons as the strained cocoons invariably affects neighboring cocoons. Cocoons should be sorted out before transacting in cocoon market to get better price and more profit.

11. Floss removal :

After sorting of cocoons, floss can be removed either by hand or by using rod if quantity is small. In large scale rearing , hand operated deflossing machines or mechanised deflossing machines can be used. While using deflossing machine small quantity of cocoons should be fed each time to avoiding damaging of cocoons (Fig : 15). Floss removing is advisable in hybrid cocoons to get good price. In seed cocoons deflossing is not advisable as it leads to pupal damage.

12. Packing of cocoons :

After sorting of the cocoon, floss removal and screening of the cocoons, the good quality cocoons are thinly spread out till marketing. If required they are kept for a long time packed in a basket or bag (Fig : 16). The cocoons become hot due to respiration by living pupae and adversely affect the cocoon quality. The low quality cocoons eliminated often carry diseases and hence should be disposed quickly. Good cocoons can be packed in perforated gunny or plastic bags loosely and should be transported in cool hours to fetch better price.

13. Conclusion:

The type and nature of mountages, mounting technology, spinning conditions and harvesting methods play a vital role in the production of quality cocoons. Correct time of mounting matured larvae and harvesting the cocoon after the pupation is very important to minimise the defective cocoons. Even after raising the healthy and robust silkworms, incorrect mounting technology and use of improper type of mountages

used can lead to inferior quality of cocoons. Further, the activities of mounting , harvesting, sorting and deflossing are time bound and requirs to be attended correctly and at proper time. The details provided in this compilation on the mountages, mounting and harvesting technology along with merits and demerits of the mountages are required to be understood and adopted by the farmers so that the cocoons i.e., marketable end product of sericultural activity can be of good quality which determines returns and profit of the farmer. This will also enable reelers to get better recovery of quality of silk on one hand help the country to produce international grade of silk on the other.

Table 5. : Comparison of and economic characters of cocoon from different mountages (CSR hybrid)

Type of mountage	Cocooning (%)	Double cocoon (%)	Floss (%)	Defective Cocoon (%)	Single Cocoon Weight (g)	Single Shell Weight (g)	Shell %	Reelabitlity (%)
Shoot rearing rack rotary type	93.25	0.05	1.20	1.06	1.810	0.415	22.9	91.95
Plastic collapsible	92.16	6.50	2.50	7.10	1.715	0.380	22.1	83.00
Fixed vertical type	88.00	0.76	1.33	1.78	1.800	0.410	22.7	88.15
Rotary mountage	93.75	0.60	1.15	1.26	1.800	0.410	22.7	92.25
Bamboo mountage	94.00	3.25	3.95	8.59	1.690	0.380	22.5	85.00

Source : The 20th Congress of the International Sericulture Commission, France, 2005

Table: 6. Comparison of different types of mountages (CSR hybrid)

Types of mountage	No of mountages required	Cost /mountage (Rs)	Cost for 100 dfls	Cost of Mounting Labour (mandays)	Life span (crops)	Cleaning & storage care (mandays)	Rate/kg Cocoon (Rs)
Shoot rearing rack rotary type	150	75.00	11,250.00	12	25	1	176.50
a) Two cardboard							
b) Three card board	100	12.00	12,000.00	12	25	1	176.50
Plastic collapsible	160	45.00	7200.00	12	50	2	160.00
Fixed vertical type	40	260.00	10400.00	12	25	1	172.50
Rotary mountage	40	500.00	20000.00	16	25	2	175.00
Bamboo mountage	40	250.00	10000.00	14	25	1	160.50

Source : The 20th Congress of the International Sericulture Commission, France, 2005

Table No. 7 Requirement of the modified (hybrid) mountages

Type of mountage	Rate of mountages (Unit cost) Rs	No. of mountages 100 dfls	250 DFls /crop (1 acre land holding)		500 DFls /crop (2 acre land holding)	
			No.	Cost (Rs.)	No.	Cost(Rs.)
1. Shoot rearing rack type						
A. Two card board frame	75.00	150	375	28125.00	750	26250.00
B. Three card board frame	120.00	100	250	30000.00	500	60000.00
2. Fixed Vertical type	260.00	40	100	26000.00	200	52000.00

Source : Indian Silk , 43, 2004

1 acre requirement can be used for 2 acre in 10 crop system

2 acre requirements can used for 4 acre in 10 crop system

(Assumption- 50000 eggs / 100 Dfls ; 95 % hatching = 45000 larvae ; 89- 90 % ERR = 40000 cocoons)

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