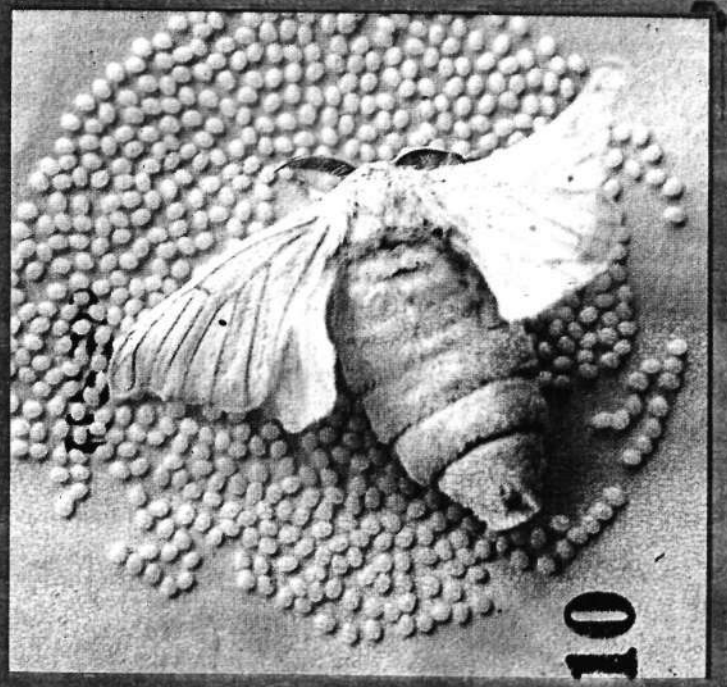
ABOUT THE AUTHOR

Dr. M.N. Narasimhanna is one of the senior sericulture scientists of the country having over 30 years of experience in sericulture Research and Extension. He has published many Research Papers and has represented India in many international sericulture conferences. He was the Director, Central Sericultural Research & Training Institiite, Mysore, Central Tasar Research & Training Institute, Ranchi, Director, International Centre for Training and Research in Tropical Sericulture and presently Director, National Silkworm Seed Project. He is the receipient of many national and international awards Recently, he was awarded the Louis Pasteur award by International Sericulture Commission, Roxne for his contribution to sericulture. He believes in "Sound seed is sound sericulture". He has organised a number of Basic Seed Farms and Egg Production Centres in the country to cater to the needs of different zones. He h^s visited all the leading sericultural countries like Japan, China, U.S.S.R., South, Korea etc. He has published several books on sericulture. Manuals on sericulture published by. Food and Agricultural Organisation of UNO. Rome is referred to as a text book on sericulture. His popular book for the common sericulturists "Hand book on Practical Sericulture" has been repeatedly published in English and translated to several Indian languages. In this Manual on silkworm egg production, he has emphasised the need of quality silkworm seed cocoons and standards to be followed in production of silkworm egg on which stability and success of sericulture depends.

Manual on Silkworm Egg Production

Dr. M. N. Narasimhanna



MANUAL
ON
SILKWORM EGG PRODUCTION

Dr. M.N, NARASIMHANNA
Director
National Silkworm Seed Project
Bangalore.

CENTRAL SILK BOARD
(Ministry of Textiles — Government of India)
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FOREWORD

Supply of good quality disease free silkworm eggs is the main limitation in the expansion of sericulture in India. The main reason for getting good yields in countries like Japan, South Korea and China is, apart from the hygienic conditions of rearing, preparation of good silkworm eggs. The dreaded pebrine disease has to be controlled primarily at the egg preparation stage. In the case of bivoltine silkworm eggs, more care has to be taken in tropical countries to either keep them in cold storage scientifically or treat them by either cold or hot acid treatment. All these require very detailed and precise scientific methods.

Prior to the preparation of Fi hybrid silkworm eggs, there are a number of activities such as basic parental seed farms, preparation of parental layings etc., leading to preparation of hybrid layings. Silkworm eggs preparation is, therefore, a highly complicated activity which requires a lot of organisation and accuracy. It is, therefore very necessary to have a manual for those engaged in silkworm egg production. The manual written by Dr. M.N. Narasimhanna on silkworm egg production is, therefore, timely and extremely useful. I am sure this will go a long way in helping all those engaged in silkworm egg production including the licensed seed preparers.

(V. BALASUBRAMANIAN)
MEMBER-SECRETARY
CENTRAL SILK BOARD.

PREFACE

Success of Sericulture as a cash crop depends on the vitality and disease freeness of the silkworm seed supplied to the farmers. Production of disease free silkworm seed has two important aspects:-

1. Rearing of pure races as parent seed crops, and
2. Production of disease free silkworm seed in grainages.

Rearing of pure races differ from commercial hybrids. They are slow in growth require lower temperature and humidity, poor in appetite and are easily susceptible to diseases as compared to hybrids. Such races are maintained at different levels of multiplication such as P3P2 and Pi without loss of vigour. Selection is imposed at various levels of egg, larval, cocoon and moth stages to ensure the quahty of pure races. Commercial silkworm seed produced from such races maintained by a systematic parent seed cocoon organisation can only show high heterosis for survival, and silk yield. An attempt has been made in this book to explain the technologies to be followed in rearing pure races at the three levels of multiplication i.e., Ps, P2 and Pi levels.

Similarly production of silkworm seed which is not only free from diseases but also having high heterosis, in the commercial hybrids, involve following techniques at various levels, of egg production. Adoption of techniques for egg production in a mass scale, to meet the huge demand of silkworm seed, differs from those of small scale in laboratories. The management of a commercial grainage requires a careful study of the rearing seasons, silkworm breeds, availability of agricultural labour and even social customs in an area. Such factors like

management of labour, adoption of techniques and ultimate association with the farmers govern the success of a commercial grainage.

An attempt has been made in the manual on silkworm egg production to explain the various technologies as applicable to Indian conditions.

Writing 'Manual on Silkworm egg production' involve collection of literature on adaptable technologies in the field. In this direction I received the full cooperation and support from senior scientists of Central Silk Board, my fellow scientists from the research institutes of Central Silk Board, Government of India, sericultural technicia:ns in the various sericultural states and the farmers. 1 profusely thank them for their help. Even though I had an ambition to write a book on Silkworm Egg Production for quite some time, it was possible due to necessary support I received from Sri V. Balasubramanian, I.A.S., Member Secretary Central Silk Board, Bangalore. I thank him in this regard. 1 am grateful to Shri. S. Muniraju, chairman. Central Silk Board Bangalore for his encouragement. I also thank Sri Sampath, Publicity Officer, Central Silk Board, Sri DwarakinathS.R.O., Sri H.K. Basavaraj, S.R.O., Smt. Jalaja Menon, S.R.A., Sri Krishna Murthy, T.A., Smt. Nutan, L.D.C. and J. Geetha Kumari, Jr. Steno of National Silkworm Seed Project who assisted me while writing this book.

If only this book is made use of by the Egg producers and common man who produce seed cocoons, I feel my efforts honoured and rewarded.

Dr. M.N. Narasimhanna
Director
*** National Silkworm Seed Project**
Central Silk Board: Government of India
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FOREWORD

PREFACE

CONTENTS

INTRODUCTION

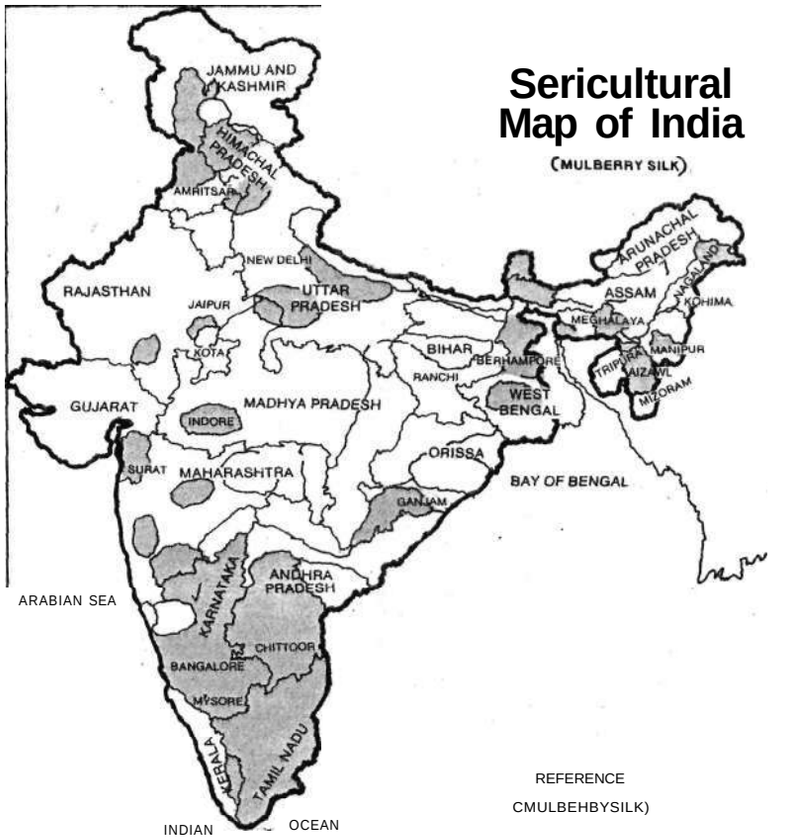
SILKWORM seed is the sheet anchor of sericulture industry. Timely supply of superior quality silkworm seed can alone sustain sericulture as a commercial crop in competition with other cash crops. Sericulture in India is practiced both in temperate and tropical zones where seasons and rearing conditions vary and hence the silkworm breeds differ (Fig. 1). Thus silkworm seeds suitable to ecological conditions of the region has to be supplied for optimum production of silk. In areas where sericulture is practiced as seasonal crops, timely supply of quality seed demands proper planning of seed production and distribution of the same. In India both in univoltine and bivoltine areas of Jammu & Kashmir and Western part of U ttar Pradesh where only one or two cocoon crops are raised, a properly planned production of silkworm seed coupled with its preservation is essential. Similarly, in tropical regions of West Bengal, even though multivoltine pure races of silkworms and their hybrids are reared for commercial cocoon production on seasonal basis, supply of silkworm seed requires proper planning. In this zone production of seed is more difficult because, the seasonal conditions for rearing pure races for seed cocoon production are not conducive.

Karnataka enjoys a celubrious climate for rearing silkworms throughout the year. In this state, seed production can be continuously organised. Even here demand for silkworm seed increases all of a sudden with the onset of monsoon favouring sprouting in vast areas of mulberry fields in rainfed areas. Thus, seed production poses problem for arrangements for sudden supply of large quamity of silkworm seed. Sometimes due to inconsistancies in monsoon the demand for seed fluctuates widely. Inadequate supply of silkworm seed result in wastage of leaf and thus causing loss to the rearer. Thus planning silkworm seed production in the country, cannot be on a common pattern but will depend on seasons, ecology and suitability of silkworm breeds.

Advanced sericultural countries always plan the demand of silkworm seed in advance and are always self-sufficient in seed. Generally, they produce additional 10% of silkworm seed than required. Countries like Japan, export silkworm eggs and this has become a trade India, till recently was importing silkworm seed from Japan to meet its demand in Jammu & Kashmir.

It is estimated that in Karnataka, Andhra Pradesh and Tamil Nadu, one hectare of mulberry under irrigated conditions require 2,500 dfls per annum, whereas the rainfed mulberry of one hectare about I 000 dfls per annum. In West Bengal about 5,000 dfls are utilised for one hectare of mulberry under rainfed conditions because of heavy rain-fall and rich soils. In Jammu & Kashmir where nature grown mulberry is mostly used, an estimate IS made on the capacity of rearer to rear silkworms. On an average one oz. of silkworm is reared by a rearer.

The annual requirement of silkworm seed in the country is estimated to be about 32 crores of dfls However, the overall production is only 25 crores of dfls



Fii'. I Sericultural map of India

annually thereby leaving a gap of 21%.

Emphasis has been laid during the 7th plan to increase the silk production from the present production of 5,214 m. tons to about 9,000 m.tons of mulberry silk annually.

The total demand of silkworm seed by the end of 7th plan is expected to be 45 crores of dfls.

Table — I

Production and requirement of Siii(womi Seed jn India (1984)

Slates	Area Under midberry in Hectares	Total Require-ment (lalth dns)	Total produc-tion (lakh dHs)
Andhra Pradesh	33.603	300.00	88.00
Arunachal Pradesh	30	0.22	-
Assam	600	6.00	4.26
fiihar	200	4.00	4.00
Hitnachal Pradesh	95	2.12	2.12
Jammu & Kashmir	632	40.61	40.61
Kamataka	1.21.500	1.800.00	1.651.00
Madhya Pradesh	322	3.22	3.08
Maharashtra	150	2.00	0.53
Meghalaya	.360	2.70	2.20
Mizoram	50	0.37	0.37
Nagaland	35	0.27	0.2!
Orissa	180	1.70	O.tI
Punjab	57	1.14	1.15
Tamil Nadu	22.245	233.60	110.00
Tripura	407	4.00	0.19
Uttar Pradesh	2.480	10.26	10.26
West Bengal	11.206	600.00	600.00
Manipur	400	40.00	0.90
	1,94,5S2	3,252.20	2,520.00

Silkworm Seed for Commercial Cocoon Production

Quality silkworm seed is the back bone of sericulture industry. A country's silk production and its quality are measured by the quality of silkworm seed it produces. Seeds of superior silkworm brceas ensure high silk recovery. A well organised healthy seed production ensures high cocoon yields.

Standards have been prescrib;d as to the quality of silkworm seed for commercial cocoon production. They are:

a) Only hybrid seed shobld be supplied for commercial silk productipn.

b) Only hybrid seed of app[•oved silkworm breeds which give high heterosis] are to be supplied.

c) The parent seed cocoons used for production of hybrid seed must be only Ifrom a systematic three tier multiplication programme

d) The silkworm seed should] be absolutely free from Pebrine disease.

e) Eggs are to be produced by following standard technology of seed prod ilction.

Hybrid dfls produced by adopjting proper technology can only support the silk industry Hybrid silkworm seeds ensure robustness of larvae andtlj eir quick growth. They are resistant to disease and surv ve better and produce cocoons with rich silk contents as do mpared to pure races, All sericulturally advanced cou jitries use only hybrid seeds.

Disease freeness is the primary factor of quality seed. Even a seed of high heterosis with Pebrine disease can be fatal. Pebrine is a sporozoan disease, which is not only contaminalive but also "Hereditary." It is a transovarial disease, carried only from the diseased mother moth.

The production of high quality seed which is absolutely free from Pebrine disease is essential for successful cocoon crops and flourishing sericulture industry. Only such hybrid seeds, which are free from Pebrine disease with high degree of heterosis are fit to be called as 'Disease Free Layings'. It is the responsibility of egg producers to organise production of silkworm seeds free from disease and having high heterosis for silk yields.

Production of superior quality silkworm seed involves two aspects viz.,

a) Parental seed cocoon production
b) Silkworm seed production

While the former assures production of high quality parent seed cocoons which contribute for high hybrid vigour in industrial seeds produced, the latter ensures the seed is free from dreadful Pebrine disease. Both are essential components of quality silkworm seed for mdustrial silk production and vital to sustain sericulture as a commercial venture. Thus the aim of silkworm seed production is not only to produce silkworm seed free from Pebrine disease but also with high degree of heterosis or hybrid vigour.

PARENT SEED COCOON PRODUCTION

INDUSTRIAL silkworm seed is a hybrid between two silkworm races. Rearing hybrids have specific advantages such as, the larval duration is shorter, growth rate is faster, they have better survival, yield more silk and cocoons are more uniform as compared to pure races. In fact, sericulture is one of the few industries where hybrid vigour has been exploited to the maximum. Exploitation of hybrids in sericulture was first adopted in Japan as early as 1908. .Fapan, South Korea, China and USSR, which are sericulturally advanced countries rear only hybrid silkworms lor industrial cocoon production.

Karnataka state, in India which is sericulturally more advanced adopted rearing of multivoltine hybrids since 1932. Systematic production and utilisation of hybrids are still wanting in some of the sericultural states in India.

Exploitation of heterosis for higher silk content and better cocoon harvest can only be possible, when the parent silkworm races are properly maintained. When silkworm races are continuously bred for more than 6-7 generations, without any selection for quality of cocoon, they loose their vitality and vigour. Seeds produced utilising such parental stocks naturally yield cocoons

small in size, poor in silk content and worms succumb to /disease quickly. To ensure the vitality of parent stocks, scientists have evolved techniq le of **maintenance** the vigour of silkworm by a systematic seed organisation.' This envisages maintanence of basic stocks of silkworm races, their periodical release ard multiplication for a limited number of 2 or 3 generatic ns only, without loss of vigour, before their use for hybric seed production. Only such hybrid seed can yield rich crops and cocoons with high silk recovery. Thus silkworm seed organisation is a vital programme for any successful sericultural programme.

Evolution of Silkworm Breeds

Silkworm breeders at the esearch institute are constantly engaged in evolving new high yielding silkworm races (Fig. 2). Havin ; successfully evolved silkworm races they are tested with other races for heterosis. Thus, specific combi lations of hybrids of silkworm races having vigour for ill economic characters and resistant to disease are establislhed. The new silkworm races are tested for their hybrids performance. Specific combination of pure races are isol ated for exploitation of hybrid vigour. These silkworm aces are defined with their specific characters for identification. Mysore silkworm race is multivoltine having longer larval duration, slender elongated larvil form, spin greenish flossy cocoons and moths carry s)ecific markings on the wings. Nistari race of West Bengal is multivoltine with shorter larval duration of 18-2(i days, marked larvae producing deep yellow cocoons which are not so compact but flossy. NB4D2is a bivoltine with stumpy larvae without any larval marking i. The larval duration is

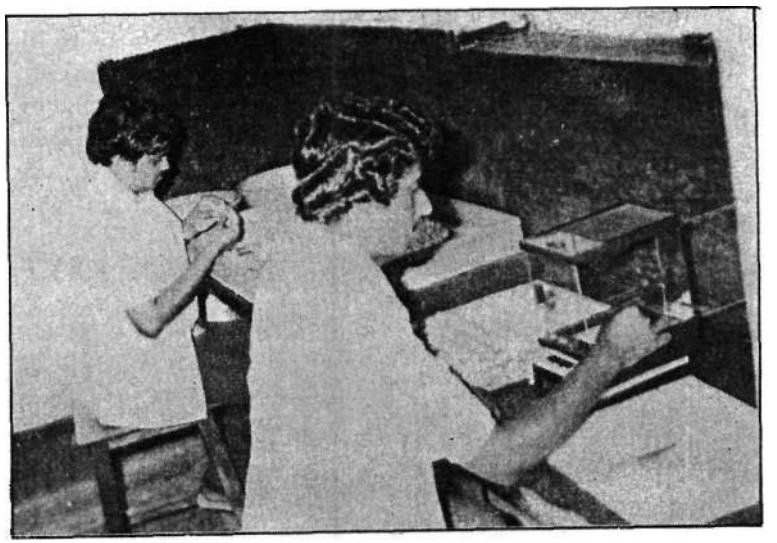


Fig. 2. Silkworm Breeding Section of a Research Institute

26 days, cocoons are white in colour, peanut shaped with mild constriction and elongated shape. Cocoons carry grains. Thus the characters of the races are defined by the breeder who has evolved these silkworm races.

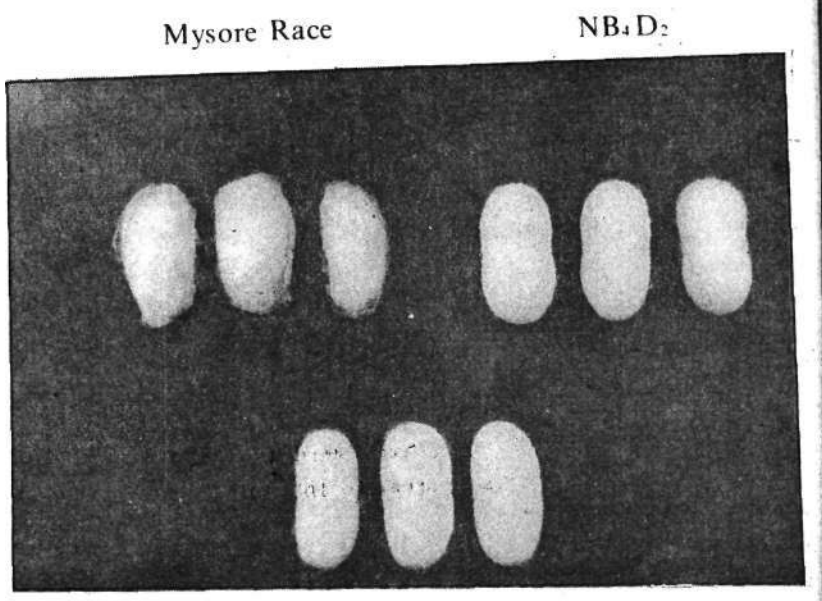


Fig. 3 Parent Seed cocoons and hybrid

By a constant study for the expression of heterosis or hybrid vigour, the breeder also suggest the combinations of pure races having high heterosis for larval growth, cocoon weight, silk content, denier of fibre etc., for commercial production of silk. For eg., Ficombinations of KA X NB4D2named 'Nandi'and NBsNBinare suggested as good bivoltine hybrids for South India. Multivoltine hybrids of Mysore race x NB4D2or Mysore x NBisare superior to Mysore x NB7and Mysore x KA (Fig. 3). Such combinations are suggested by the breeder for production of commercial hybrids.

The silkworm breeds reared in Karnataka are Pure Mysore and Hosa Mysore as multivoltine and KA, NB4 D2, NByand NBi«as bivoltine.In Jammu & Kashmir — bivoltine oval races viz., Chang Nang, Hoalock, Yokwei and bivoltine constricted races viz., Juj, J122, B40 are reared. The newly introduced breeds NB4D2, SH6, YS.i and SFi9are also recommended for Jammu & Kashmir and Uttar Pradesh. Similarly, Nistari, 'G' race of multivoltine origin and KA, NB4 D2, NBrand NBisof bivoltine origin are reared in West Bengal.

Having evolved these silkworm breeds, they are released to the field. It will be the responsibility of those who are engaged in silkworm seed organisation to maintain the basic stock of these races, multiply and supply them to the main stream of seed production. For

this purpose basic seed farms are organised by the Government. The research institutes maintain the breeders stock of these races and can release these stocks and supply in small quantity of 5-10 dfls occasionally or whenever a deterioration is noticed at basic seed farms.

BASIC SEED FARMS

THE basic seed farms are also called 'Pj stations' as they release the silkworm stocks continuously for multiplication.

A basic seed farm has two specific roles to play. Firstly, it has to maintain the silkworm breeds released by the research institutes. The defined, characters of the silkworm breed should be maintained by careful study and selection; The vigour of the silkworm breed is maintained by providing optimum rearing conditions. Secondly, it also releases silkworm stocks at required regular intervals and as per programme to the main stream of seed production. These are multiplied in due course in two generations to meet the demand of highly vigourous seed cocoons for industrial seed production. Basic seed farms are the temples of seed organisation and seed production. These are to be maintained under highly hygienic conditions and manned by highly qualified and experienced silkworm breeders. In some of the advanced countries like Japan, prefecturalircsearch institutes have been assigned this job, while in sericultural countries like China and USSR, these are independent of research institutes and are manned bv qualified silkworm breeders.

The work of a basic seed farm being highly technical, it requires careful study and analysis of the characters of silkworm breeds. Hence these farms are maintained by Government as developmental programmes. These farms are small in size with about 3 hectares in extent with about 2 hectares under mulberry and rearing capacity of about 3,000 dfls only per annum.

a) **Mulberry**

A Basic seed farm should be a small farm with two hectares of mulberry. The soil PH must be in the range of 6-7. Any wide variation should be corrected periodically as required. A spacing of 3' x 3' between plants and rows as in Karnataka (Fig. 4) and 4'x6'as in Jammu & Kashmir (Fig. 5) are suggested. Row system of plantation with 2' between rows and 6" between plants is not good for maintaining silkworm stocks as selection of quality leaf is not possible.

The variety of mulberry planted must be one which produces leaves with high nutritive value and better moisture retention capacity. For southern zone Kanva-2 variety is suggested. For Darjeeling district of West Bengal and Jammu & Kashmir area Nizama Gaishi, Ichinose and Goshio earami varieties are suggested for P_3 Farms. For West Bengal S_1 variety is suitable. Mulberry plantation must have irrigation facilities. Annual application of 40 to 50 tonnes per hectare per annum of Farm Yard Manure (FYM) and red earth are regularly practiced for Karnataka, Tamil Nadu and Andhra Pradesh for maintaining the fertility of soil. The quantity of fertiliser used for mulberry plantation for seed cocoon growing must be much less than the commercial rearing. While the fertilizer dosage recommended for commercial

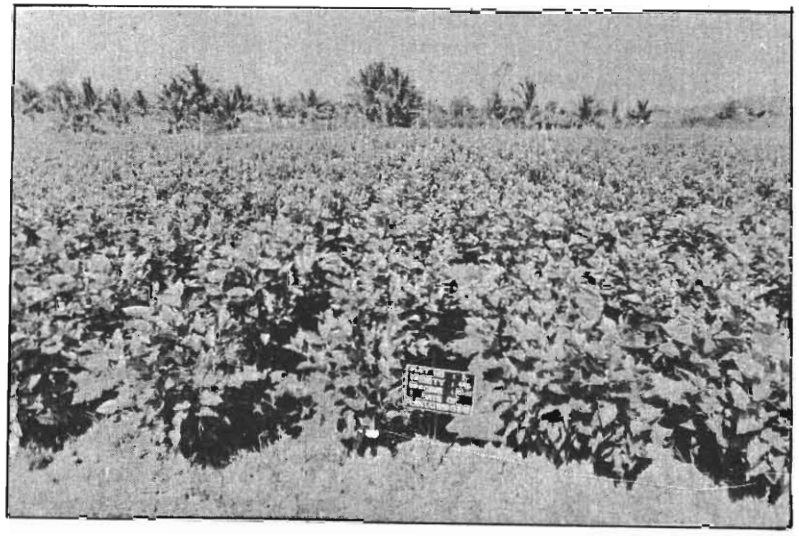


Fig. 4 3' x 3' Mulberry plantation of Karnataka

Fig. 5 4' x 6' Mulberry plantation of Jammu and Kashmir

Fig. 6 Well grown mulberry plantation of a P1farm

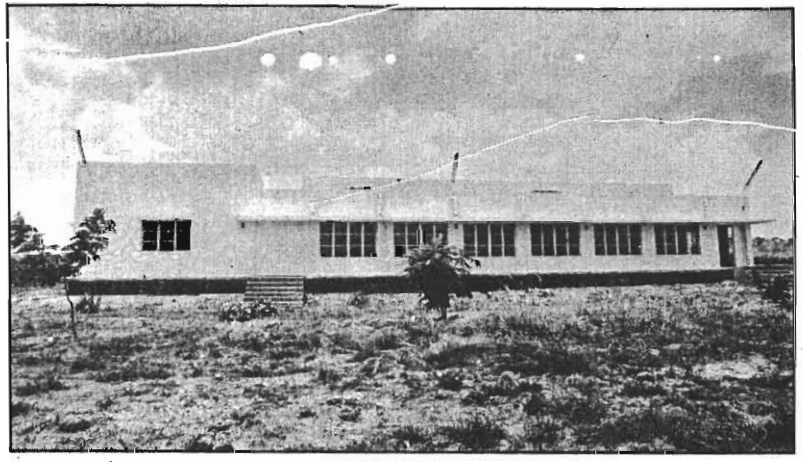


Fig. 7a A model rearing house of Central Silk Board

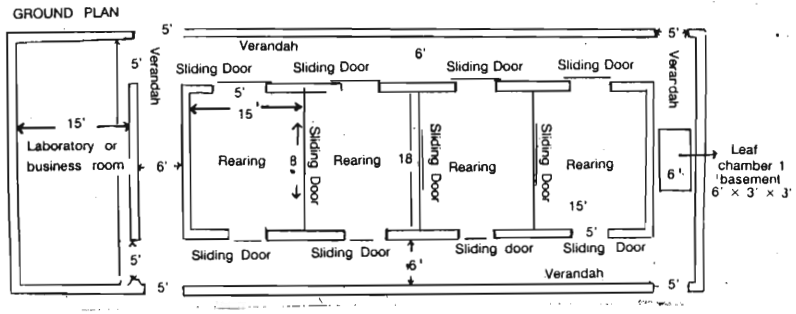
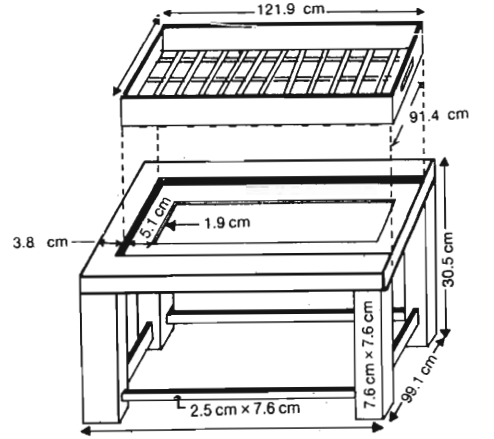
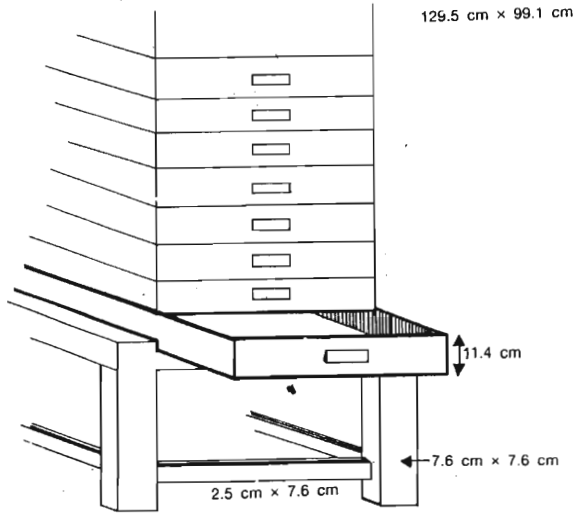


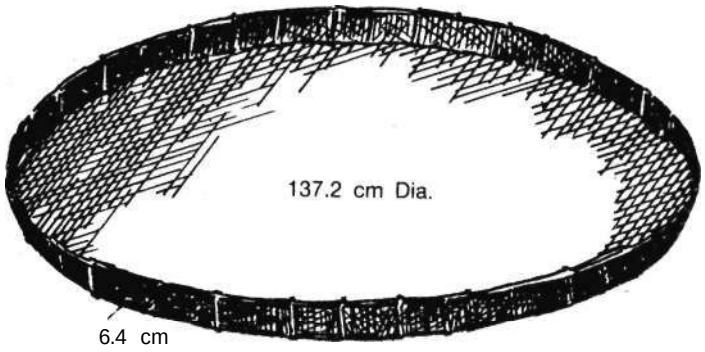
Fig. 7b Ground plan of CSB rearing house



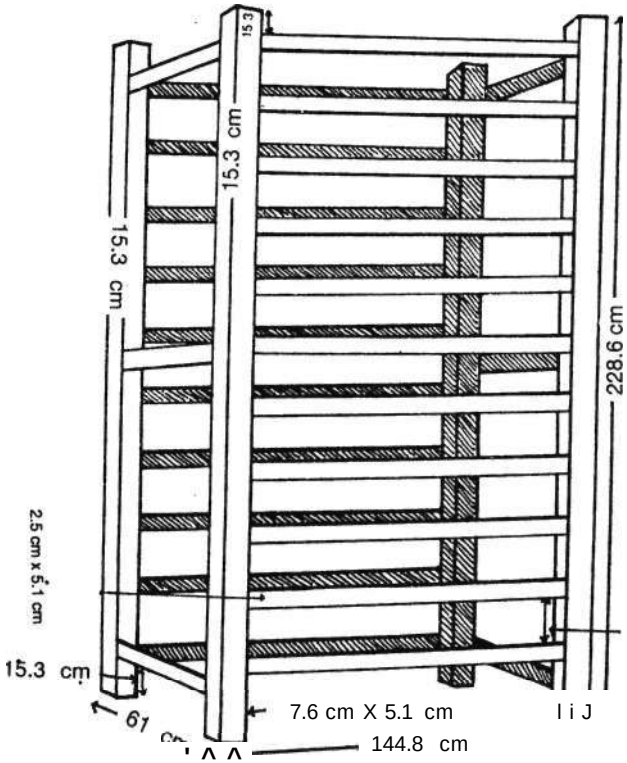


Chawki rearing box with stand

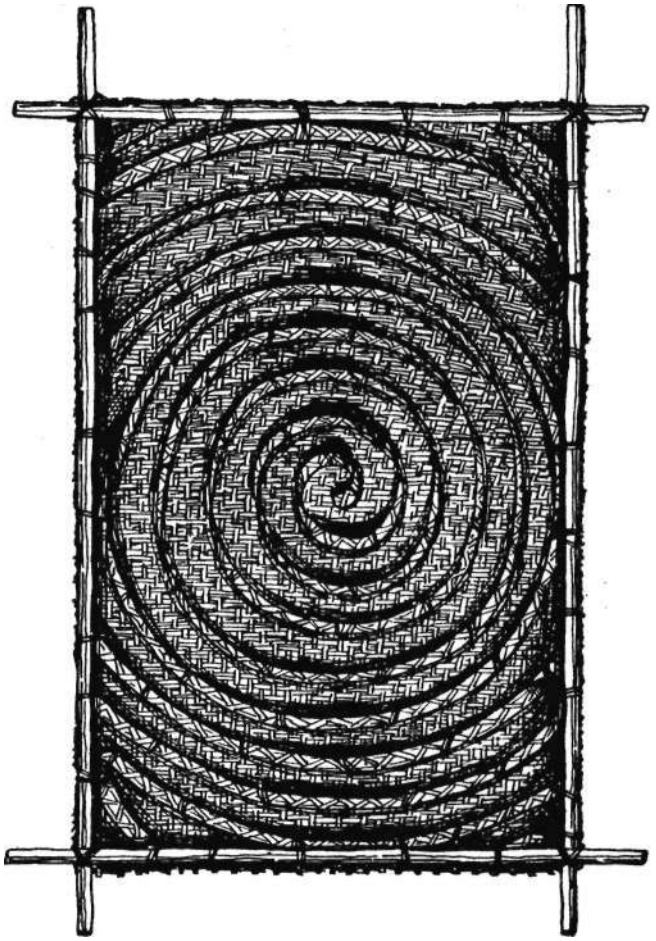
Fig. 8 Rearing equipments



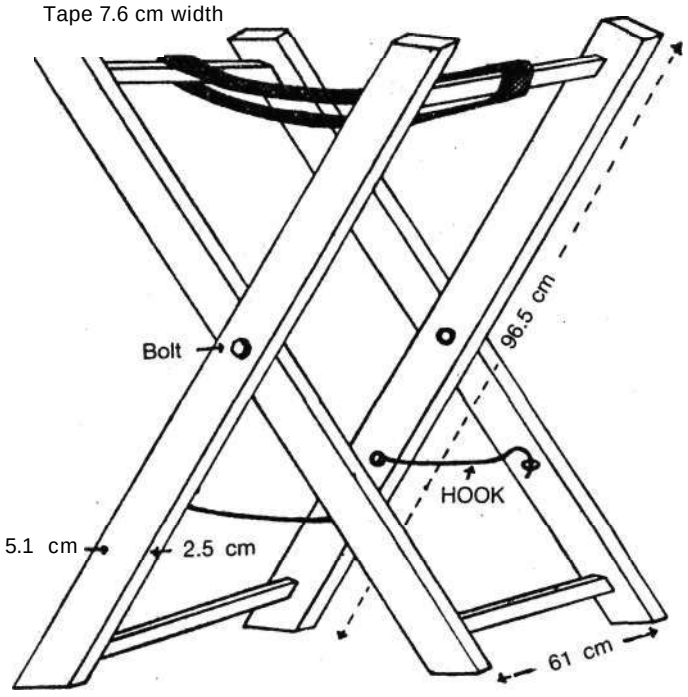
Bamboo Tray (Round)



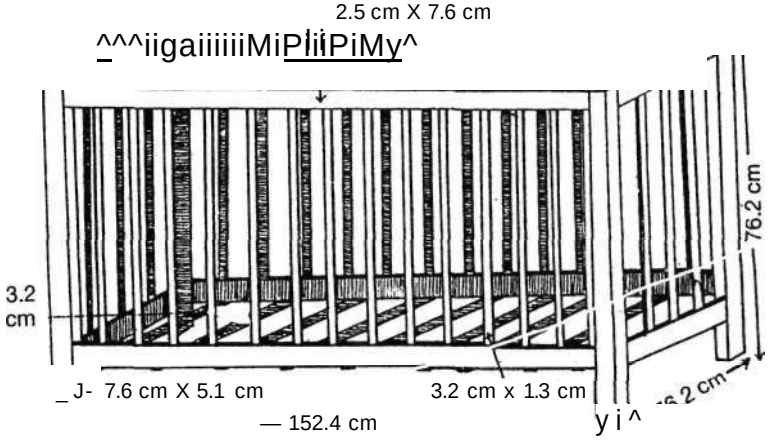
Rearing stand (Wooden)



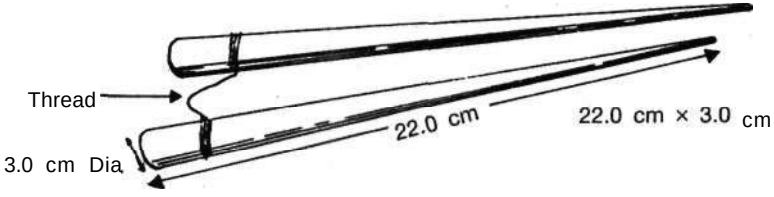
Chandrike



Feeding Stand (Wooden)

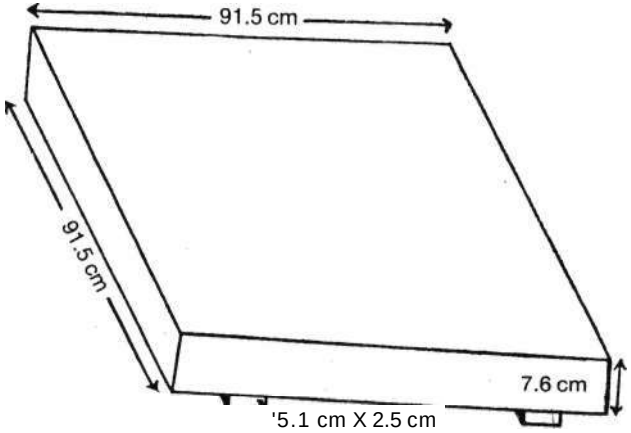


Leaf Chamber

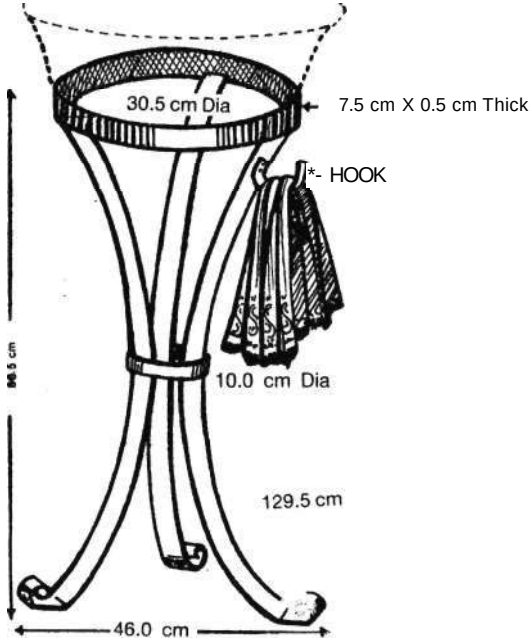


Chop Sticks

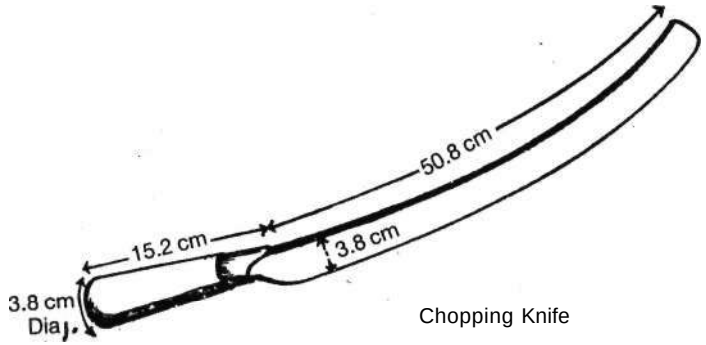
Feather



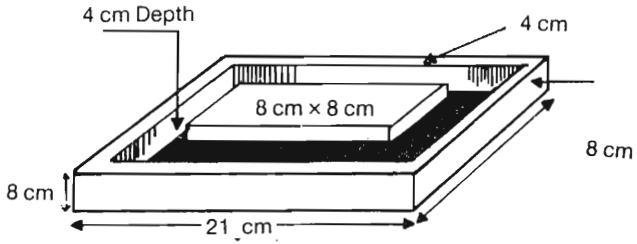
Chopping Board



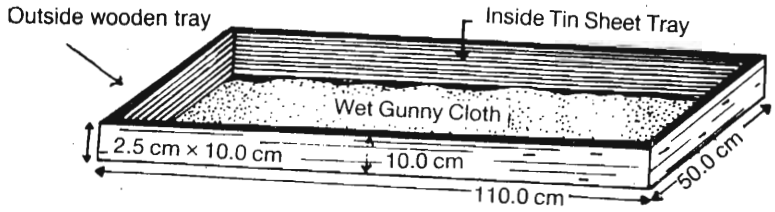
Basin Stand (Iron)



Chopping Knife



Antwell



Foot Cleaning Tray

rearing is 300N: 120P: 120K per hactare/annum the fertiliser application for seed cocoon production should be 250N:100P:100K or even less. Application of more farm yard manure is recommended for seed cocoon production both in P_3 and P_2 farms. For West Bengal conditions recommended FYM and fertiliser application is 20 tons of FYM and 336N:180P:112K of fertiliser/hectare/annum. For Jammu & Kashmir conditions, inputs of 35 tons of FYM and 200N:100P:100K fertilizers per hectare/annum is suggested.

Cultural practices of ploughing and weeding, pruning and irrigation should be followed periodically in a P_3 farm. The plots are divided into small sub-plots for convenience of silkworm rearing and synchronising schedules of rearing (Fig. 6).

Each farm must have two rearing houses of Central Silk Board model, (Fig. 7a & b) one chawki rearing house, a farm house and a small grainage building. In tropical conditions of Karnataka where silkworms are reared throughout the year, the station must be provided with two good rearing houses for rearing one batch once in 20 days. This will ensure the continuous supply of silkworm stocks for the main stream of seed organisation. The rearing houses must be constructed in east-west direction with the width facing the east and west so that the surface exposed to sun is limited. But for conditions of Jammu & Kashmir where silkworms are reared only in favourable seasons the number of rearing houses must be more. This also helps in fully utilising the seasonal production of leaf. It is worth maintaining temperature and humidity by providing air conditioners to the rearing house in warm climate of West Bengal. Requirement of rearing equipments for P_3 farm is given in Annex-I (Fig. 8).

b) Silkivorin Rearing

The aim of silkworm rearing in Pjfarm is to provide optimum environmental conditions for worms for expression of their characters, so that they produce healthy and strong cocoons for egg production. This is the fundamental difference between hybrid rearing for commercial cocoon production where emphasis fof high silk content is made.

Basic stocks are less resistant to diseases as compared to hybrids. Disinfection of rearing houses and maintaining hygienic conditions during rearing is of primary importance. The rearing appliances are thoroughly washed with disinfectants before they are used. They are first washed with 1% bleaching powder solution and followed by 3% formalin solution. The rearing house is disinfected by spraying or by fumigation of 3% formalin. The doors and windows are closed after keeping the washed equipments. They are sprayed with I % bleaching powder solution and followed next day with 3% formalin. About 8.6 litres of 3% formalin is required for disinfecting a building of lOOm-. The doors and windows are opened after 24 hours of disinfection. Disinfection is conducted two days earlier to brushing.

The silkworms require delicate care at rearing. They are to be reared in congineal environment for their growth. (Fig. 9) Young age silkworms must be taken care with attention. It is claimed that temperature and humidity for pure races must be comparatively lower than that of the hybrid rearing. During early .stage 26-27''C with 80%-85% RH is suggested. The temperature and humidity conditions are maintained a day earlier to brushing in the rearing house. This will enable larvae to grow healthy, firm and give rise to moths that lay more

Fig. 9 Silkworm rearing in PiJarm

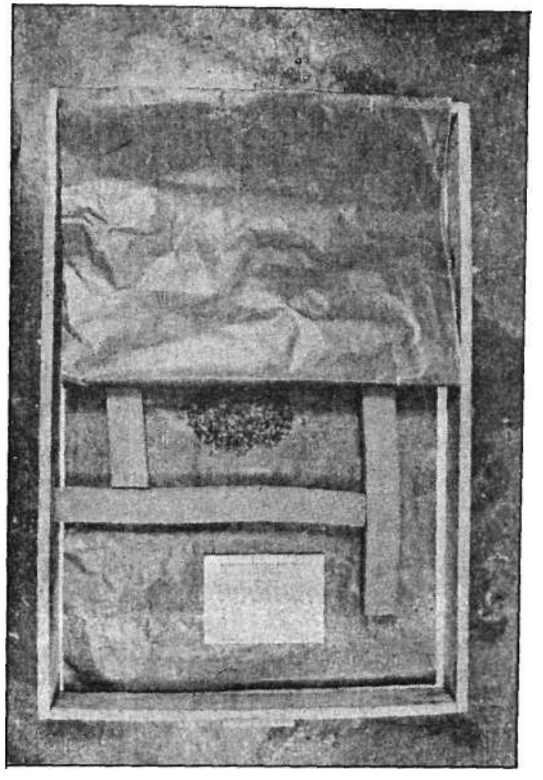


Fig. 10 Chawki rearing'in a Uay

eggs. Hence rearing of pure race is more laborious and requires more labour and skill as compared to hybrids. The silkworms are reared in wooden trays of 90 cms x 60 cms provided with paraffin paper and foam pads. (Fig. 10)

Even during rearing lateage silkworms, ideal environmental conditions are followed as below:

	Temperature	Humidity
111	25-260C	85%
IV	24-25"C	75%.
V	23~240C	709i

The growth of pure race larvae is slow, and their appetite is poor, accordingly feeding of silkworm should be regulated. Feeding should be in smaller quantity but more frequent. It is suggested to give five feedings a day with less quantity of leaf/feeding for pure races as compared to four feedings/day with more leaf for hybrids. The leaf consumed by pure races is less than those of hybrids. Feeding silkworms with large quantity of leaf to pure races lead to fat pupae, which lay less number of eggs. For this purpose, the feed of larvae in basic stations is regulated and the leaf fed from the middle of 5th stage is controlled. This reduction does not mean to skip the number of feedings but to reduce the quantity of feed.

Leaf required for rearing silkworms must be nutritive and properly preserved. Suitable quality of leaf for the age of silkworm must be carefully selected. (Fig. 1 la,b&c). The first largest glossy leaf from the tip, which stands erect when the tip is pulled to a side is ideal for brushing. Quality of leaf for different stages is. the largest

and fully grown glossy leaf, the next and 3rd leaf for 1st Jstage, 4th, 5th & 6th for 2nd stage; 7th and 8th leaf for 3rd stage and 9th and 10th onwards for 4th and final stages. Feeding of tender leaves at final stage leads to improper growth of larvae and incidence of diseases. It also leads to heavy pupae which do not survive.

In order to ensure rearing of pure races scientifically a basic seed farm must have properly qualified technical personnel. Each technician should know the environmental and food requirements of pure races and methods to control them. Requirement of technical staff for Pifarm is given in Annex-Il. These staff should not be frequently 'transferred to enable a continuity in maintenance of stocks and selection procedures followed at different stages of growth.

c) Stock Maintenance

Maintenance of silkworm races evolved by the research institutes without loss of vigour is the fundamental function of basic seed farm. It cannot depend on research institutes for supply of large number of dfls of silkworm races^^for commercial seed production programmes. For maintairting purity of stock, rearings are restricted in a Pi farm. At every rearing not more than 30-35 dfls which are rich in number of eggs are released from the basic stocks. Bivoltines are released from hibernated stocks. Multivoltines are selected from the stocks. The details of the race such as laid on date, lot number etc., are made available on the back of each laying: Before rearing strict disinfection of rearing equipments and rearing house are conducted. First disinfection is done with bleaching powder and lime and later with 3% formalin.

How to Pick Leaves ?

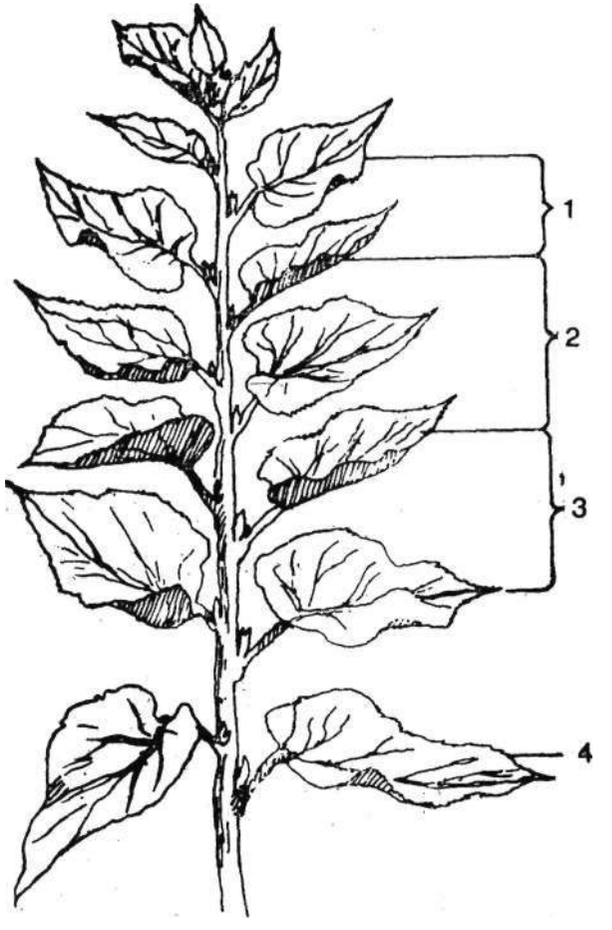


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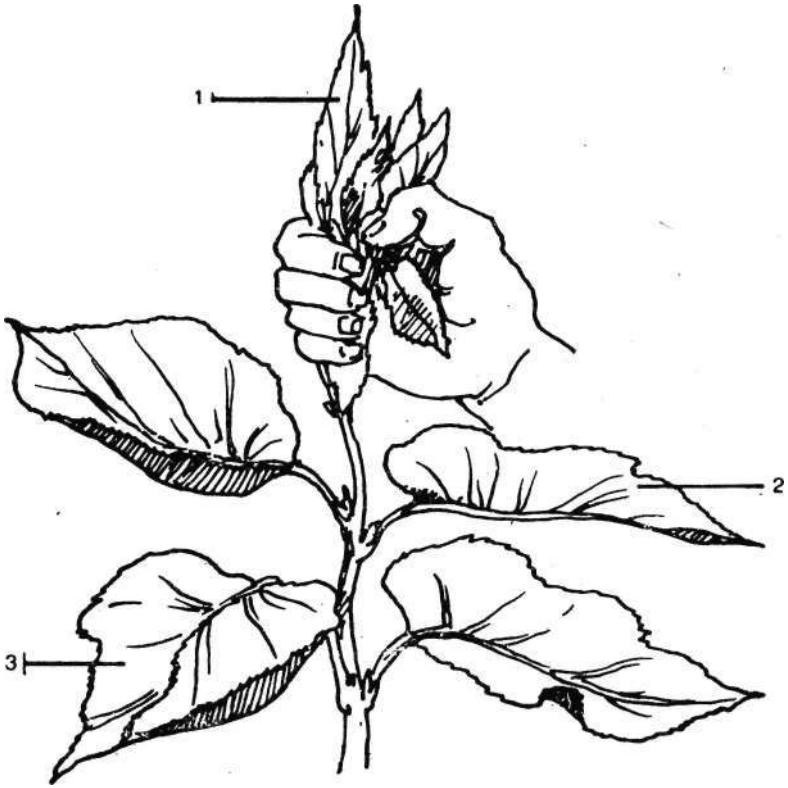
Fig. i la Leaves suitable (or dilTerent ages

Leaves for I age (chawki) worms.



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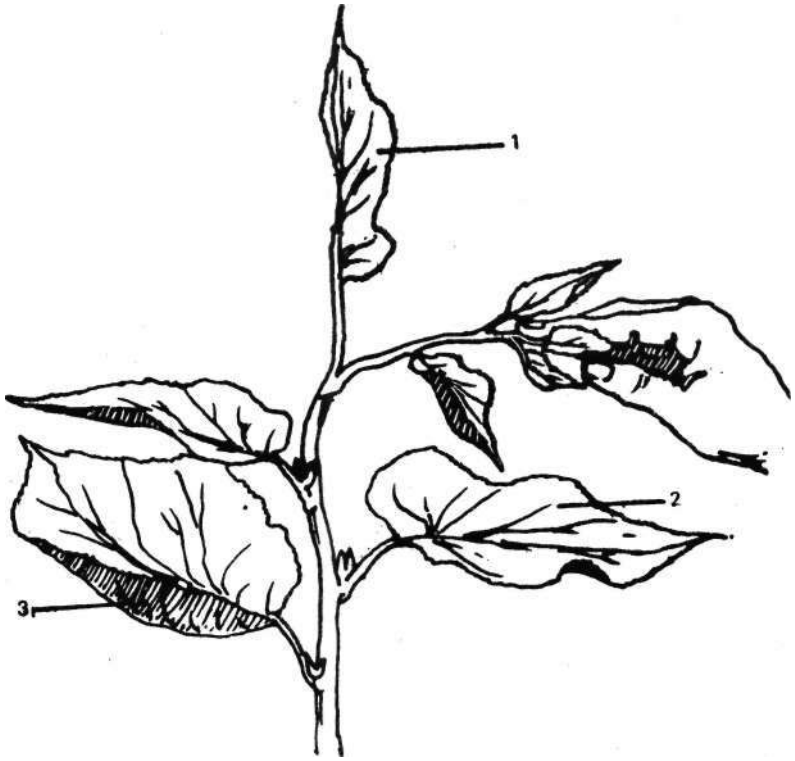


1. & 2. I age. 3. II age.

Fig. 1 I c Leaves suitable for chawki worms

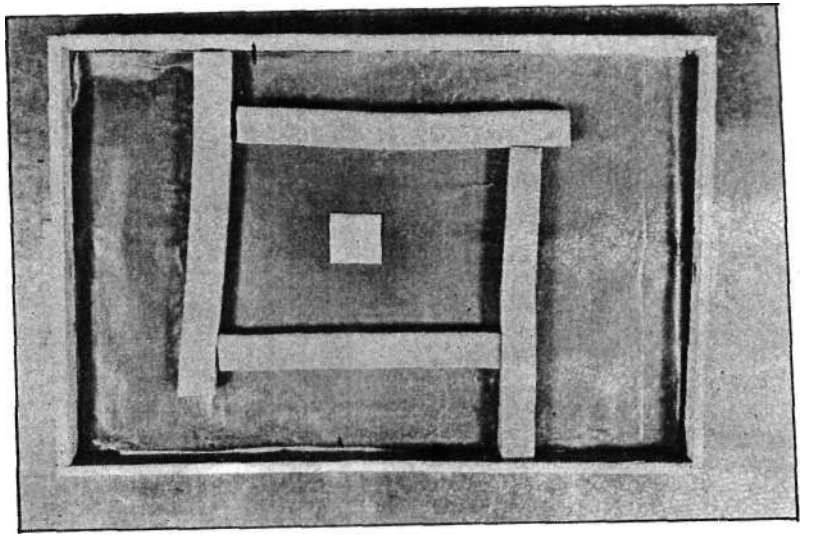
^ After release of eggs they are kept in incubation chamber at a temperature of *IS^C* and humidity cf 75-80%. These eggs when they turn blue on 9th day are wrapped in white semi-transparent tissue paper and kept back for incubation. On the due date of hatching, each dfl is kept separately in wooden trays which are provided with paraffin paper at the base (Fig. 12). For brushing, powdered charred paddy hiisk is sprinkled on the hatched worms. (Fig. 13). This will enable the worms to leave the egg shells and crawl over the powdered husk. After 5-10 minutes, chopped leaf of 0.5 cm square is sprinkled over the worms. Worms crawl onto the leaf in 10-15 minutes. They are tapped to the wooden tray with paraffin paper to the base. After brushing wet foam pads are kept all round and covered with another sheet of paraffin paper for chawki rearing. Soon after brushing, the eggs on the card are counted, hatching percentage, dead eggs and late borns are recorded. Of the 30 or 35 dfls brushed, only 20 dfls which sijow high hatching percentage and large number of eggs are retained for rearing and stock maintenance. - ^

Hygenic conditions are maintained in the rearing^ 'house. Before entering the rearing house the legs and hands are thoroughly washed and dipped in formalin. The rearer must use a coat and labourers must use apron. The staff and labourers after entering the rearing house should not frequently come out. This reduces the chances of contamination from diseases. Before each feeding of silkworms, hands should be dipped in *2%* formalin solution, which is always kept outside the rearing room in wash basin. Each person working in a Pifarm is provided , with feather for brushing and a pair of chop sticks to provide spacing.

Silkworms are reared in wooden trays provided with paraffin paper for the base and top and foam pads in between for retention of humidity (Fig. 14). Temperature and humidity for chawki rearing is maintained at 26-27"C and 80-85% RH'respectively. As suggested earlier leaf picked for chawki worms are preserved in wooden leaf chambers, covered with wet gunny cloth on all sides and on top. If quantity of leaf is small they are stored in big earthern pots covered with lid and kept in wet sand bed (Fig. 15). The earthern pots have small holes on top for ventilation.

Leaves are cut to bigger size for feeding as worms grow. For chopping the leaf, the chopping board must be kept on a mat and leaf cut on the board is directly collected in the plastic basin, which is kept clean (Fig. 16). If leaf chopped is more, the same can be kept on the mat and collected for feeding, chopped leaf thrown on the floor should never be used. Silkworms are fed five times a day at 6 A.M.,10 A.M.,2 P.M., 6 P.M. and9 P.M. According to growth rearing space is increased.

it is better to avoid cleaning during 1st stage. To allow bed to dry up higher spacing is given. 30 minutes earlier to, feeding, paraffin paper is removed and beds exposed. After feeding, the rearing bed is covered with paraffin paper after keeping wet foam pads all round. Worms settle for 1st moult in 3-3'/^ days. While stopping the bed for moult, fine lime powder taken in a muslin cloth is sprinkled on the worms and the top paraffin paper is removed to allow leaf in the beds to dry. Feeding must be resumed for 2nd stage only when all worms have come out of moult and rearing continued. Only one or two cleanings are given during 2nd stage by using cleaning nets. Worms settle for 2nd moult jn 2'/^-3 days. Care



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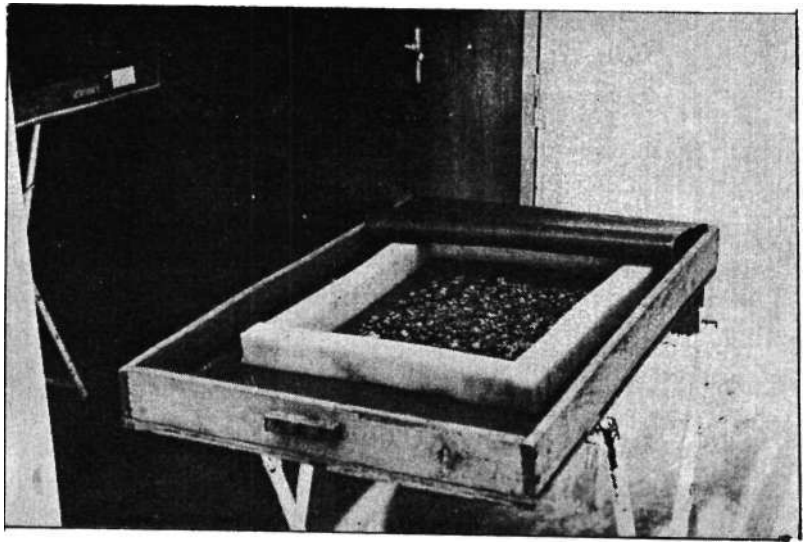
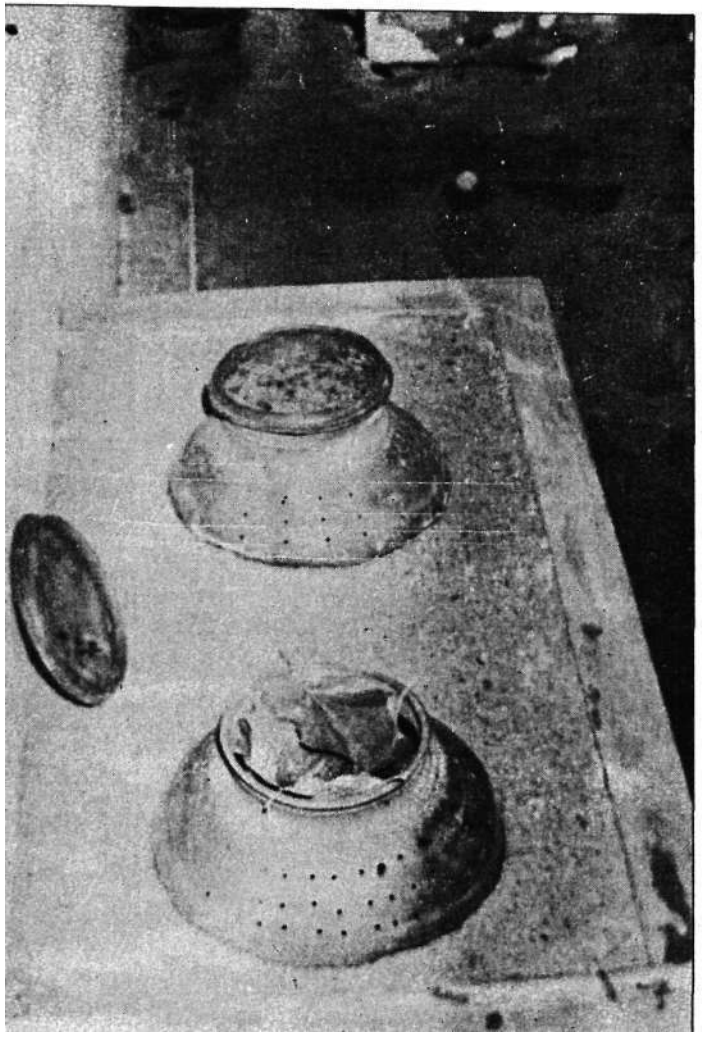


lig. 14 C'hawki silkworm rearing



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f-ig. 15 Picscnation of chawki leaf in carthern pots

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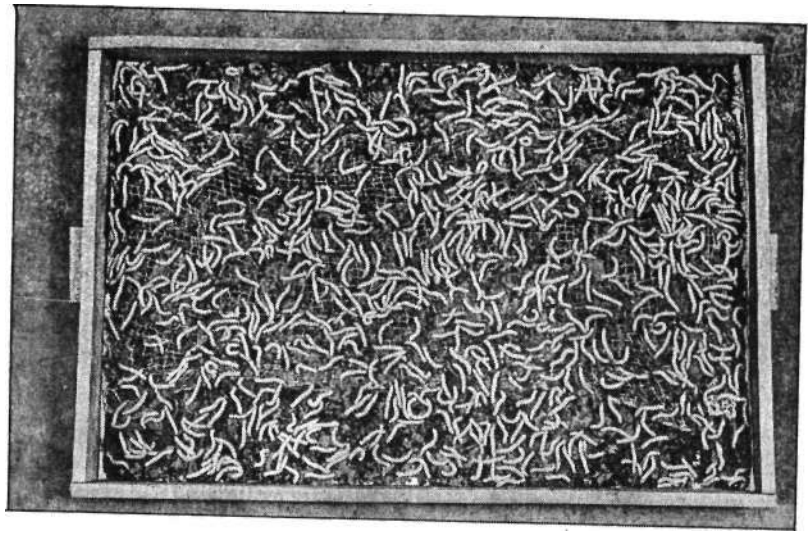
Fig. 16 Leaf chopping for chawki worms



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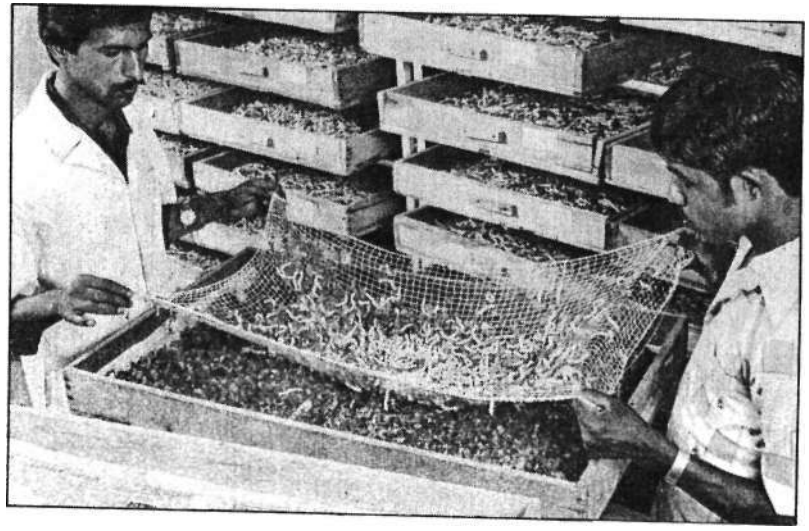

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should be taken at every stage of growth. Proper quality leaf must be picked from the plant, preserved and fed from time to time. The growth of worms is closely watched and care is taken at moult.

For later age silkworms, an environment of 23 to 25"C temperature and 70%-75% humidity with good light and ventilation is maintained and proper spacing is given. The quality of leaf fed to 3rd and 4th stage differ from the 1st and 2nd. The leaf must be medium type, which is 7th or 8th one from the largest glossy leaf. It should be from a plot which is provided with heavy dose of farm yard manure and red earth. Leaves are preserved in wooden leaf chambers covered with wet gunny cloth. Leaf plucked from the garden in the early or late hours of the day are preserved in the above manner and gunny cloth should be made wet from time to time. Leaf chambers with leaf should never be kept in the same rearing room. Leaf chambers when kept moist, builds up humidity in the rearing room. Leaf is chopped to size 4-6 sq.cms for 3rd stage and entire leaf is giyen from 4th stage onwards.

Cleaning of beds is practiced by use of cotton nets, the net size is 2cms square for 3rd age and for 4th age (Fig. 17a&b). The net is spread before the 2nd feeding of the day on the worms and leaf is fed over the net. In about 20 minutes all worms crawl through the net to fresh leaf. The worms with net are transferred to another tray. For 3rd stage rearing the top paraffin paper covering the bed is removed and only the lower one is retained. The foam pads used in 2nd stage are also removed. Proper spacing is given at each stage. By the time worms settle for 4th moult a spacing of 60cms x 90cms is given to the worms ofadfl. Grown up larvae at 5th stage are transferred to bamboo

trays of lOScms diameter or to 2 wooden trays of 60cms x 90cms. Bamboo trays are light and easy to handle. Proper typeof leaf isfed 5 timesaday at6 A.M., 10 A.M., 2 P.M., 6 P.M. and 10 P.M. Beds are cleaned with nets once a day. As the worms grow more spacing and more leaves are provided (Fig. 18).

Temperature of 23 -25"C and humidity of 70%-75% as mentioned earlier depending on the stage of growth of larvae is maintained. As worms grow entire leaf is fed. Before feeding it is better to spread a mat so that the leaves falling on the floor are not used. This is a crucial period of rearing. If tender leaf is given to the worms, the worms soon suffer from diseases.

About.two round bamboo trays of 105cms diameter spacing must be given for each brood of worms at final stage. Cleaning of beds by using cleaning nets is preferred. At final stages of rearing care should be taken to regulate the frequency and quantity of leaf to enable the larvae to grow firm, healthy and to prodyce moths that lay more eggs, which is the aim of rearing basic stocks. Proper data from hatching to rearing for each bed is maintained in a log sheet. A proforma of a log sheet is given in Annex-Ill.

At the time of-mounting, the worms are mounted on small mountages broodwise separately (Fig. 19). In order to protect the worms crawling from one bed to other and getting mixed up, they are covered with mosquito curtain cloth.

On the 6th day, the cocoons are harvested (Fig. 20) broodwise, after harvest, flimsy cocoons; deformed Cocoons, Uzi infested cocoons are sorted out and only 'good cocoons are selected. Thfc performance of the broods are analysed for the following characters:-

a) Effective rate of rearing i.e. No. of healthy pupated cocoons to hatched worms and its percentage.

b) Number of double cocoons

c) Cocoons that conforms to racial character

d) Cocoon weight

e) Shell weight

f) Shell percentage (for studying cocoon weight, shell weight, and shell percentage 10 male and 10 female cocoons at random are picked weighed separately and average taken)

g) In each brood about 5 cocoons are reeled on an eprouvette to find out filament length and denier of the filament.

The data fpr the above characters are collected individually for each of the broods reared and recorded on t'ne log sheet of rearing.

The data of all the beds of the above character are tabulated and only those 10 elite healthy broods which show maximum survival cocoons with healthy pupae, maximum cocoons which conform to the characteristics of the breed and showing high cocoon and shell ratio are selected for breeding and maintenance of stocks and other batches of cocoons are rejected.

(d) Selection of Cocoons for Breeding

Selection of cocoons conforming to the characters of the race is a highly technical job. One must be careful in selecting cocoons. Carelessness at this $tage leads to variations in the cocoon characters and the loss of vigour of the stock. Selection is practiced by two methods viz.,

i) Visual selection
ii) Individual cocoon selection

(i) Visual Selection

Visual selection of cocoons helps in identifying the inferior grade cocoons, which includes the stained cocoons, flimsy cocoons etc., which are generally eliminated at the time of harvest itself. From each of these selected broods best cocoons are selected by visual selection. Visual selection is only a means to collect large number of breeding cocoons which are similar to the approved characters of the race (Fig. 21). In Japanese breeds one can select cocoons with proper constrictions by visual test. Similarly in Chinese races the oval non-flossy and flossy cocoons and those with grains on the cocoons are identified and selected. Simultaneously each of the cocoon is tested for its build. For this purpose the cocoons are taken by hand and rolled between the middle finger and the thumb. If there is any improper build in the cocoon formation it can be easily identified as that end becomes flat. Such improperly built cocoons are not good for breeding and eliminated. Similarly, pointed cocoons and thin end cocoons are identified and rejected. For this purpose the cocoons are held between the middle finger and the thumb. A slight pressure is applied at the tip of the cocoons with the fore-finger. The thin end show a depression, thereby indicating the looseendofthetipof the cocoons. Such cocoons are not fit for breeding. A silkworm breeder in a research centre can select the cocoons of his choice for further breeding, but in P.i station, the breeder has to select the cocoons defined for the character by the breeder.

(ii) **Individual Cocoon Selection**

Cocoons selected by visual selection are cut and sex separated. They are kept separately in cocoon counters in

Fig. 18 Rearing of Final age silkworms

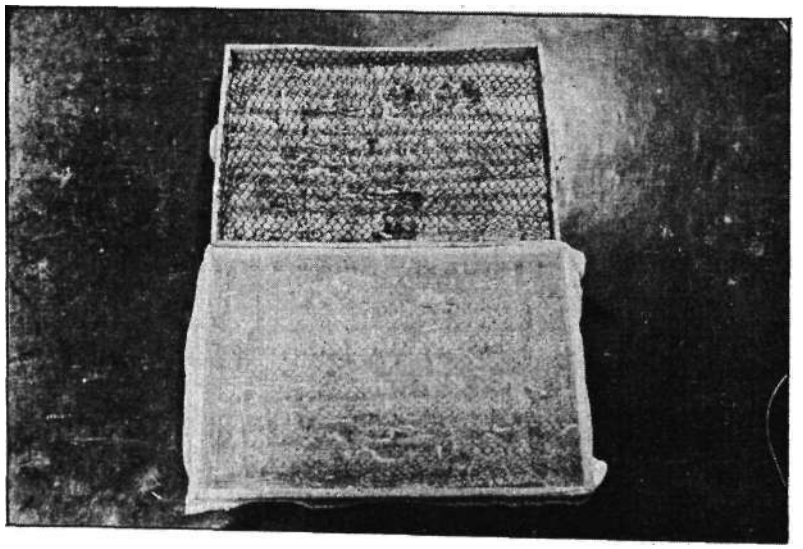

Fig. 19 Mounting silkworm in plastic mountages in a Pilarr

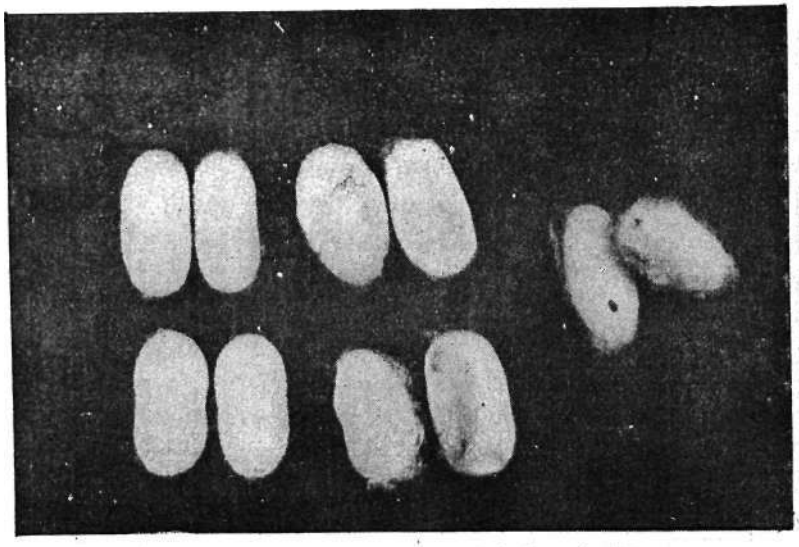

Fig. 20 Good. flimsv and uzi infested cocoons

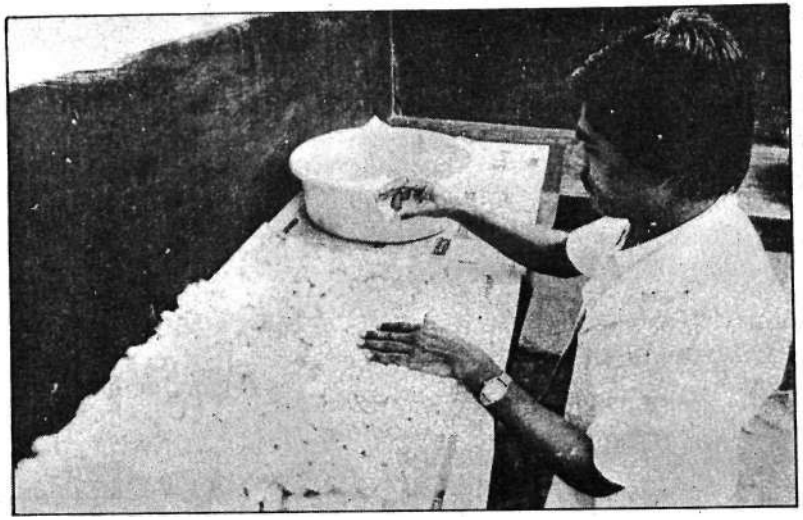

Fig. 21 Visual selection ol cocoons

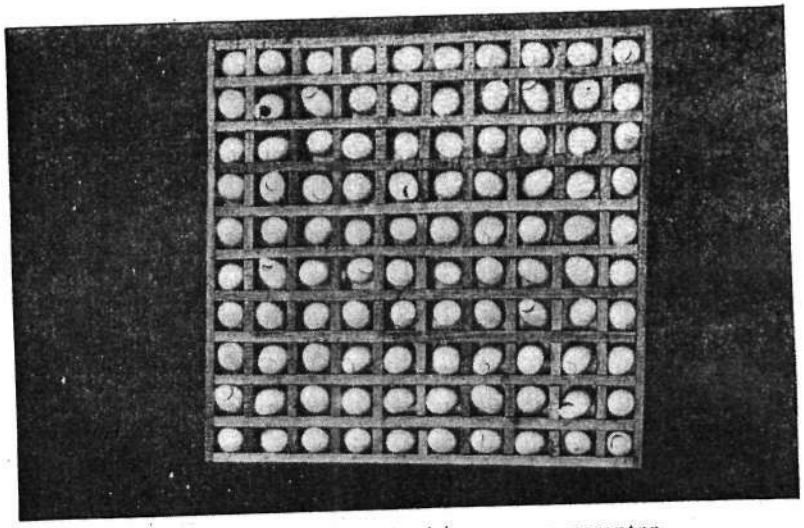

Fig. 22 Cocoons arranged in cocoon counter

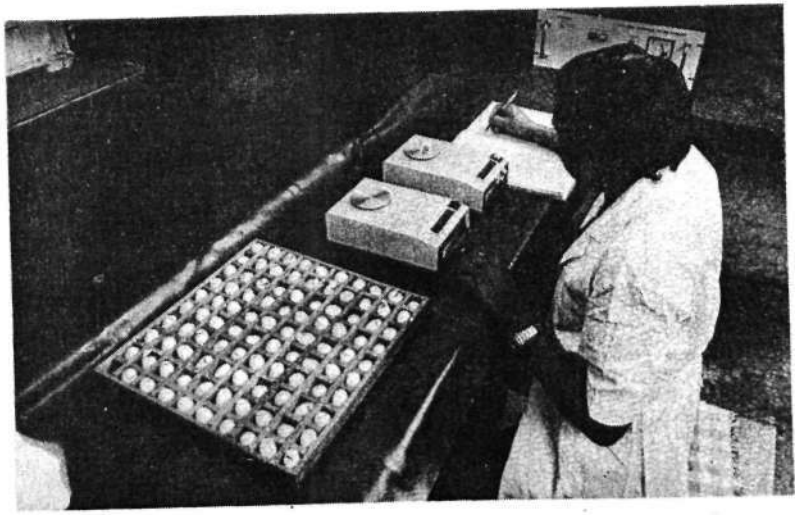

Fig. 23 lndi\idual cocoon assessment

serial order (Fig. 22). Individual cocoon is now subjected to the analysis of cocoon weight, (Fig. 23) shell weight, and shell ratio. It is necessary to select the best material for the future breeding programme. For cocoon analysis, electronic balance showing weight up to two decimal points, which are now available in India, are generally used. In advanced sericultural countries electronic balances attached with automatic printing machine which are computerised are available.

Individual cocoons now arranged in cocoon counter, are weighed on the balance. After the cocoon weight is recorded, shell weight is taken after removing the pupa. The shell percentage is calculated with reference to the total cocoon weight. For this purpose a ready reckoner is generally referred for quick calculation. A copy of the *ready reckoner* is enclosed in Appendix.

The weights of the cocoons recorded individually are now analysed. Averages of cocoon weight, shell weight, and shell ratio for the selected batch of cocoons are recorded separately for males and females. Generally the average weight and shell ratios are higher than the average of the sample cocoons drawn for the analysis of the breed and during harvest of cocoons. This is because of the selection pressure enforced at visual selections on the batch.

After the analysis of the individual cocoons, the breeder at the Pi Station selects those cocoons which conform to the characters ofthe race for further breeding. These cocoons are the best available from the breeder stocks.

e) Dfls Preparation

At the grainage these selected cocoons are preserved separately for emergence of moths. Thus from each face about 300 male and 300 female cocoons selected from 10 broods are kept for preparation of seed. In the grainage the cocoons are stored in wooden trays of 60cms x 90cms size and covered with wire mesh cover trays to prevent from mixing up of different races of cocoons and the moths emerging from therh later. About 150-200 cocoons are kept in a single layer in each tray of size 60cms x 90cms. One end of the cocoon is cut. This helps in emergence of healthy moths. Temperature of IS^C and humidity of 75% are maintained in the grainage.

On the day of moth emergence, only healthy moths are selected. Moths with crumpled wings, if any, are rejected (Fig.24). Selected female and male moths of the same race are allowed to couple (Fig. 25). They are kept in cellules in oviposition room, where a temperature of 25"C and 75% humidity is maintained. Darkness is provided to allow the moths to copulate undisturbed. After 4-5 hours of mating, the male moth is rejected (Fig. 26). Male moth is not used again for 2nd pairing. This is to ensure that all the eggs laid by the female after coupling are fertilised eggs. After rejecting the male, each female moth is allowed to urinate. She is allowed to lay eggs on egg card and covered with cellule in oviposition room. A bivoltine female moth lays about 600 eggs and multivoltine about 450 eggs in about 24 hours (Fig. 27).

Next morning the mother moths are examined to check whether they are free from Pebrine disease. For this ipurpose, individual moth is crushed in a moth crushing set and a drop of fluid is taken on a glass slide (Fig. 28). A

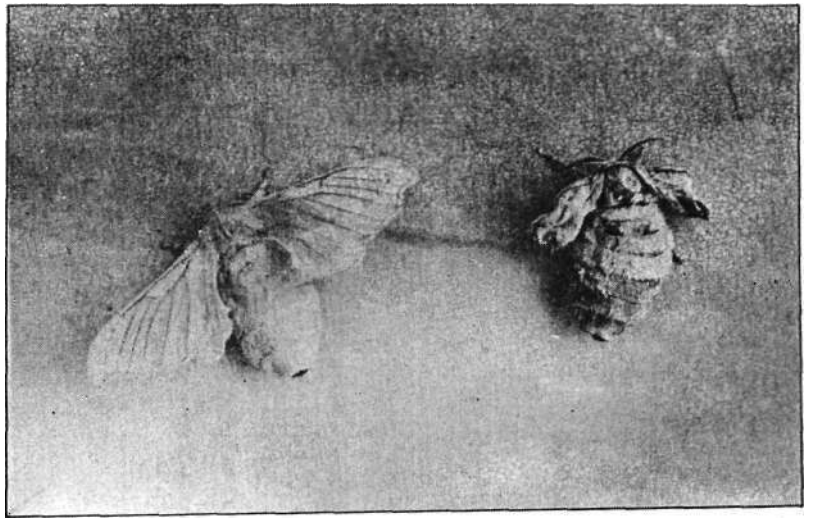

Fig. 24 HealtliN and dclbimed \\jnj.i moth

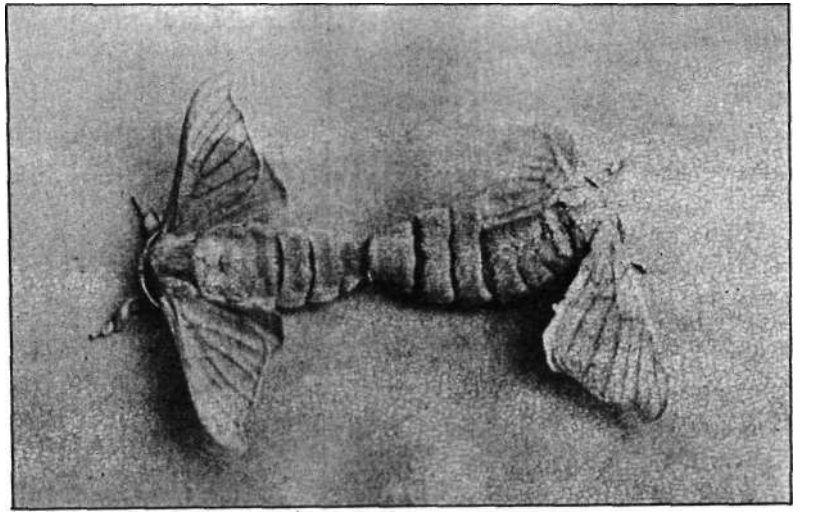

Fig. 25 Pairing ol moths

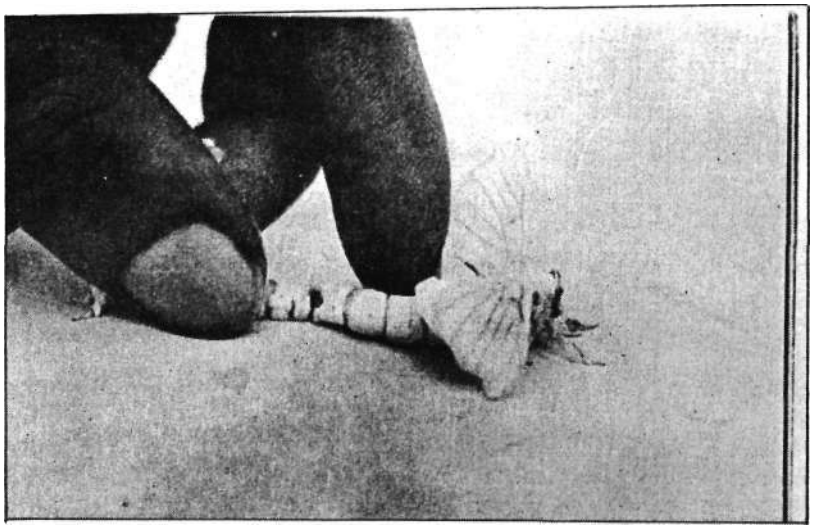

Fig. 26 Depairing ol moths

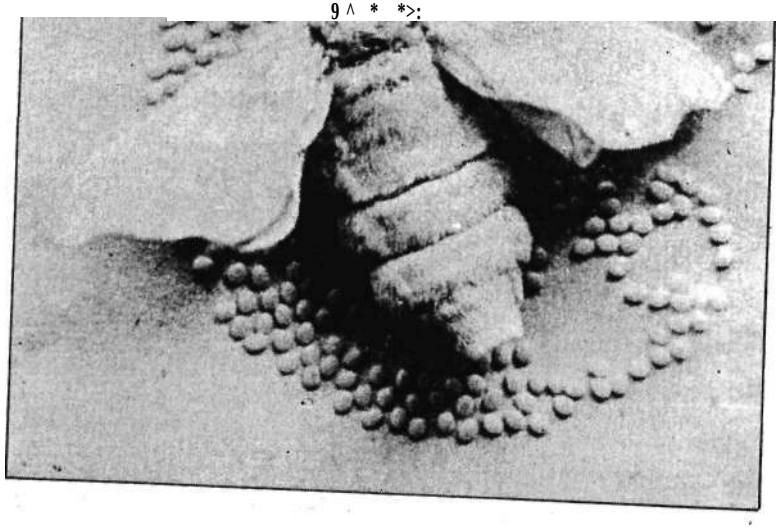

Fig. 27 Moth laying eggs

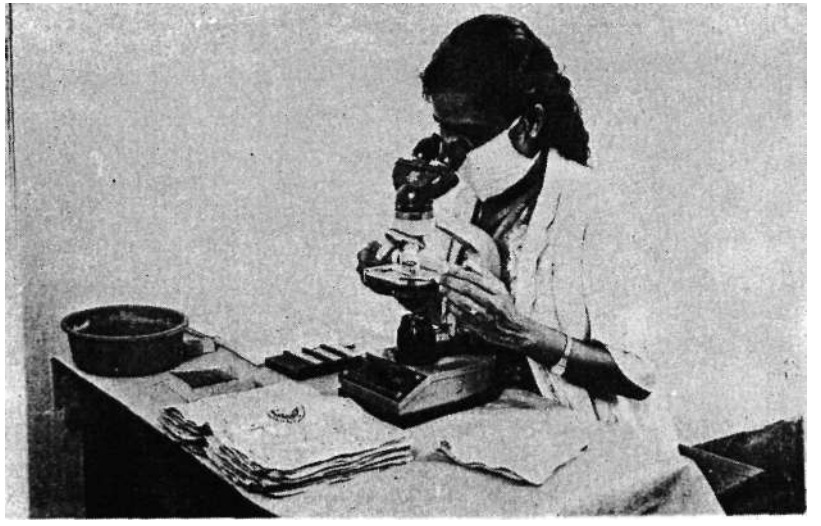

Fig. 2S Moth examination

smear js prepared by putting a cover glass. The same is examined under microscope with magnification of 600. II even a moth shows Pebrine disease, the entire lot of cocoons are rejected and action taken to disinfect the rearing house, grainage etc.

It is advisable to conduct dry moth testing in basic seed farms. For this purpose, the moths are kept in numbered square card board boxes (Fig. 29). The cubicle number on the box corresponds to the number on the sheet. These boxes along with moths are dried in hot-air-oven maintaining a temperature of 65 -TS^C for 6-7 hours. Next day, these dried moths are ground individually in a moth crushing set by adding a drop of 2% Potassium Hydroxide solution. A drop of fluid is taken on a slide, a smear is prepared with a cover glass and examined under binocular microscope with 600 magnification.

Only layings with large number of eggs are selected for further breeding. They are washed in *2%* formalin for 15-20 minutes for surface sterilisation. They are again washed in water to remove formalin. About 100 such dfls in each of the races are selected.

• Bivoltines are stored in cold storage for hibernation. Generally 6 months or 10 months hibernation schedule is followed for preservation of basic stocks. This will enable rearing of stocks only for one to two generations in a year. This helps to avoid repeated multiplication and inbreeding depression.

In multivohines, dfls are prepared by following the same procedure mentioned earlier. The dfls are selected for rearing next generation as there is no hibernation in this breed.

In a basic seed farm about 8-10 stocks of each of the silkworm races are maintained and reared to meet the requirement of seed multiplication programme.

f) **Seed Multiplication Programme**

Supply of dfls of basic stocks of silkworm races for multiplication in seed organisation programme is another important function of a basic seed farm. The entire programme of supply of quality parent seed cocoon to the industrial seed production depends on this supply. Of the 100 dfls released from basic stock, about 30 dfls are reared separately in cellular beds for stock maintenance and the remaining 70 dlfs are reared as Pi stocks for P: seed production. These are reared in cellular beds.

S) **PI Seed Preparation**

About 70 dfls in each race are reared at a time in a Pj farm for seed organisation programme. These are reared in cellular beds by following the same technique adopted for maintaining basic stocks. Records on the behaviour and performance of the cellular beds are kept in log sheets. After assessment of effective rate of rearing, cocoon quality in each of the cellular beds, cocoons of 30-40 cellular beds, or broods only are selected. The criteria for selection of these broods are effective rate of rearing, pupation percentage, cocoon weight and shell weight. The remaining cocoons ;.re rejected. The selected beds must conform to the norms fixed for the race and Pj Stocks of the silkworm race.

The cocoons of selected broods are subjected to individual cocoon selection by visual test. The selection criteria are compactness of cocoons, cocoons devoid of

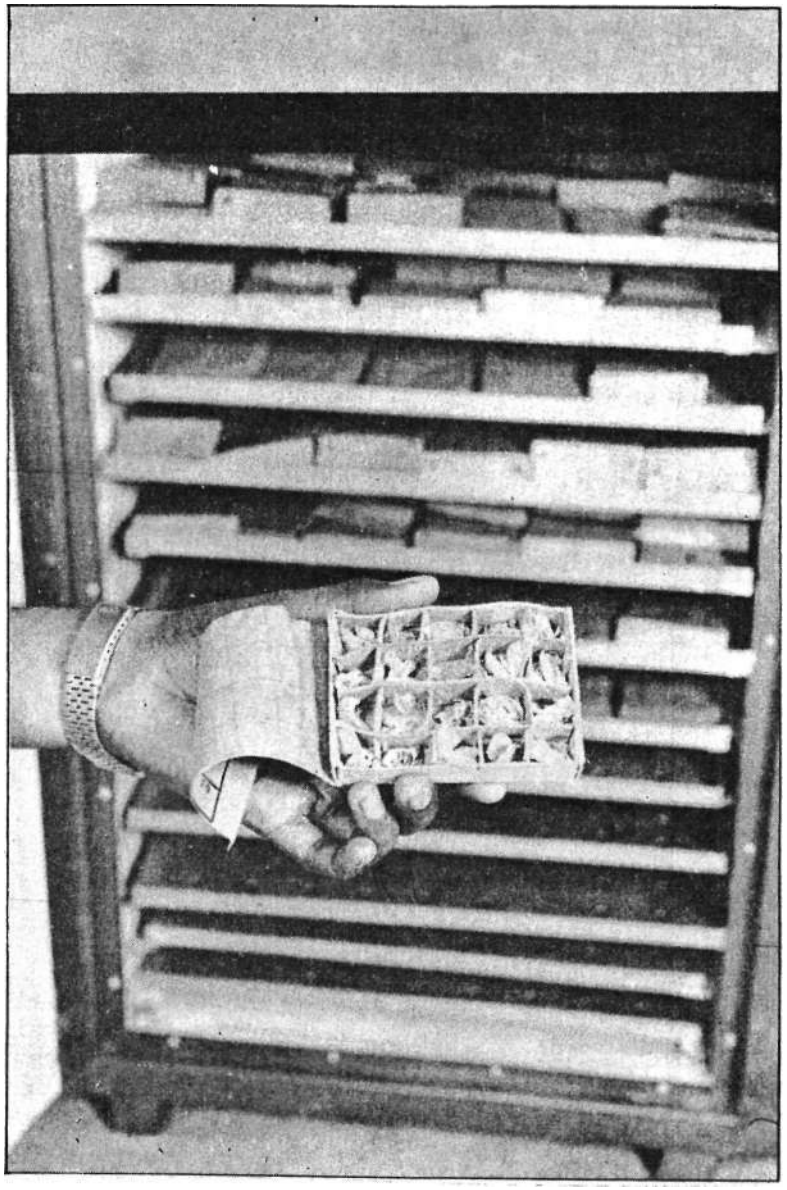

Fig. 29 Individual moths kept in box (or drying

open ends or thin ends, cocoons with uniform stiffness at the girdle and cocoons conlorming to other characters of the breed. About 20% of the cocoons from each of the selected broods are selected for *Pi* seed preparation. Samples of these cocoons are subjected to cocoon analysis to confirm their performance and those superior than the average performance of cocoon of the cellular batches or broods reared are selected. Once again they are subjected to visual selection by the breeder or the officer who is directly involved in maintenance of stocks. This process is necessary. About 4,000-5,000 cocoons are selected for preparation of P: seed. The grainage techniques and procedure described earlier are followed. At the time of preparation of Pjseed they are subjected to individual dry moth examination. Only those dfls, which have not less than 450 eggs, are selected for Pjseed both in bivoltines and multivoltines.

Norms for Pj stock both for bivoltines and multivoltines are given below for guidance.

Selection Criteria for Batches in Ps Farms

	Bivoltinc	Multivoltinc*
1. Eg£/dns not less than	S00	4M
2. Hatching on 1st day		90%
3. EffeaiveRateofRearing(E.R.R)	**90%**	
(cocoon with live pupae)		
4. Cocoon yield for 100 dfls	**80%**	
By Number.	**40.000**	**3Z0OO**
By weight, (kgs)	**70.0**	**32.0**
5 Average cocoon weight, (gnis)	**1.8 + 0.2**	**1.1 +0.1**
6 Average shell weight, (gms)	**0.38 + 0.02**	**0.14+0.01**
7 Shell percentage	*2\%*	**13%**

These norms are somewhat less in Nistari race.

The selected batches for production of P_2 seed should conform to the above norms. This will ensure high standard of cocoons for parent cocoon supply programme. Only 20% of the cocoons are taken for P_2 seed preparation.

The worms and cocoons rejected from the "stock maintenance programme" are transferred from P_3 rearing section and included in the P_2 programme as these are super elite stocks. Selection procedure for maintaining stocks and rearing of P_3 broods is given in next page.

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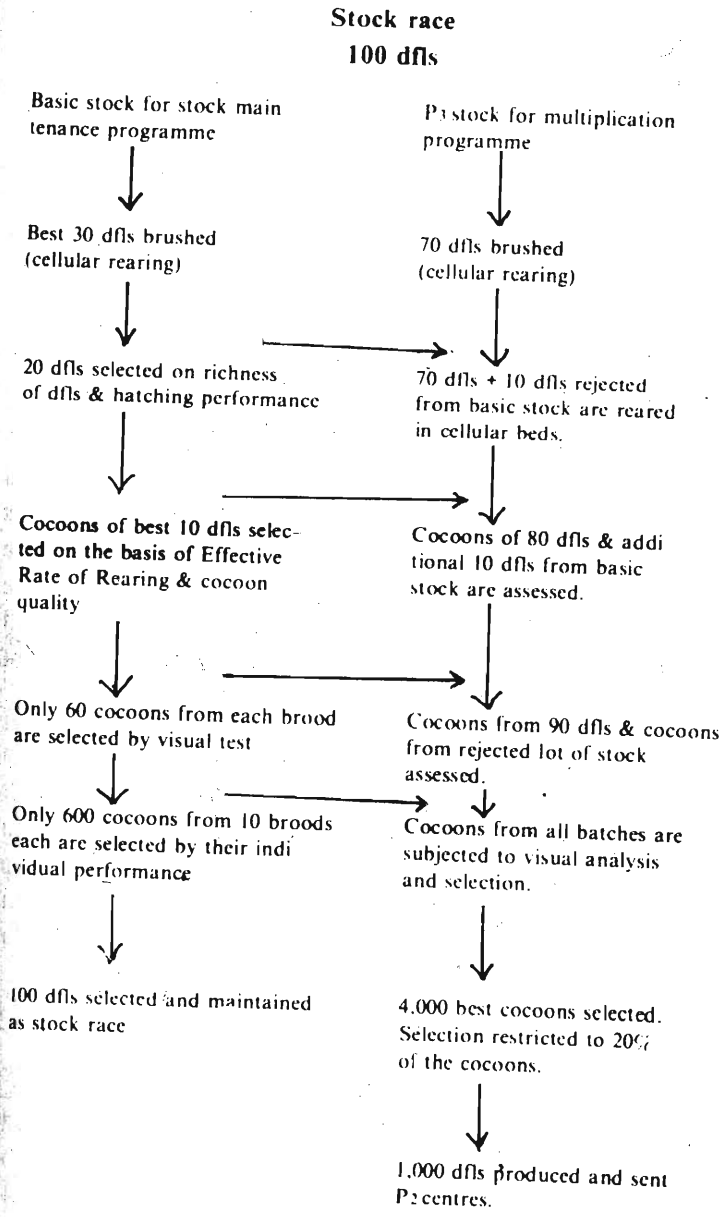
Procedure for Maintaining Stocks and P_3 Broods



A basic seed farm or Pi farm having 2 hectares of mulberry yielding about 50 tonnes of mulberry leaf annually in Karnataka conditions is sufficient to rear 150-200 dfls of bivoltines or 300 dfls of multivoltines in each of 18 crops a year. However, Jammu & Kashmir, Dehradun area of Uttar Pradesh and Kalimpong of West Bengal can produce about 20 tonnes of leaves annually. This is sufficient to rear about 1,350-1,600 dfls in two crops of the year viz.. Spring and Autumn. Rearing of too many silkworm races may lead to mixing of races. Hence it is advisable to rear not more than four races at a time.

Pi centres or basic seed farms are the temples of Sericulture Industry. They are to be maintained with hygienic care by well trained scientists in breeding and maintaining of stocks. Rearing and maintaining of stocks is an art. One Pi farm can feed 5 to 6 Pjcentres. These institutions are essential components for good sericulture in any country and cannot be treated on commercial basis. Basic seed farm should be an integral part of development of industry.

SEED MULTIPLICATION FARMS

THE first stage of mass multiplication of seed cocoons in the seed organisation programme is taken up in P: Farms. Here silkworm rearing by cellular batches is I avoided and selection is not so rigid.

These centres have to take up rearing of larger number of dfls as compared to Picentres. This is necessary to meet the requirernent of parent seed cocoons for industrial seed programme. Further, rearing them in cellular batches is *i* not required as the care for maintaining the characters of *I'* the race is taken up at P.icentres. Rearing of cellular beds I is laborious and expensive. However, hygienic conditions and silkworm rearing techniques followed are similar to those of basic seed farms. These farms are maintained by Governments.

Seed Multiplication Farm (Pi Farm)

A P2farm should have 6 hectares of land of which 4 hectares of mulberry plantation is raised under irrigated conditions. Spacing for plantation is 0.9m x 0.9m in Karnataka and West Bengal conditions and 1.8m x 1.2m

for Jammu & Kashmir conditions. Remaining afea is marked for buildings and roads. The mulberry plantation is maintained as in Pi centres by providing irrigation, optimum inputs and cultural operation for production of good quality leaf. Each farm is provided with four rearing houses of Central Silk Board design and two chawki rearing houses. They are also provided with a farm house and grainage. The grainage building should be constructed away from the farm to avoid contamination of diseases.

, Even at P2 centre, rearing is conducted under ideal hygienic condition and following recommended technologies of silkworm rearing strictly under supervision of the technical staff. Requirement of equipments and technical staff for a P2farm is given in Annex-IV & V.

Before rearing silkworms, all appliances are cleaned with bleaching solution. Rearing houses are disinfected first with 1% bleaching powder solution followed by 3% formalin. In Karnataka silkworms are reared once in 15 days, so that about 24 batches are reared in a year. This will enable the continuous supply of Pidfls to the rearers almost daily.

Pzdfls produced only from the Picentres are brushed. Each batch consists of about 400 dfls.

It is advisable to rear only two races at a time in a P2 centre. Rearing too many races lead to mixing up of races. One rearing house of Central Silk Board model can take up 400 to 500 dfls at a time in a P^centre. These are reared in batches of 2 dfls each.

Only rich dfls with not less than 450 eggs in bivoltines and 400 eggs in multivoltines are selected for rearing. Two selected dfls are wrapped in a semi-transparent paper. Care is taken to incubate the eggs properly at 25"C and 75%-80% humidity. 2 dfls brushed together in a tray are reared. Brushing techniques as suggested for Pjcentres is also followed at P: centres. Only those batches with 90%-95% hatching are taken for rearing. Others are rejected. Date of hatching, dead eggs, late borns etc., are recorded.

Chawki rearing is conducted in a chawki house by maintaining a temperature of 26<'C-27"Cand humidity of 75%-80%. Two dfls are brushed in each wooden tray of 60cm X 90cm. They are reared strictly following the techniques of chawki rearing as suggested in Pjcentres. Worms are brushed in trays with paraffin paper for the base and cover, with foam pads around the rearing bed to provide optimum humidity.

Strict hygienic conditions are maintained. The faceal matter and the left out leaf of rearing should not be thrown into the farm. They are to be properly put into the compost pit and covered.

Late age worms are reared at 23<'C-26<'C with a humidify of 70%-85%. The aim is to produce large quantity of cocoons for seed production (Fig. 30). The worms of 2 dfls must settle for 3rd moult in a single tray. After 3rd moult they are transferred to bamboo trays. Attention should be given to provide proper spacing. Leaves suitable to the stage must be picked, preserved and fed to silkworms. Worms must settle for 4th moult in I-I'/2 round trays of 105cms. diameter and by spmning, they must have a spacing of 2-3 trays for each batch of

2dfls. This is necessary in viewof large number of eggs in a ' laying brushed and higher larval population brushed in a batch.

The worms of each batch are mounted in chandrikes separately. At the time of spinning a temperature of IS^C and humidity of 70% is provided. The cocoons harvested from each batch are analysed for their quality and data tabulated. Only those batches (2 dfls) of cocoons which give higher effective rate of rearing in respect of cocoons with live pupae, better cocoon weight and shell ratio are selected. Further from these selected batches, cocoons conforming to the racial character such as shape, colour, grain and high silk content are selected. Thus of lOOdfls rearing of a race in 50 batches (each batch of 2dfls) about 30 batches are selected on the performance of effective rate of rearing (E.R.R.,) average cocoon weight, shell weight, shell ratio and live pupal percentage.

The norms followed for a P2 rearing is given below:-

Character	Bivolline	Multivolline
Egg laying not less than	450	400
?; of hatching	90%	909f
Effective Rate of Rearing	75%	75%
individual cocoon weight(gnvs)		
Not less than	1.5	1.0
Shell Ratio	20%	13%
Pupation Ratio	90%	90%

About 15,000 to 20,000 cocoons are harvested from 30 batches. Only 8,000 cocoons out of these batches are selected from each race by visual selection. Only those

1-ig. 30 Silk.\vorm rearing in I'Marm

cocoons having the characteristic features of the race, stiffness to touch, without any pointed ends, without a depression when pressed and having medium size and cocoon weight are selected. Selection of heavy cocoons and cocoons with poor silk content should be avoided. The cocoons thus selected by visual selection are taken for grainage. The fundamental difference between a P.icentre and P2 centre is that individual cocoon analysis is practised for maintenance of stocks in Pj centres. Selection is restricted to a certain limit in Pjcentres while it is very strict in P.i centres.

The cocoons are preceded at separate P2 grainage for production of Pi dfls. These cocoons should never be processed in a commercial grainage. Further cocoons of different centres should not be brought to the grainage. I The grainage should be away from the rearing house and the farm. After each grainage operation, the building should be disinfected. These precautions are taken to *h.* check diseases.

The technique of preparing dfls as suggested for P.< centres are followed here also. These cocoons are deflossed and one end of the cocoon is cut and kept in wooden trays in a single layer. About 300 cocoons are ke^t in each wooden tray of 90cms x 60cms for bivoltines and about 400 cocoons for multivoltines per tray. The cutting of ends of bivoltine cocoons facilitate easy] emergence of motifs. The cocoons are covered with a thin ' newspaper to allow emerged moths to crawl easily over 1 the paper for easy picking of moths. A temperature of 25"C and humidity of 75% are maintained in the grainage room. It is better to keep races in separate rooms to avoid mixing of stocks. Only healthy males and females are picked and allowed to copulate. About 5 hours of

copulation is suggested, male moths should not be used for second copulation. The moths are individually tested for Pebrine disease by dry moth technique. If Pebrine is noticed, the entire batch is rejected and strict disinfection of rearing houses, farm house and other buildings is taken up.

A P2centre can prepare every fortnight about 6,000 to 8,000 dfls (for two races) and about 2 lakh dfls/year.

In temperate climate of Jammu & Kashmir, where only two rearings are conducted, large number of dfls are brushed for spring and autumn depending on the requirement. The selection procedures, and the rearing techniques suggested earlier are followed. Since rearing seasons are restricted, the eggs are preserved by following hibernation schedules strictly.

MANAGEMENT OF BASIC SEED FARMS

BASIC seed farms are essential for organised production good quality seed cocoons with vitality. High silk content and the survival rate of the commercial hybrid seed depends on the vigour of the basic stocks. Good quality parent seed cocoons can only ensure production of commercial seed with high heterosis for silk content, survival of larvae and there by high yield^of cocoons. Thus the very existence of sericulture as commercial crop depends on the planned programme of preservation of the silkw^orm stocks, their organised multiplication without loss of vigour and free from disease. The production of sufficient quantity of parent seed cocoons to meet the requirement of hybrid seed production is also necessary. As explained earlier the rearing of pure races is entirely different from commercial hybrids. Pure races are slow in growth, more susceptible to diseases and loose vigour by repeated multiplication. Thus basic seed farms should always be organised on scientific lines immaterial of cost involved. These farms are essential complements of a good seed organisation on which the entire survival of sericulture industry depends and should never be treated on commercial lines.

Management of basic seed farm is a technique by itself as on one hand it has to maintain the vigour of stocks and on the other maintain the supply of stocks for the seed organisation programme. The concept of rearing and seed production is entirely different from an industrial rearing or a commercial grainage. The officer-in-charge of the farm must have full knowledge of management of the mulberry garden, silkworm rearing and selection procedures. He must have first hand information on the variety of mulberry planted, its age, its response to inputs, such as farm yard manure, fertilizers and irrigation and cultural operations. He must be well conversant with different plots of mulberry, their soil PH and corrective measures adopted for optimum productivity of quality leaf. Response of the plant for pruning and seasonal variations should be understood. Application of heavy doses of farm yard manure, red earth and tank silt enrich the soil and enable the plant to produce rich nutritive leaves. Optimum doses of fertilizers must be applied for each plot. Cultural operations change from plot to plot depending on the leaf requirement for silkworm rearing. One cannot use a yard stick of pruning all the plots at one stage as in commercial hybrid rearing, because one has to rear silkworm stocks in smaller batches in Pjand Psfarms. Management of farm with proper labour and with bullocks and machinery is essential.

Considering the rearing season and need for supply of stocks for seed organisation, rearings are to be arranged and managed in a basic seed farm. Plots of mulberry plantations are to be sub-divided in keeping with the seasonal demand for seed. One should always aim to get good quality nourishing mulberry leaf and not merely large quantity. Leaf is required for seed cocoon production and not commercial cocoons. Plantations of wider spacing give better quality of leaf than closer plantations. Too much of spacing also reduce the leaf yield. Optimum spacing of plant should be known. Individual leaf harvest ensure supply of correct quality of leaf for different stages of larval growth of basic stocks. Such selection of leaf quality cannot be ensured in closer plantations or row-systems. It is the duty as well as the responsibility of the official managing the basic seed farm to attend to the needs of the farm every day, to ensure quality leaf production and its supply for rearing silkworms. In other words, he should co-ordinate the good quality leaf production with rearing of pure races. He should be assisted by a knowledgeable farm manager to look after the management of labour, inputs, and cultural operations of the farm.

A good farm manager is one who visits each of the plots atleast once or twice a day and personally supervises the labourers and arrange inputs and cultural practices. Labour management is a human problem. One cannot always enforce only rules in labour management. How to get maximum work from the labourers is an art.

Rearing of silkworms and its management in basic seed farm depends on the techniques followed systematically at various stages. One should have a clear knowledge of the technology to be followed at different levels of larval growth periods. A mere book knowledge will not be sufficient in the management of rearing. Practical experience in rearing is essential for the manager. Many times intricate problems during rearing or disease do occur and the manager should know and decide about the course of action for improvement. He cannot look to the research institutes everytime for guidance for day-to-day

work, but should take on the spot decision for improving growth of larvae and production of quality cocoons.

Rearing of silkworms can be divided into batches at intervals. When one batch reaches third or fourth stage, a second-batch can be brushed. This requires a separate group of staff for brushing silkworms for its chawki rearing and adult rearing. Such division of work and responsibility should help in efficient discharge of work. Each group of staff tnust be headed by one technician having good knowledge of niaintaining proper environment for rearing silkworms. These staff must have a clear knowledge of the techniques of silkworm rearing and should be guided by the senior level technician who is managing the station.

Selection of cocoons, specially for maintenance of stocks is a highly technical job and cannot be expected by or entrusted to the lower level staff. The senior technician managing the farm must know the characteristics and behaviour of silkworm breeds reared at egg, larval, cocoon and moth stages. He must be a practical silkworm breeder. This is because he has to maintain the stocks and also supply them for multiplication programme. Selection of batches of silkworms, with higher effective rate of rearing, fast growth of larvae, selection of cocoons for shape fixed for the race, assessment of cocoons are vital for maintenance of stocks. The official in-charge of the farm, who is a breeder himself must have expertise of the techniques. Selection of cocoons by visual test is a very important aspect. Any mistake at this stage leads to loss of quality of the breed and the cocoons. The breeder must have practical experience in this technique. He, should personally attend to selection of cocoons, individual assessment of cocoons and their selection for

breeding. He should always bear in mind that he is rearing pure races, maintaining vigour for the rich seed production and the performance of the hybrid produced from these stocks governs survival of silk industry.

Maintenance of equipments in working condition is essential. Many times, just on the plea that a heater is not functioning proper temperature cannot be maintained and this will have an adverse effect on rearing. Before rearing starts, equipments should be repaired and kept ready for use.

It is the responsibility of those working in rearing section to manage the labour for rearing, cocoon harvest and assistance in cocoon assessment. The requirement of labour in a Pjstation is always higher than that of hybrid rearing. Rearing pure races is more laborious because of their nature of slow growth, susceptibility to disease etc. Many times it is commented that the cost of production of Pjand P: cocoons is much higher than that of hybrid cocoons. This fear is unfounded and is so because we are dealing with rearing of basic stock races and maintaining their vigour, on which the silk industry depends.

Requirement of labour and inputs of Piand Pifarms in Karnataka is given below as a norm for guidance.

Mulberry Farm

1	**Variety of mulberry**	**= K 2or M 5**
2	**Plantation type**	**= 3'x3'(0.9m X 0.9m)**
3.	**Leaf productivity**	**= (kg, Hectare, Annum)**
	1st year plantation	**15.000**
	2nd year plantation	**20.000**
	3rd year onwards	**25,000**

	Inputs / Hectare/ Annum	
(0	Farm yard manure	40-50 tons
(li)	Red earth & Tank silt	10 cart loads
(iii)	Fertilizers	250N:100P:100K
5.	Irrigation	Once in 10 days
6.	Labour/Hectare	
	Garden maintenance	3.0
	Rearing	4.0
	Total:	7.0

Silkworm rearing

	Bivoltine	**Muitivoltine**
Leaf requirement/ 100 dfls (depends on the population of larvae brushed)	1,200-1,400 kgs	700-800 kgs
No. of dfls brushed/ year/hectare of mulberry plantation (irrigated)		
(a) P,	1,500-1,750	2,200-2,500
(b)P,	1,700-1,900	2,500-3,000

Selection criteria

	Pj level	Bivoltine	Muitivoltine
			Mysore Race
1.	Eggs dfls	500	450
2.	Hatching %	90%	90%
3.	Effective rate of rearing		
	(cocoons with live pupae)	80%	80%
4.	Average cocoon wt. (gms)	1.8+0.2	1.1+0.1
5.	Average shell wt. (gms)	0.38+0.02	0.14+0.01
6.	Shell %	20%-21%	13%

	Pj Level	Bivoltine	Muitivoltine
1.	Eggs dfls	450	**400**
2.	Hatching %	90%	90%
3	Effective rate of rearing	75%	75%
4	Average cocoon wt (gms.)	1.5	1.0
5	Shell ratio	19-20%	**12-13%**

Grainage:-

		Bivoltine	**Muitivoltine**
	Selection of seed cocoons for PJ seed preparation	20%	40%
I 2.	P, Seed preparation	40%	60%
3	Cocoon dfl ratio at P3&P2	**3:1**	3:1
	Mother moth examination	100%	100%

Requirement of Pj and Pj Stations of Jammu & Kashmir is given below:-

Mulberry

Variety of Mulberry	=Goshio erami, K-2 etc.,
Plantation Spacing	=4'x4' or 4'x6' (1.2m xl.2m or 1.2m x 1.8m)

Leaf productivity/Hectare/Annum.

	Spring	Autumn	Total
1st Year	3,000	4,500	7,500
2nd Year	5,000	7,500	12,500
3rd Year	7,000	10,000	17,000

1) Inputs Per hectare/Annum.

Farm Yard Manure - 25 tonnes
Fertilizers = 250N;100P:100K

2. **Labour:-** per Hectare

Farm maintenance = 2
Rearing = 3
Total = 5

3. **Silkworm Rearing:**

Leaf requirement/100 DFLs - 1,200-1,400 Kgs.
No. of dfls/annum = 1,300-P;& 1,600 Pj

4. **Selection Criteria for P,** & P,
Same as in Karnataka

5. Grainage:

P, and P,
Cocoon dfls ratio = **3:1**
Motlier moth examination = 100%

PARENT SEED COCOON PRODUCTION

THIS is the last stage of multiplication of the parent stock in 3 tier silkworm seed organisation programme. The Pi seeds from P:centres are reproduced in large numbers to meet the requirement of Figrainages. Those are produced with the trained farmers because rearing them in farms involves heavy expenditure. P.iand Pjfarms having taken care of the vigour of the stock races, multiplication of these stocks by well trained sericulturists for one generation will not have any ill-effects. Trained farmers, can rear Pi seed with hygienic conditions. Cocoons produced by these selected and trained farmers are once again subjected to selection, while purchasing them for grainages. Rearing of P i seed is practised in a seed area established by legislation and by trained selected seed rearers in commercial cocoon production zone,

(a) **Seed Areas**

The Pi seed produced at Pjfarms are supplied to the rearers in notified areas. Here they are allowed to rear bnly the pure races as per law. Such areas are declared by Government as *'Seed Area.'\n* Karnataka there are two

seed areas, one for muItivoltine(Fig. 31) and another for bivoltine. Such seed zones are organised in every sericultural state in the country. In these areas all the farmers are enlisted as seed cocoon growers. They are given special training in rearing of pure races, the behaviour of the silkworm races, their care at different stages of growth, their feeding and mounting. Thus, these group of farmers are specialised in rearing pure races of silkworms and growing seed cocoons. Incentives are also given to these farmers in the form of special subsidies for improving their plantations, rearing houses etc. Loans on soft rate of interest are also given to attract them to growing of seed cocoons. Government also ensure all the cocoons produced by them are purchased at high rate, if they are according to norms of seed cocoons, fixed from time to time by Government. Government has also many obligations to these farmers. It is the responsibility of the Government to ensure supply of only Pi seed from Pj farms, provide technical guidance by the Government staff by visiting the rearers house periodically, supply formalin and other disinfectants free of cost and disinfect the rearers house before rearing commences. In response to all the support given, the farmer has the obligation by law to rear only pure races approved by Government. Action can be taken by Government to destroy the crop and lay penalty on the farmer, if he rears hybrid silkworms.

This system of declaring seed area has many advantages. Since pure races of silkworm require more care than hybrids, vigilance can be enforced on the crops to check the out break of Pebrine disease by conducting mass disinfection programmes effectively and systematically. Field staff of the sericulture department

Fig, 31 PI seed cocoon leaiinu in Mysore seed area

can visit the farmers houses frequently and follow each of the cocoon crops for freeness from disease and good growth of larvae. The cocoons produced are subjected to test by the staff and only those crops which are certified as free from disease and according to norms are allowed to be marketed as seed cocoons. Generally, areas where groups of farmers are scattered and land holding is limited are selected as seed areas. This helps to control disease, before it occurs as an epidemic form. Further, since rearing is of small size the farmers can take good care of the crop personally than a big farmer who depends on labourers for rearing. Labour requirement in rearing pure races is higher than cross breeds. The larval growth is slow and requires more care.

However, it has some disadvantages in that, in seed areas even the poorest farmer having hardly any land is also bound to rear pure races. Cocoons of these farmers are of poor quality. Many times diseases breakout due to carelessness of such rearers.

Farmers have a fear that bivoltines require much more care, more particularly in tropical conditions. Many farmers believe that these are more susceptible to disease than hybrids and multivoltines. Hence in bivoltine seed areas where even the poor farmer has to rear bivoltines, sometimes they switch over to rear cross breed silkworms without the knowledge of the field staff. This naturally is a disadvantageous factor.

Proper support price is essential for the farmers to take to seed cocoons growing. One of the major hurdles farmers face in seed areas is the fluctuation of price of seed cocoons. If the demand for hybrid seed in the field is less, then there is no demand for seed cocoons and those cocoons which are in excess for seed production are sold

at very cheap price, Because of their poor silk content as compared to hybrids. Hence farmers always demand that all their cocoons are purchased by the Government at high rates. Even if cocoons are not fit for seed production, they should be paid high rate to satisfy them. The distribution of cocoons produced by the farmers are regulated in cocoon market, who ensure quality and price and allot cocoons to grainages. Thus in this system of seed areas the grainage owner cannot enforce his choice of cocoons always. Many times the market officers allot cocoons to the grainages.

Such a system of seed areas is in practice in Dehradun of Uttar Pradesh and multivoltine and bivoltine seed areas of Karnataka. In this system the entire system of Pi seed cocoon production dnd industrial seed production is completely controlled by the Government either directly or indirectly. But one great advantage is that the grainage is assured of the supply of disease free cocoons. The commercial egg producers naturally do not give much importance to examination of mother moth for disease, during hybrid egg production. Such carelessness also leads to spread of diseases by oversight. Generally in seed areas about 40%-45% of excess of seed cocoons than required are grown as buffer and this also helps in supply of quality seed cocoons to grainages.

(b) Selected Seed Rearers

In sericulturally advanced countries, the egg producer is the supplier of Piseed. He gets the required Pidflsfrom *Pi* farms and distributes them to the rearers, whom he feels, are having space, equipment and technical knowledge and confidence of rearing pure race silkworms. These rearers are called *"Selected Seed Rearers".* These farmers need not be in seed areas. On the other hand, they are located in the areas where hybrids are reared. But these rearers are selected considering their mulberry garden for growing good quality leaf, a good rearing house, spacious enough for pure race rearing, and the technical knowledge of the rearer to rear silkworms (Fig. 32). Generally, he is a rich farmer as compared to unselected poor farmers in seed area. The grainage technicians supply incubated eggs or just hatched worms to the seed rearers and assure to purchase the seed cocoons at 1 *'A* times to 2 times higher than the price of industrial cocoons. Thus a close relation is established between the selected seed rearer and the grainage technicians, which is lacking in seed areas. Once the pure race seed is supplied, the technical staff periodically visit the rearers house and guide the farmer in rearing pure races. He also checks the growth of worms and examines them for their being free from Pebrine disease. There is an understanding between the egg producer and the farmer. Norms are fixed for quality of cocoons purchased for seed production. Those cocoons which are not according to norms are not purchased. The farmer has the responsibility to produce cocoons as per the norms and demand for quality (Fig. 33). In most of the cases the grainage technicians select such farmers who are away from the industrial areas to avoid contamination of diseases.

In Japan, some egg producing companies select a group of farmers in isolated islands as seed growers because of fear of contamination of disease. In U.S.S.R. and China, groups of farmers of a commune are selected as seed cocoon growers, and are given special assistance and

guidance by the grainage. Selected rearers system brings a close link between the parent seed cocoon producer viz., selected seed rearer and the industrial egg producer, the grainage. One depends on the other and one supports the programme of the other. Such a close link is one of the factors responsible for good quality seed cocoons produced and good quality of disease free seed in'these countries. Even in India, such a system of selecting seed cocoon grqwers is in vogue in Karnataka, Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Jammu«& Kashmir and West Bengal.

Selection of a good seed cocoon grower is a very important factor for the grainage. He should have good irrigated mulberry garden and a good rearing house. He must be a literate to understand suggestions frequently made by the visiting field staff from grainages. He must be capable of engaging labourers as required for rearing pure races. Special training programmes are arranged for these selected seed rearers by the grainages. Such farmers take adequate care of silkworms, disinfect the rearing house and equipments regularly and follow sericulture hygiene strictly. They must be aware that they are rearing pure races, which is more suceptible to disease in commercial cocoon growing areas. They get very high rates if their cocoons are of good quality and free from disease.

The egg producer procure the Pi seed only from the P: centre and distribute to selected seed rearers. Before supply of seed, he inspects the farmer's mulberry garden as to the availability of leaf and its quality. For estimation of leaf one should know the average yield per hectare for the variety under optimum conditions. Leaf from pit system of mulberry garden is good for pure race rearing as one can select the proper quality of leaf for the age of the

larvae. One hectare of Kanva-2 variety of mulberry under irrigated condition yields about 25,000 Kgs. of leaf/year in five crops in Karnataka. While S-1 yield about 20,000 Kgs in West Bengal conditions. The availability of leaf varies according to season. Estimates of leaf available in one hectare of mulberry under above conditions are given below for guidance:-

STATE	VARIETY	SEASON	QUANTITY Kcs./bec
Karnataka	**K-2**	**Jan-Feb**	**4.500**
		Api-May	**5,500**
		Jul-Aug	**5.500**
		Sep-Oct	**5.000**
		December	**4.500**
West Bengal	**S-1**	**Bhadurl**	6.000
		Jesla	4,000
		Agrahini	6.000
		Chaitra	4.000
Jammu & Kashmir	**Goshio - erami**	**Spring**	3,000
		Autumn	4,000

Similarly, the yield of other varieties of mulberry may be estimated. However, rearer must know the optimum inputs to be provided. Inputs like farm yard manure, fertilizers, cultural operations and irrigation govern the leaf yield. Considering the inputs and the season one can estimate the leaf available. 100 dfls of bivoltine pure race require about 1,000 Kgs of leaf and lOOdfls of jnultivoltine pure race (Mysore) require 700 kgs of leaf. One can estimate the number of dfls required to be brushed. Generally many rearers cannot estimate the

availability of leaf particularly during winter and due to shortage of leaf in his garden often he goes in search of leaf from other gardens. This may affect the crop. As far as possible this should be avoided. It is better to brush a few dfls less than estimated.

(c) Preparation For Rearing

Many times the' silkworm rearers get equipments from others for rearing. This may contaminate rearings. Bamboo trays, wooden stands, and wooden chawki trays must be disinfected before indenting eggs. The requirement of equipments for 100 dfls of pure races are given in Annex-VI. After estimating the availability of leaf in the garden the farmer places indent for dfls. It is always advisable to indent for Pi dfls in advance rather than taking whatever dfls are available, immaterial of its standard.

After the farmer places indent for dfls with grainage technician, the extension worker takes up disinfection of the rearing house of the farmer. On the 4th day of egg laying, the equipments and the rearing rooms must be first cleaned. On the 5th day the equipments are thoroughly washed with 1% bleaching powder solution. On 6th day the equipments are kept in the rearing house and disinfected with bleaching powder. On 7th day the rooms are sealed and disinfected with 3% formalin. The rearing room is opened on 9th day and on 10th day the chawki worms are brushed.

(d) Disinfection Methods

The rearing house and equipments are first washed with 1% solution of bleaching powder. After keeping the washed equipments, the house is sprayed with 1% bleaching powder solution. For this purpose, 1 Kg of bleaching powder is mixed with 100 litres of water and sprayed. The chlorine available in bleaching powder is unstable. Hence it is always advisable to use freshly prepared or properly packed bleaching powder. Stored Bleaching powder loose its disinfection capacity. Bleacing powder is a good disinfectant against Cytoplasmic Polyhedrosis virus, " Nuclear ^olyhedrosis virus, Flacherie virus, fungus causing'Muscardine and Pebrine spores. 1% bleaching powder solution is sprayed at 225 cc per square meter of the area. Sprayed area must be kept wet atleast for 30 minutes to have good effect of disinfection. After a day the house is disinfected with 3% formalin.

Commercial formaldehyde available in the market is 38%-40%. To prepare 3% of formalin, the following procedures are followed:-

I. Strength of the commercial formaldehyde minus strength of formalin required divided by the strength of formalin required, gives the parts of water to be added to get 3% solution i.e.

$$\frac{40\% \text{ (Commercial Formaldehyde)} - 3\% \text{ \{Required Strength)}}{3\% \text{ (required strength)}} = 12.3$$

i.e., for every litre of formaldehyde 12.3 litres of water is
W added to get a solution of 3%.

2. The 2nd method of estimation of formalin required is:-

Quantity of formalin required = $\frac{\text{required concentration} \times \text{required quantity of solution}}{\text{Available concentration of commercial formaldehyde}}$

$= \frac{3 \times 1{,}000 \text{ cc}}{40} =$ 75 cc of commercial formaldehyde.

i.e., 75 cc of formaldehyde to be added to 925 cc of water to get 1,000 cc of 3% formalin.

The requirement of 3% formalin solution for disinfection of the rearing house of 100 sq. m. area is about 8.6 litres. This is calculated by the following formula:-

i)	Floor Area	=Length X Breadth
ii)	Area of 2 walls	=Length X Height of each wall x 2
iii)	Area of 2 other walls	^Breadth x Height of each wall x 2
iv)	Roof of terrace	=Length x Breadth
		Add up to gel the area to be disinfected.

To disinfect a rearing house of 6.1 mts x 9.1 mts with height of 3.05 mts and with terraced roof, the requirement of 3% formalin solution is calculated thus.

Floor Area	=6.1 mts x 9.1 mts	=55.51 mis- or (20'x30>r 600 sq ft.
Area of 2 walls	=6.1 mis x 3.05x2	=37.2 mts^ or (20'xlO'x2)_ 400 sq. ft.
Area of 2 other walls	=9.1 mts x 3.05x2	=55.51 mts^ or (30'xl0'x2)- 600 sq ft.
Area of roof	=6.1 mis x 9.1 mts	=55.51 mls^ or (20'x30') 600 sq. ft.
Total irea	203.74 mts sq.	2,200 sq. **ft**

Requirement of 3% Formalin solution = $\frac{203.74 \times 8.61}{100}$ = 17.5 litres

Add equal quantity for spraying rearing equipments i.e., total requirement of 3% formalin is 35 litres.

1st **method** of **calculation**

To get 35 litres of 3% formalin solution commercial formaldehyde required is:

$\frac{40 \times 3}{37} = 12{,}3$

One litre of Commercial formaldehyde is to be added to 12.3 litres of water to get* 13.3 litres of 3% formalin.

To gel 35 litres of 3';; formalin = $\frac{35}{13.3}$ 2.63 or 2.7 litres

About 2.7 litres of comrhercial formaldehyde is required to disinfect rearing equipments and a rearing house of size 6.1 mts X 9.1 mts with terraced roof, which can accommodate about 250-300 dfls.

2nd method of calculation

Required concentration	= 3%
Required quantity of 3'/i formalin	= 35 litres
Concentration of commercial formaldehyde	= 409f
Quantity of formalin required	=3x35
	40
	=2.62 or say 2.7 litres

i.e., 2.7 litres of commercial formalin is required.

Lime is also added to formalin solution for effective killing of Cytoplasmic Polyhcdrosis virus. Fresh lime is added at a rate of 5 grams for 1000 cc of freshly prepared 3% formalin solution. The turbid fluid after mixing with fresh lime must be used for disinfection.

Disinfection is conducted by using sprayers (Fig. 34). In villages it is advisable to use power sprayers to ensure spraying of formalin in all corners and crevices. Before spraying the holes and crevices are tightly closed. Spraying should be conducted when the temperature is at *25°C.* If it is cold, disinfection has no effect. It is advisable to conduct formalin spraying at 10.00a.m. when room temperature is *IS^C.* Disinfection of the rearing house is not effective on a rainy day. Formalin solution irritates the soft skin and naturally the labourers who disinfect the room feel very uncomfortable and thus may not conduct disinfection properly. Hence they should always use gas masks. Spraying formalin should be done after keeping all the equipments required for rearing in the rearing room. Care is taken to spray on all the corners and joints of equipments, the door and window panes and corners. After disinfection the room is sealed off for 24 hours, so that the formalin vapours can effectively kill all pathogens. Pebrine spores are killed within 10-20 minutes of contact of formalin.

Fumigation

Fumigation of formalin solution is suggested for compact rearing houses and compact chawki rearing room. For this purpose, formalin kept in an iron pan is placed over a hot oven in the rearing room and allowed to evaporate for 4-5 hours. However, care should be taken to keep only just sufficient fire or cinders to evaporate formalin, if not it may lead to fire hazards.

Besides conducting disinfection, the surroundings must be cleaned and dirt etc., removed. It is advisable to sprinkle lime and bleaching powder mixture around the rearing house. This will help to check pathogens entering

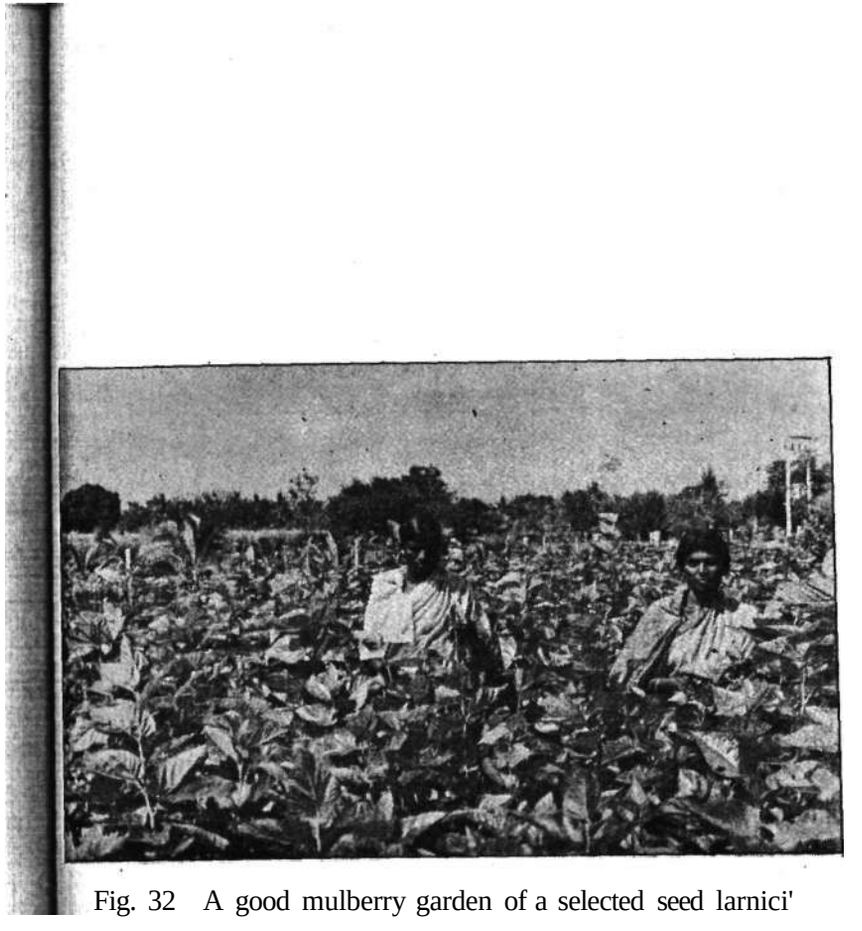


Fig. 32 A good mulberry garden of a selected seed larnici'

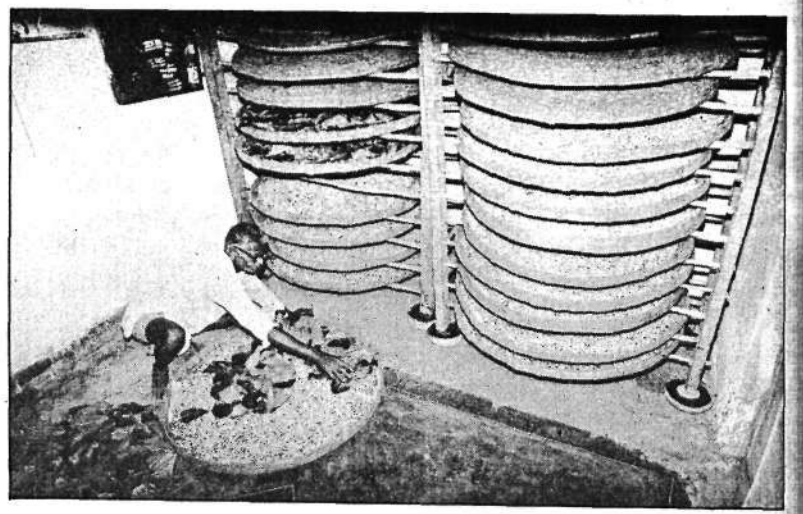


Fig. 33 Bivoltine rearing of a selected seed rearer

Fig. 34 Disinfection of a rearer's house

into the rearing house. Even when the rearings are under progress sprinkling of bleaching powder and lime mixture at least once in 5 days helps in keeping the room free from pathogens. The labourers who rear silkworm must clean their hands and legs in *2%* formalin. This helps in checking the contamination of Pebrine disease. Use of too much of formalin in the room when silkworm rearing is in progress is not advisable.

The rearer should realise that if the stock, he is rearing is contaminated the cocoons will not fetch high price and the cocoons are sold at much lower rate than cross breed as they contain less silk.

(e) Incubation

The silkworm eggs are to be incubated properly to avoid irregular hatching. An ideal incubation is to maintain a temperature of 25"C and 75% to 80% humidity continuously. In most of the places incubators are not available. In such cases, the eggs are kept spread in wooden trays provided with paraffin paper for base and the cover and foam pads kept wet all around inside the trays to maintain 70%-80% humidity. In each chawki tray of 90cms X 120cms about 4 sheets of eggs can be kept for incubation (Fig. 35).

The room temperature is piaintained at 25°C. On 9th day the egg sheets are rearranged. About 25 dfls are kept in a chawki tray of 90cms x 120cms to enable brushing and proper spacing for young worms later. The egg sheets are covered with a sheet of black paper or paraffin paper. On the due date of hatching and when a few larvae have started hatching, black paper and the paraffin paper are removed and the eggs are exposed to dim light for about an hour.This facilitates the uniform hatching of larvae.

(0 Young age Silkworm Rearing

When all the worms have hatched, they are brushed at 25 dfls per wooden tray of size 90cms x 120cms. Each tray should have a layer of paraffin paper for the base and lined internally by wet foam pads to maintain humidity. After brushing, the tray is covered with another sheet of paraffin paper for the top (Fig. 36).

The leaf suitable for early age rearing is the one from a good garden which is provided with all inputs. The leaf for brushing is the one which is the 3rd or 4th leaf from the top or the largest glossy leaf. This can be judged by holding the tip of the bud and bending to a side, the largest glossy leaf stands erect. Only such individual leaves are picked. (Refer Fig. 11a, b & c in Chapter MI). The leaf required fof brushing should be obtained in the early hours of the day. Individual tender leaf is collected in baskets covered with wet gunny cloth and transported to rearing house.

Leaf is cut to 0.5 cms sq. and sprinkled over hatched worms on the sheets. The worms are allowed to crawl on to the leal for about 20 minutes, they are tapped into rearing tray, with paraffin paper and the bed is made. The size of the bed for 25 dfls in a tray must be about 30 cms x 30 cms and must be made in the middle of the tray. The worms are again given a light feeding in the bed. Wet foam pads are kept round the bed and covered with paraffin paper. Wooden trays containing the worms arc mounted one above the other.

(i) **Environment for Young age Silkworms**

Success of silkworm crops, specially pure races to a great extent depends on tfie techniques followed in rearing of young age silkworms. Young age silkworms

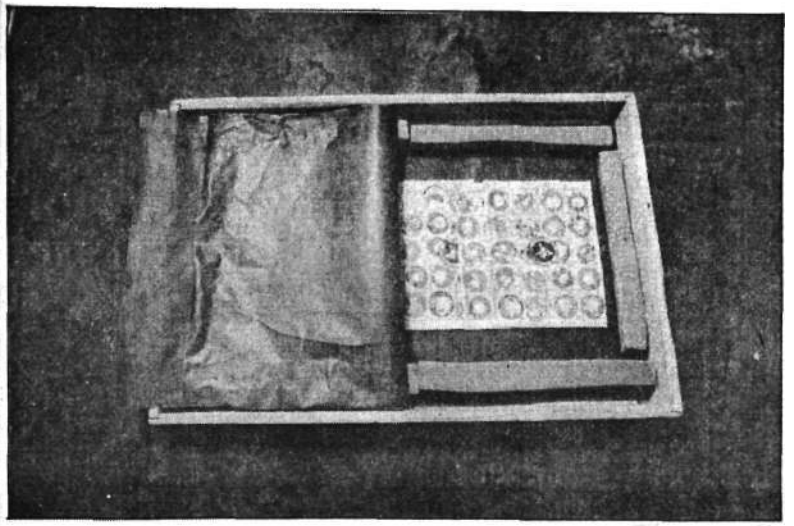


Fig. 35 Eggs kept for incubation

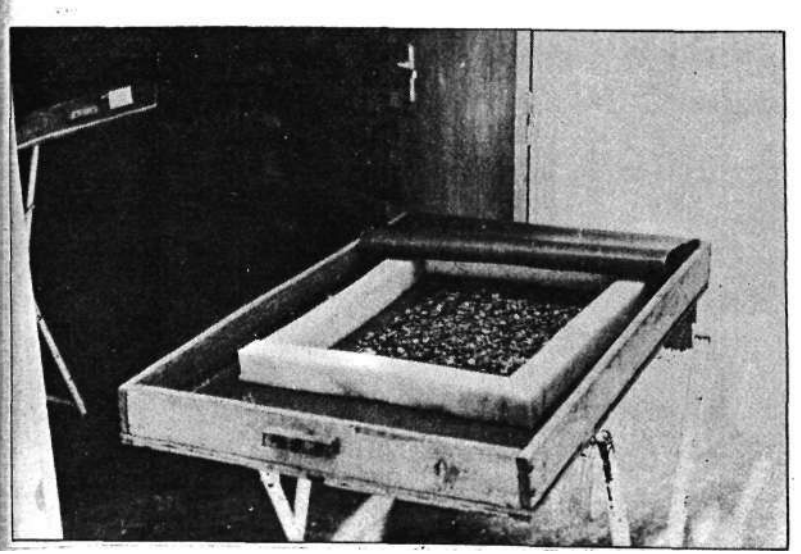


Fig. 36 Rearing with parjiirin paper

Fig. 37 leaf preser\ation in wooden chamber

grow very fast, hence proper nutritive leaf is to be provided. The fast growth of the worm also needs higher temperature and humidity. High humidity also helps in preserving the leaves fresh. For pure races a temperature of 26«C-270C and humidity of 80%-85% is suggested during chawki rearing period. The chawki worms react to accumulating bad air in the rearing tray. Hence the paraffin cover paper of the bed is removed half-an-hour earlier to feeding. It is also desirable to open windows at least once a day for an hour to allow fresh air in chawki room.

(ii) Leaf for Chawki Worms

The leaves suitable for 1 st, 2nd and 3rd stages is given in figure 11a, b& c. The largest glossy leaf on twig and four leaves below are suitable for 1 st stage, 5th, 6th and 7th leaf for 2nd stage and 9th and 10th leaf for the 3rd stage. These leaves must be individually plucked from a garden to which sufficient farm yard manure and lesser quantity of fertilizers are applied. The leaf must be from irrigated gardens. In summer when the growth of leaf is very fast, the best leaf for chawki rearing is 4th, 5th and 6th for 1st stage. The leaves picked are stored in wooden leaf chambers covered with wet gunny cloth (Fig. 37) or earthern pots with holes on top and embeded in wet sand bed. Leaf is cut to following size for the different stages of silkworms.

1.	**Brushing**	**= 0.5 cm. sq**
2.	**Middle of Ut stage**	**= 2.0 cm. sq.**
3.	**Last feeding of Iststage**	**= I cm. sq. or even less to enable quick dr>ing.**
4	**Beginning of 2nd stage**	**= 2.0 cm. sq.**
5	**Middle of 2nd stage**	**= 4.0 cms. sq.**
I 6.	**Settling for 2nd moult**	**= 2.0 cm. sq.**
7.	**Beginning of 3rd stage**	**= 4.0 cm. sq.**

Five feedings at 6am, 10am, 2pm, 6pm, and 10pm are suggested for rearing pure races.

The quantity of leaf fed to 100 dfls of silkworms of pure races at different stages is given below for guidance. Multivoltines consume slightly less leaf.

	QUANTITY IN Kgs.	
AGE	**BIVOLTINE**	**MULTIVOLTINE**
1st Stage	3.0	**2.5**
2nd Stage	10.0	**7.0**
.Ird Stage	40.0	**30.0**

(iii) Bed Cleaning and Spacing

Bed cleaning is necessary to keep the bed free from germs and keep it dry during moult. The silkworm brushed and reared at *26^C* and humidity of 85% develop shining body by the 3rd day. This is the sign that it goes for moult. Lime powder is dusted to keep the bed dry before feeding at this stage. When the worms have developed shining body, a cleaning is given to remove the faecal matter, old leaves and lime. For cleaning a net is spread over and feeding given over the net. The worms crawl through the net by two feedings. Nets with worms and the leaf are transferred to another tray. Left over worms in the bed, if any or weak worms are taken and tested for disease by the extension officer. As worms settle for moult quantity of leaf fed is reduced. There are other methods of cleaning. Paddy husk is spread over the bed. After feeding, worms of the top layer are brushed to another tray.

Pure race worms depending on race settle for 1 st moult in 3 to 3'/i days. When they settle for moult lime is dusted to dry the leaf and prevent out of moult worms feeding on older leaf, lime also acts as disinfectant. Thus during 1st stage one cleaning is given. During 2nd stage two cleanings are given, first, two feedings after 1st moult and second when worms start settling for 2nd moult. Three cleanings are given during third stage. Generally, worms take *I'A* days in the 2nd stage and 3'/4 in 3rd stage. Multivoltine Mysore race take a little longer duration and Nistari race of West Bengal take lesser larval duration.

Spacing is provided to accommodate the growing larvae. As informed earlier, the growth of larvae is very fast during early ages. The optimum spacing suggested for a batch of 25 dfls in a tray of 90cms x I20cms is given below:-

Ist Instar	Area of Bed
Brushing	30 cms X 30 cms
End of 24 hours	35 cms X 45 cms
End of 48 hours	45 cms X 53 cms
End of 72 hours	45 cms X 75 cms
Settling for 1st moult	50 cms X 80 cms

2nd Instar	Area of Bed
At the time of resuming feeding	45 cms X 75 cms
After 24 hours	75 cms X 90 cms
After 48 hours	90 cms X 120 cms
Settling for 2nd moult	90 cms X 120 cms

Spacing is provided daily at 10 a.m. While feeding also, space is expanded by providing leaf on the sides. Chop sticks are used for providing space. They are cleaned, washed in formalin and kept dried. Spreading by hand

should be avoided as it may contaminate the worms. The farmer should note thai he is rearing pure races and it should be free from diseases.

(iv) **Chawki Centres**

Many times the worms are reared by the technical staff in chawki centres and distributed to the farmers. In such cases the farmer must get the certificate from the extension officer or the staff of chawki centres that the worms have been tested and are free from diseases.

It is emphasised that success of the crop depends on proper young age silkworm rearing.

(g) **Rearing Pure Races at Later Ages**

Rearing of late-age silkworms is always conducted in the rearers house, immaterial of younger worms reared in chawki centres or in his own chawki house. The responsibility of the seed cocoon rearer is much more than that of the hybrid silkworm rearer, because he should maintain the stocks free from disease and grow healthy larvae, which build good quality seed cocoons. Generally later age silkworms do not tolerate high temperature and high humidity. Secondly, their digestion rate is comparatively lower than early ages and is lower than hybrids. They succumb to disease due to bad quality of leaf very quickly. They require an optimum condition.

The optimum environment for rearing of different ages of pure silkworm is given below:-

Age of silkworms	Temperature	Hun
3rd age	25''-26»C	80%
4th age	24o_25«C	75%
5th age	23»-24»C	70%

The rearing room must be well ventilated to provide fresh air. In colder seasons if the temperature outside is lower than 200C the room must be heated and windows opened once a day to allow fresh air. If the temperature outside is high it is better to sprinkle water on the roof or put thatch on the tiled roof and make it wet. The windows must be opened to allow fresh air to get in and provided with a thatched covering to cool the incoming air.

Leaf for grown up silkworms must be from a good irrigated mulberry garden, where optimum inputs of farm yard manure and fertilizers are given. Heavy doses of farm yard manure, red earth and tank silt not only enrich soil in the garden, but also helps in growing good quality leaf. Worms reared on leaves from such gardens are healthy and do not suffer from Grasserie disease. There is a relationship between growth of mulberry plant and silkworm rearing. Immature mulberry leaves cannot provide proper nutrition to larvae and they suffer from diseases. Larval growth is poor and cocoon quality is very poor when fed with over-mature leaves.

Mulberry leaf is picked from the garden only during early hours or late evenings and stored separately in wooden leaf chambers covered on all sides by wet gunny cloth. This will enable to keep leaf in as fresh state as possible. In grown up stage silkworms eat lot of leaf, hence, the management of leaf supply and feeding becomes difficult. It is better to construct a rearing house nearer to the garden, and labourers should be divided separately for leaf picking and silkworm reading. Silkworms are cold blooded animals, when atmospheric temperature is high, the physiological activity increases and they have greater appetite, which falls at cooler part of the evening or night. However, the dose of mulberry

fed should be increased at evening and night feeding during warmer days. Leaves are chopped to 6 cm. sq. -during early 4th stage and entire leaf is provided after two feedings of 4th moult and during final stage.

Selection of proper quality of leaf is very important in rearing pure races. Feeding tender leaves during final stage increase the growth of larvae but the worms succumb to Grasserie disease just before spinning. Feeding such leaves also increases the melting cocoons due to pupal mortality at the time of cocooning or later.

Many of our farmers in seed areas are in the habit of feeding tender and medium leaves to increase the growth of larvae and pupal weight to gain the yield by weight. They should also note that such cocoons with heavy pupae are not fit for seed cocoon and seed preparation. This habit is specially in vogue with our bivoltine seed rearers, which is not good. They must produce good healthy seed cocoons. The farmers also have a habit to feed heavily the pure races. They should know that pure races eat less and slowly than hybrids. Hence they should regulate the feeding in such a way that they increase the number of feedings from 4 to 5 and decrease the quantum of leaf fed as compared to hybrids. Feeding silkworms of pure races heavily at final age tend to make pupae heavy and egg laying efficiency of the moth from heavy pupae get reduced. Hence, it is necessary to regulate the quantity of leaf fed from the middle of 5th age i.e., from 4th day onwards. This will make the body strong and produce pupae with comparatively less of fat. Such practices will enable to produce good quality seed cocoons of average cocoon weight of 1.8 gram, and with high pupal survival of 90% to 95% in bivoltines and 1.10 gms. and 90%-95% survival of pupae in multivoltine races.

The ideal spacing to be given for pure races for 100 dfls of worms i.e., 40,000 larvae brushed is given below:-

BIVOLTINE	SPACING	No. of Tr»ys of 1.06m (3.5*) diameter
Vd Stage	4 X sq. metres	4 X
4lh .Stage	X IX sq. mts,	X IX
5ih .Stage	IX 4<) sq. mts	IX 40

For Multivoltine Mysore **Race**

.Ird Stage	} 5 sq. mis.	} 5
4th Stage	5 15 sq. mis.	5 \}
5th Stage	15 ,15 sq. mts	

Quantum of feeding during different stages for worms of pure races (100 dfls) is given below:-

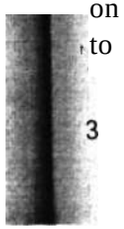
BIVOLTINE

.^rd Stage	.15 40 Kgs
4th Stage	X5 95 Kgs
5lh Stage	750 850 Kgs

MULTIVOLTINE:

Jrd Stage	25 30 Kgs.
4ih Stage	60 70 Kgs.
5th Stage	550-600 kgs.

The above two factors of spacing and feeding depend on the larval population and must be adjusted according to population density and the silkworm race.



h) Mounting

Multivoltine Mysore race of silkworm start spinning after 7 days while bivoltine spins after 6 days of 4th moult. Larvae cease to take food and crawl restlessly in search of a scafold for spinning. Multivoltine Mysore race worms and Nistari worms appear yellowish in colour as the silk glands have yellowish coloured silk and the digestive system is empty. Bivoltines which generally look bluish white in final stage appear yellowish white at spinning. These are mature worms fit for spinning cocoons.

Such worms are mounted on "Chandrikes," the bamboo mountage used commonly in our country. In Jammu & Kashmirand Dehradun, plant leaves and straw are used as mountage. A bamboo mountage i.e., Chandrike of 1.82 m x 1.2 m can accommodate about 1,000-1,500 worms, depending on the race, for spinning (Fig. 38). Mounting more than this number of larvae on a mountage results in over crowding and worms spin double cocoons, where two worms spin a single cocoon. Sometimes unripe worms which are not yet mature to spin cocoons are mounted on the mountages. Such larvae crawl restlessly and spin bad-Jind flimsy cocoons. Delay in mounting mature larvae result in worms wasting silk in the rearing bed and spinning flimsy cocoons. Hence properly matured larvae are mounted on chandrikes to get good quality cocoon for seed. At the time of spinning high humidity must be avoided. High humidity leads to secretion of liquid excreta in the form of urine which falls on the cocoons. Such cocoons are called urinated cocoons and are not fit for seed. Chandrikes must not be disturbed frequently as such disturbances leads to formation of flimsy cocoons.

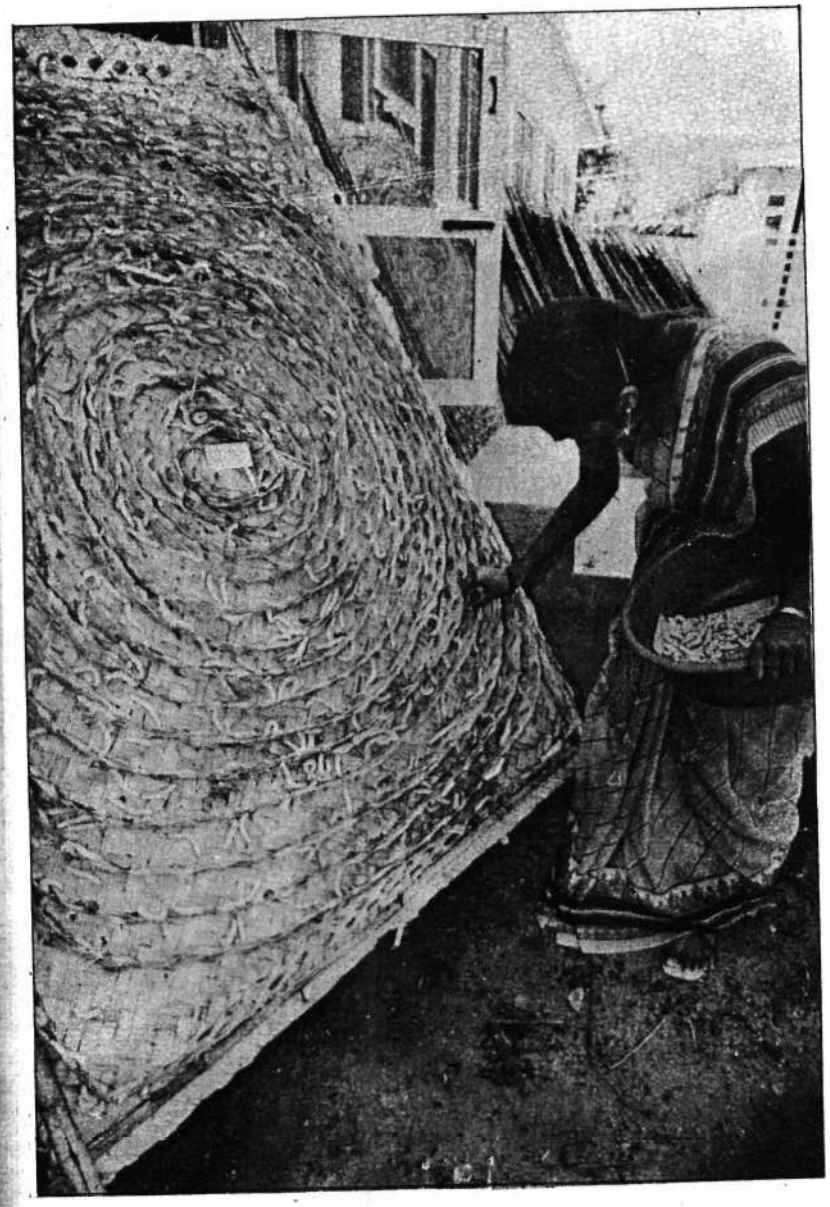


Fig. 38 Mounting of silkworm

Fig. *i9* Harvesting ol seed cocoons

6* Cocoons are harvested on the 6th day of spinning of the last worm in bivoltines and 5th day in multivoltines. By I this time the worm has completed spinning of cocoon and transformed to pupae by casting its larval skin and has developed brown thick cuticle. This is the proper time for harvest of cocoons. If harvested earlier theskin of pupa is soft and has not yet turned brown, such pupae when disturbed burst and die in the cocoons. These are called melted cocoons. Increase in melted cocoons makes the batch unfit for seed.

By the time the larvae have started spinning, the extension officer of the grainage visit the rearer's house frequently and periodically, test the larvae for disease and watch the progress of the cocooning. Before the cocoons iare harvested some flimsy cocoons and early spun cocoons are examined for Pebrine. If even traces of Pebrine is noticed such lots are not taken for seed. The aim of the seed cocoon grower is not only to produce cocoons with high yield but also those which are free from Pebrine disease.

Cocoons are harvested on the 6th day (Fig. 39), they are |cleaned"of faecal matter, melted cocoons and flimsy S cocoons. Only good quality cocoons are separated and !sent to the grainage. Seed cocoons should never be transported on lorry or on top of the bus and that too in iafternoon when the temperature is high. This leads to I pupal death and melted cocoons.

Norms have been drawn for fixing the price of cocoons. ^These norms are periodically revised by the Government in favour of the seed cocoon growers. Rate fixed is given as example.

1. The yield of cocoons must not be less than 30 Kgs/100 dfls on the day of marketing to the grainage in bivoltines and 20 kg/100 dfs in multivoltines.
2. Percentage of live pupae must be 92%.
3. Number of cocoons/Kg in bivoltines must not be less than 550 and not more than 700 cocoons/Kg.
4. In multivoltines the number of cocoons/Kg must not be less than 850 and not more than 1,100/Kg.
5. Price is fixed by following formula of standard cocoon for bivoltines as follows:-

   (a) Standard cocoon — 650/kg

   (b) Rate for standard cocoons — Rs. 70/Kg (as fixed by the Government from time to time).

6. Rate fixed for the quality cocoons of 550/ Kg of the farmer:

$$\frac{\text{Standard rate X No. of standard cocoons/Kg}}{\text{No. of cocoons per kg of the farmer}}$$

$$= \frac{70 \times 650}{550} = \text{Rs. } 82.75/\text{kg.}$$

7. Similarly rate tixed lor mullivoltinc is:
   (a) Standard cocoons = 1000/Kg
   (b) Rate for standard cocoons = Rs. 40/Kg
8) Rate fixed for the cocoons of the farmers which is 900/Kg.

$$= \frac{40 \times 1000}{900} = \text{Rs. } 44.44 \text{ or say } 44.50$$

SERICULTURE HYGIENE AND SILKWORM DISEASES

IN silkworms, diseases spread fast as large populali()ns are reared in a limited area. Further worms succumb to the environmental changes very fast. Once the diseases are noticed quick remedial measure such as isolation (removal of diseased larvae from healthy ones) is recommended. However, it is always necessary that preventive measures are taken rather than controlling the 'disease after its occurance. Sericulture hygiene must be strictly followed not only to prevent diseases'but also for successful harvest of seed cocoons absolutely free fr.om diseases.

Cleaning of beds, spacing and feeding silkworms specially at later age is generally practiced by rearer himself or by employirtg labourers. This naturally expose the worms to the attack ofdisease, if he is careless. Hence, a rearer must wash his hands and legs and dip them in 2' i formalin solution before entering the rearing house. These are safety measures to make sure that pure races reared for seed purpose are free from disease. After cleaning the bed, the litter must be removed to a far off place and the floor is wiped. The general pKaclice with pur

farmers is to put leaf on the floor while feeding. Instead they can use mats for putting leaf for feeding. Similarly after cutting the leaf, it should not be thrown on the floor While chopping leaves, it is a good hygienic practice to use a mat under chopping board and chopped leaves collected in a basin instead of collecting from the floor. All these little precautions ensure the lot is free from disease, and successful crops are obtained.

Control of Silkworm Diseases

(i) Grasserie

Grasserie disease is also called Nuclear Polyhedrosis caused by virus. The worms suffering from Grasserie' show restlessness, the intersegmental membrane becomes swollen, the skin breaks with a slight touch oozing milky white pus from the body. The infection is through mouth or skin. Generally the viral Polyhedra bodies lurking in the rearing house, due to the failure of crop earlier *by* Grasserie contaminate the leaf and infect the crop or the Polyhedra may get deposited on the skin and cause; Grasserie.

In tropical countries, Grasserie and Flacherie diseases cause heavy damage. To check these diseases good quality nutritious and mature leaf must be provided to late age silkworms. When fed with tender and improper leaf, the worms become weak and loose resistance capacity. The viral attack on such worms spread fast leading to outbreak of Grasserie disease. Hence, proper leaf from avl garden provided with optimum inputs of farm yard manure, red earth, tank silt and balanced fertilisers should be fed to silkworms.

The control measures consist of disinfection of rearing house and the appliances with I9r bleaching powder solution. After keeping the equipments in rearing house , and washing with bleaching powder solution, the room with equipments is disinfected with *391* formalin solution.

Research institutes in India have recommended the use ol *"Resham Keet Oushadh"* \.*o* check the incidence of ;Grasserie, Flacherie and Muscardine. The chemical S composition of the mixture is Benzoic acid, Captan, 'Paraformaldehyde and lime. These are sold in ready made packets. *'Resham Keel Oushadh* 'is effective against [both Grasserie and Muscardine diseases. The mixture has to be dusted over the worms by using a thin cloth as per [the schedule mentioned below:

Krequency **of dusting**	**Quantity required for 100 dns**
Once after 1 Moult	70.0 g
Pnce after II Moult	140.0 g
pnce after **III** Moult	540.0 g
Once after IV Moult	1.440.0 g
Once on 4th day duri ng V Stage	1,440.0 g

Application should be done after moult, half an hour [before resuming feed or after thorough bed cleaning in fifth age. The worms should be fed 30 minutes after application. Mixture should not be applied when fresh or uneaten leaves are left in the rearing bed. The mixture jhould never be applied when the larvae are preparing for moult or under moult.

(ii) Flacherie

Flacherie is mainly a disease associated with nutrition, bacteria and virus. Improper quality of leaf, too much fluctuations in environment cause Flacherie. There are different types of Flacherie, many associated with bacteria others caused by virus. In most of the cases, due| to loss of vigour in the larvae due to imprOpei^^ environment and food, the bacteria or virus takes upper-hand and inflicts Flacherie. Generally Flacherie is noticedi when over mature leaves from a partially used mulberry| garden is fed to silkworms. The bacteria of virus gain' entry and cause Flacherie. Stocks of silkworms repeatedly multiplied without proper care and selection, i for many generations cause loss of vigour in silkwontil and such larvae easily succumb to Flacherie and othe^ diseases. Hence the rearer should note that he should get| only PI seed from an approved agency and rear silkworms | providing good nutrition and environment to therii.1 Periodical application of lime powder by dusting helps in| keeping the bed dry and also acts as disinfectant, Disinfection of rearing appliances and rearing house wiihl 1 % bleaching powder solution followed by 3% formalin is| essential. Temperature and humidity should be properlyl maintained. Good nutritive leaves should be fed toi silkworms to develop resistance and good growth.

(iii) Pebrine

Pebrine is caused by a protozoan *Nosema bombysi*^ The disease is both contaminative as .well asl *'transovarian'*. The spores get deposited on the leaves and! gain entry into the digestive system of the larvae to cause| Pebrine disease. These worms suffer from loss of appetite' irregularity in growth and in severe cases develop black spots. This type of contaminative Pebrine is visible at lourth and final stages.

Pebrine is "transmitted" through the mother moth. The larvae which are attacked with Pebrine spore spin cocoons from which moths carrying spores in their ovaries and eggs emerge out. Such eggs when reared shows irregularity in hatching, growth and moulting of worms. Such cases of pebrine due to infected mother moths can be noticed during the 1st moult, 2nd stage and 2nd moult. Whenever pure races are reared it is always advisable to get the worms tested at each stage by the extension officers. When worms are crushed and their body fluid is examined under microscope, Pebrine spores are visible as oval bodies. Whenever irregularity is noticed at moult such crop should be rejected and the house is disinfected properly. Generally, if contamination occurs at late ages of larval growth, the crop will not be lost, an average cocoon harvest is noticed. But pupae from such cocoons when examined for disease reveal Pebrine. Such Pebrinised cocoons are not fit for seed, even though the cocoons appear to be of good quality. Pure race seed cocoons growers must take proper precaution to check the contamination of Pebrine. Disinfection of rearing houses with 3% formalin; washing hands and legs before entry into the rearing house and avoiding use of leaf from a garden where faecal matter of silkworms are applied without proper composting, helps in checking this disease by contamination. Only Pi disease free layings from .approved source of supply must be taken for rearing.

(iv) Muscardine

Muscardine is a fungal disease. The worms suffering trom Muscardine loose appetite and sometimes a fluid flows due to the breaking of the skin and the dead worms

become white in colour due to the de\elopmcnt of the"| I'ungal spores. Hence, this is called white Muscardinc.

There are green and yellow Muscardinc also but onlu white Muscardinc is comiTtrin in India, To prevent this'i disease, it is advisable to use Dithane M 45 mixed with slaked lime as a dusting to the worms just after the\ come out of moult. This can be practiced from 1st stage regularly at each moult, and twice in the final stage.. Application of *'Resham Keet Oushad' rcguVdr*\\ alsojj checks Muscardinc disease.

Formalin chaff is also used as disinfectant. Formalin I solution of 0.49f -0.8';, is mixed with charred paddy husk' in the ratio of 10 parts of paddy husk and one part of! formalin solution. This is sprinkled on the worms which I have come out of moult and covered with a newspaper foriJl 30 minutes. The worms are fed after removing the paper cover. Use of different concentration of formalin for the J different stages is given below:

Age of worms	Concentration
I	0.4%
li	0.49f
III	0.5%
IV	0.69/
V	0.89/

If!

The dead worms should be collected and burnt. The\ should not be scattered as the fungal spore spread disease fast.

(v) **Uzifly Infestation**

Uziflies are parasites on silkworms. They are similar to house flies, but bigger in si/e. They fly over the rearing house to lay eggs on the body of the silkworms, the host

The eggs are minute, white oval shaped and are laid on the intersegmental regions of the silkworms.

The eggs hatch and the maggots, minute in size penetrate into the body of silkworms. Where the larvae has made entry a black mark is visible. The maggots grow in the body .)f the silkworm and emerge out of the larvae or pupae after the larvae has spun the cocoon. During this process they kill the larvae or the pupae. In the latter case they come out through the cocoons. After crawling out of cocoon they search for crevices to become pupae and later emerge out as flies. Generally the attack of uzifly is during the late fourth age and fifth age. Uzifly generally do not lay eggs on the early stages larvae.

Rearing silkworms by providing nets all round the rearing place is helpful. Inspite of this care, llics may still get access to the worms when mulberry leaf is brought in. They will generally be flying over the rearing trays. A good silkworm rearer can easily identify the flies and kill them. In addition to rearing silkworms in nets, thedoons and windows must be provided with wire mesh to prevent the entry of flies. Chemicals such as uzicides have been introduced. These are sprayed on the worms which kill the/ eggs *oi* the flies laid on the silkworms. Uzicides are used in addition to use of nets for silkworm rearing

SILKWORM EGG PRODUCTION

GRAIN AGES are the centres for production of large quantities of silkworm eggs. In seed areas they concentrate on production of disease free silkworm eggs of pure races. In industrial cocoon production areas they produce disease free hybrid seed. While seed organisation ensures the production of parent seed cocoon with vigour, grainage which is second vital sector, ensures that hybrid seeds produced are free from pebrine disease. Grainage is the fulcral point of seed production, as it obtains high quality seed cocoons from systematic seed organisation programme and supplies quality hybrid disease free seed. Generally it is the grainage which has a direct link with the commercial cocoon producers and are naturally more popular with farmers than basic seed farms. The farmers look to the grainage for the supply of disease free commercial seed with high- vigour and which produce cocoons with rich silk content and high yields. Since his expectations of good quality seed supply from the grainage is high, he greets the grainage technician with respect and regard.

a) Location of the Grainage

Grainages are generally located in commercial cocoon producing areas to ensure quick supply of silkworm seed to commercial cocoon producers. But they should not be far away from seed areas. If grainages are located away from the seed areas, they have a specific disadvantage in transportation of seed cocoons. Life of the cocoon is short and is hardly 5 days from the date of harvest or purchase of seed cocoons. In tropical conditions of Karnataka, West Bengal etc., where multivoltine cocoons are used in production of hybrid seed, transportation of seed cocoons is hazardous especially in summer leading to pupal death and melting of cocoons. This will upset the programme of hybrid seed production. Seed production becomes costly and uneconomical due to poor emergence of moths. Similarly, if the grainages are located away from the commercial cocoon producing areas, sale of silkworm eggs become difficult as life of eggs is short, hardly 10 days and long transportation of eggs leads to problems in hatching. Hence, grainages are generally located in commercial cocoon producing areas but not far away from seed areas, so that seed cocoons are transported early. It is advisable to transport eggs properly than cocoons. It should also be realised that grainages must not be situated in areas which are climatically unsuitable for egg production. Areas with very high temperature and areas near factories which emit gases should not be selected for a grainage.

b) **Capacity of a Grainage**

Grainages get seed cocoons having a short span of life and produce eggs whose life is also limited specially in multivoltine hybrids. Processing of egg production is highly labour intensive and requires large number of labourers for various processes in egg production. Grainages with high capacities to produce more than 50 lakhs dfls/annum is difficult to manage, as labour and organising supply of seed cocoons and moth examination are difficult. Similarly very small grainages with 5 lakh dfls capacity per annum or less lead to high cost in management, labour, transportation of seed cocoons etc.. Silkworm eggs from such uneconomical grainages are required to be sold at high cost.

Considering the various aspects of technology practiced, supply of seed cocoons, labour requirement and management in egg production, it is suggested that grainages of 15 to 20 lakh dfls capacity per annum is ideal in tropical conditions.

c) **Grainage Building**

Preservation and processing of seed cocoons for egg production require rooms for maintaining specific environment for various processes, such as cocoon preservation, oviposition and egg preservation. Light, temperature and humidity are the factors to be controlled for various activities of the grainage. Preservation of seed cocoons and their processing demands more space. Moth examination etc., require well ventilated halls. Special rooms for conducting the following processes are essential in a grainage:-

i) Cocoon receiving
ii) Cocoon sorting
iii) Cocoon preservation
iv) Pairing of moths
v) Oviposition

vi) Moth examination
vii) Egg washing and acid treatment
viii) Preservation and cold storage of silkworm eggs
ix) Sale of silkworm eggs
x) Storage of pierced cocoons

In temperate climate of Jammu & Kashmir, Dehradun and Assam, where only bivoltine dfls are produced, the various processes of egg production such as moth examination and egg washing get prolonged due to hibernation of eggs. However, cocoons are processed within a short span of time, which requires skilled labourers periodically.

In Japan grainages of very high capacity are functioning. This is possible because of high efficiency of labourers, complete control of disease in seed cocoons, availability of educated labourers and mechanisation. Such efficiency and standards are yet to be established in India. Hence it is advisable to organise grainages of 20 to 25 lakh dfls capacity in temperate areas of the country.

It is essential to construct grainage building suitable for the various processes in egg production mentioned above (Fig. 40). The rooms particularly, cocoon preservation rooms, pairing room, and oviposition rooms must be provided with facilities to maintain temperature of 25"C± I"C, humidity of 75%-80% and facilities to provide darkness and light when needed. Air conditioners and humidifers are installed in cocoon preservation and egg laying rooms. High temperature leads to high melting of cocoons and moths not laying eggs. Oviposition room is kept dark by painting black colour on window panes and by providing black curtains in addition to maintaining the optimum temperature and hunfidity.

Facilities to keep rooms ventilated and clean; and for avoiding scales from moths settling in the room must be available. Moth examination rooms are provided with wider windows and artificial light for examination. Egg washing rooms must be provided with 3 tier sinks for egg washing and facilities for acid treatment of bivoltines. There must be copious supply of waterand good drainage in grainages. Egg production being highly labour oriented, large number of labourers work here. A dormitary for labourers who work at night is a necessity for a good grainage. A grainage must be spacious for working of labourers, staff and the farmers who come to buy eggs.

In many cases dwelling houses are used for grainages. Naturally, these buildings are not suitable for organising different functions of a grainage. Dwelling houses, lack facilities in many respects such as cocoon preservation, oviposition, moth examination etc., One is compelled to adjust to the space and conditions available and such a compromise naturally will have ill-effect on quality of eggs produced.

Grainage buildings must be such that the rooms for step by step processing are located adjacent to each other to avoid movement of labourers and staff and confusion in preparation. For example, the room for pairing and oviposition must be nearer and easily accessible to both multivoltine and bivoltine seed cocoon preservation rooms. Moth examination room must be away to avoid contamination. Oviposition room must be nearer to cocoon preservation rooms. If very big rooms are provided, it is difficult to control temperature while small rooms are a hinderance to working. Pierced cocoon

rooms must be far away from grainage. Cold storage rooms must be near egg laying room for easy maintenance of optimum temperature in oviposition rooms. Considering the various aspects, it is always necessary to construct proper well planned grainage building. Requirement of space for an ideal grainage of 15 lakh dfls/annum capacity is 6,000-8,000 sq. ft. and for 25 lakhs dfls capacity grainage, the space required is about 12,000 sq. ft. An architect with the assistance of a grainage technician can plan a suitable building for grainage. An estimated space of the rooms for a 20 lakhs dfls capacity grainage is given in (Fig. 41).

d) Equipments

Equipments are designed to meet specific purpose in a grainage. Too big equipments are difficult to handle. Wooden trays are designed to check the sudden fluctuations in temperature, ant-wells to check attack of ants on cocoons, cellules to check light and to keep moths undisturbed. These are thus made for easy handling and for optimum facility to cocoons, moths and eggs during their process of preparation. Equipments required and their specific purpose are given for reference (Fig. 42).

1) Stands for arranging trays to preserve cocoons.
2) Bamboo trays to arrange cocoons for deflossing and emergence.
3) Wooden trays for preservation of pupae.
4) Ant well to check ant attack on cocoons.
5) Stands for keeping trays during picking of moths, arranging cocoons etc.
6) Craft paper to preserve the pupae for emergence

Fig. 40 Grainage building

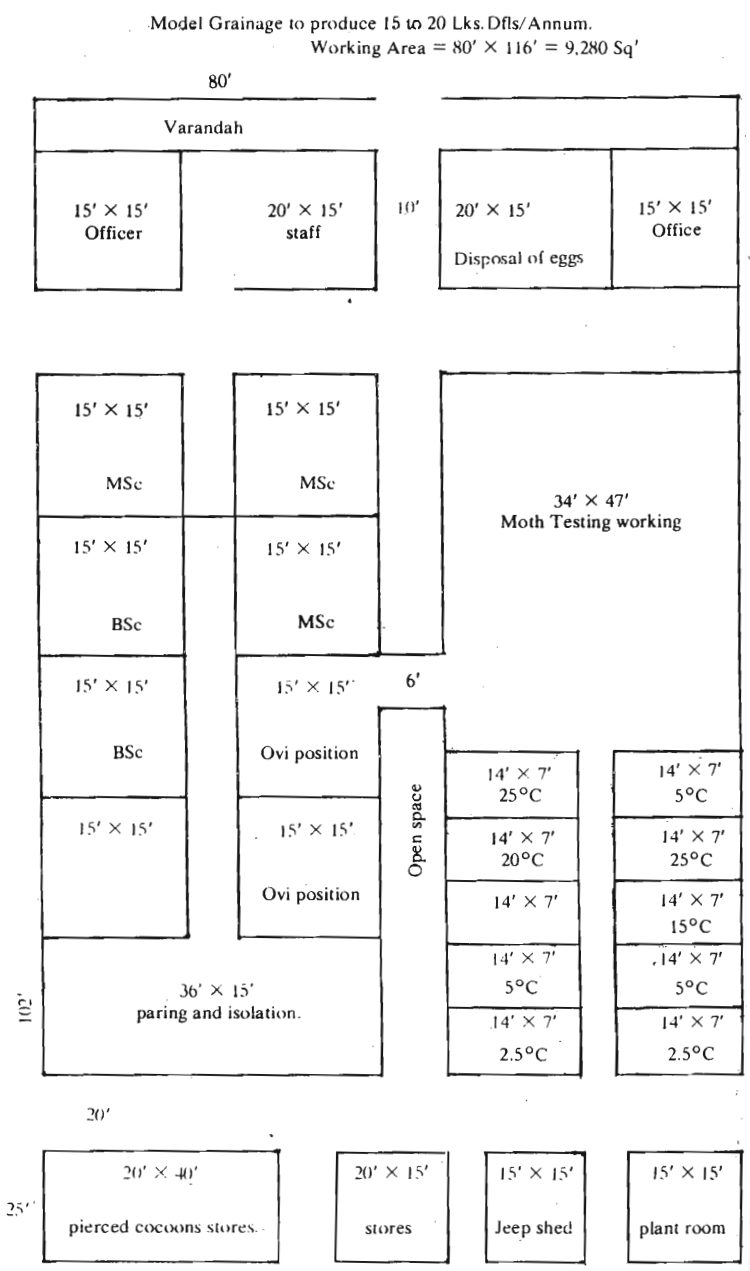
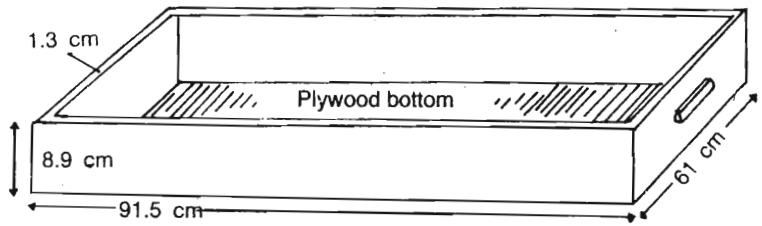
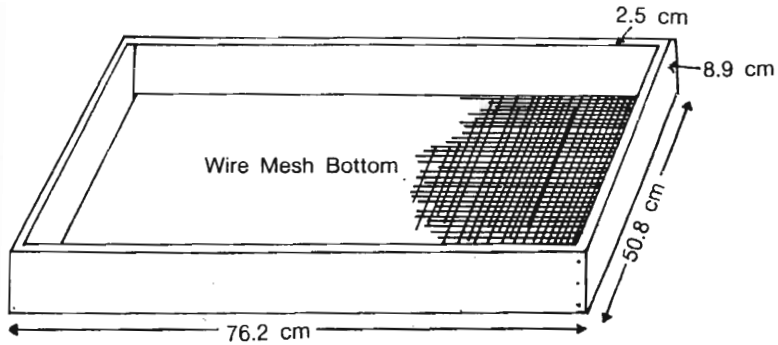


Fig. 41 Model grainage

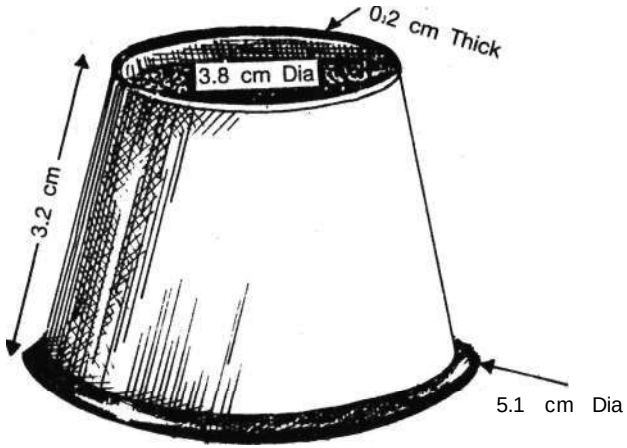


Grainage Tray (Wooden)

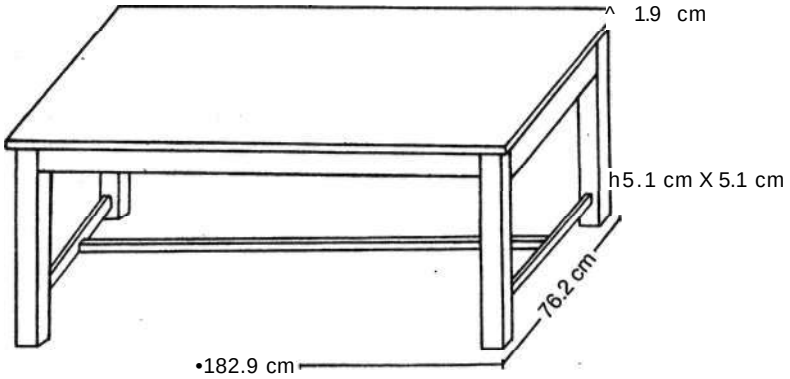


Grainage-wiremesh Tray

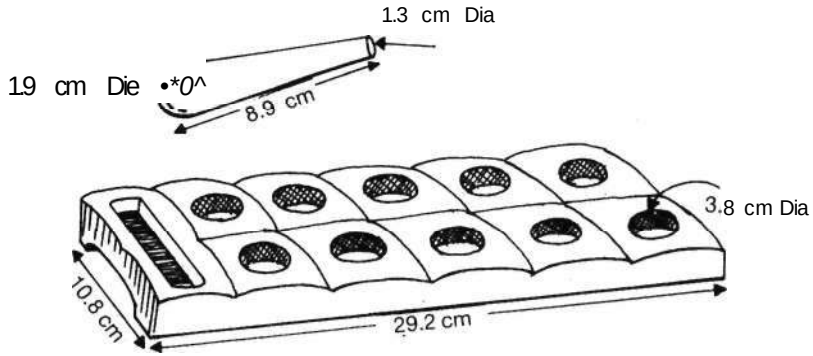
Fig. 42 Grainage equipments



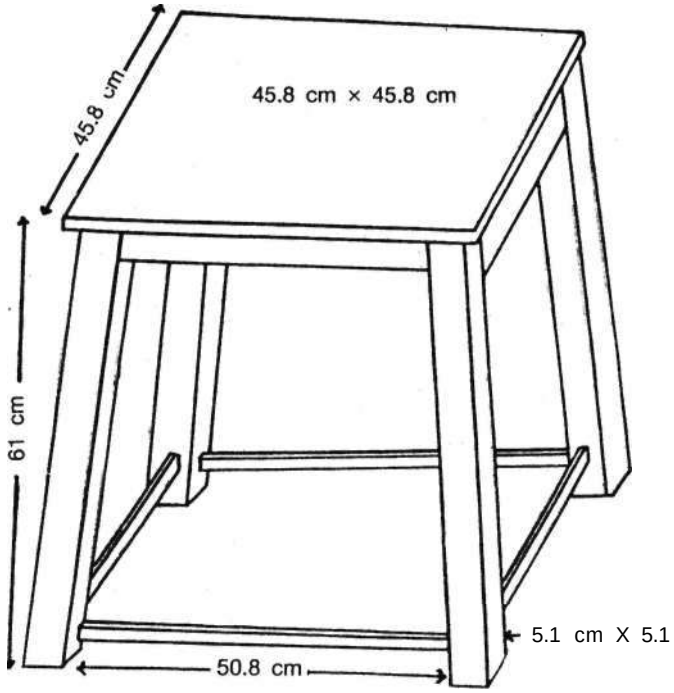
Cellule (Plastic)



Moth Testing Table (Wooden)

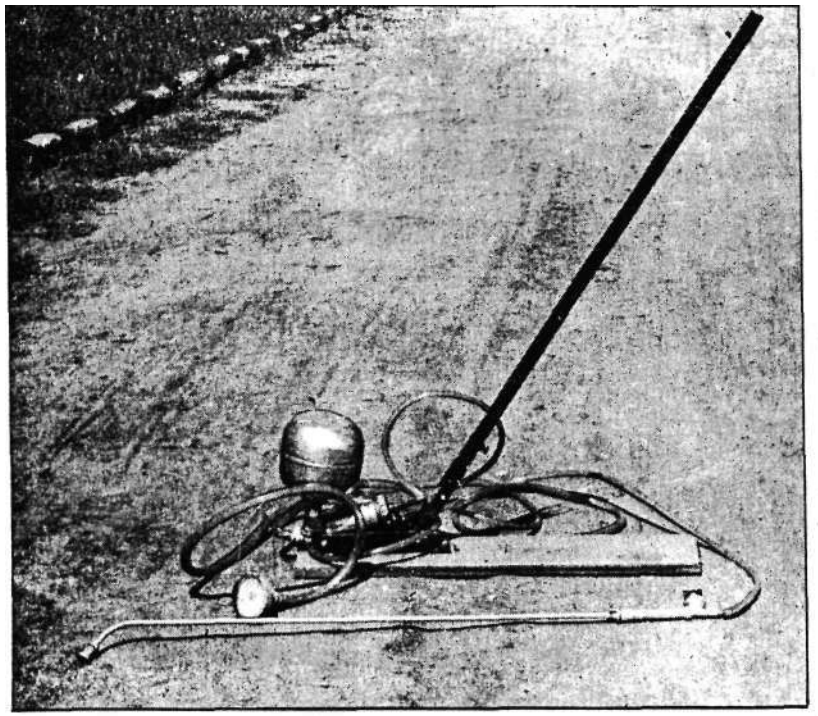


Moth Crushing Set (R?/celain)



Examination Stool (Wooden)

I }



Sprayer

7) Wet & dry bulb thermometer to assist in maintaining temperature and humidity.

8) Humidifiers for maintaining humidity.

9) Cellules designed to provide darkness and isolation to moths during pairing and egg laying.

10) Sprayers for disinfection.

11) Wooden stands for arranging trays for egg laying.

12) Zinc trays for preservation of moths.

13) Refrigerators for preservation of moths.

14) Mortar and pestle for crushing moths.

15) Electrically operated moth crushing machine.

16) Disinfection masks to provide protection during disinfection.

17) Hot air ovens to dry moths.

18) Centrifuges and shakers for isolation of sediment **for** moth examination.

19) incubators for maintaining temperature of 25"C and 80% humidity for egg incubation.

20) Egg cabinet for keeping eggs.

21) Washing equipments such as trays, basin etc.

22) Binocular microscope for moth examination..

23) Other equipments such as foot-mats for disinfection of feet while entering the grainage, basin stands, moth examination tables, benches, air conditioners etc.

m

Equipments required for a grainage of capacity of 15 lakh dfls/annum is given in Annex-VII

e) Staff

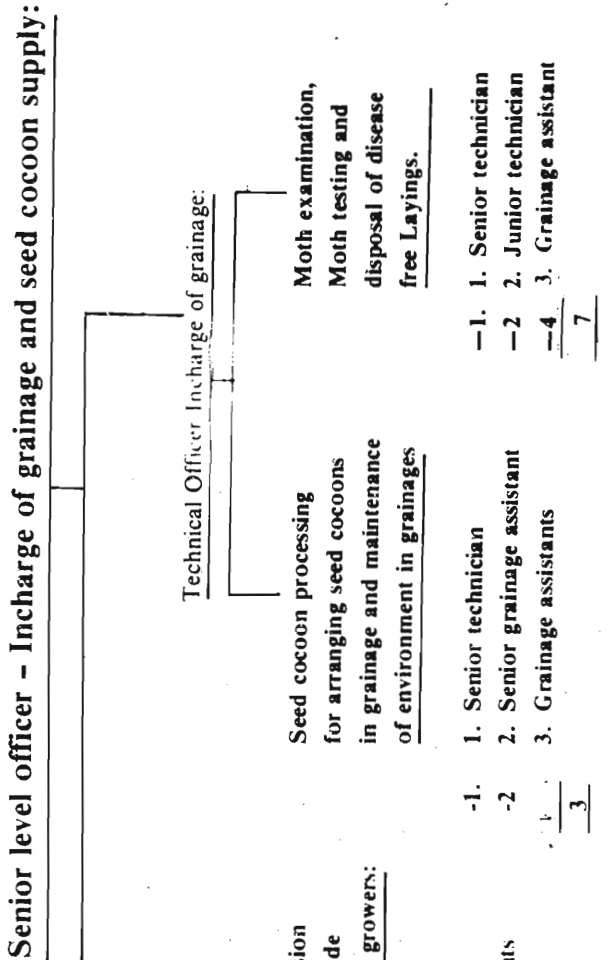
The programme of the grainage can be broadly divided into:

a) Supply of parent seed cocoons
b) Processing of cocoons
c) Moth examination & Disposal of seed.

The technology of seed cocoons production is implemented by a group of technical staff. Seed cocoon supply being an essential programme is generally looked after by the head of the grainage. He is assisted by the technical staff for extension programmes with seed cocoon growers and seed cocoon production.

The second part is the processing of the cocoons. This is led by a group of technicians who are well trained in the programme of gut examination of pupae, arranging cocoons, sex separation which is a highly technical job and vital for ensuring the lots free from pebrine. A group of moth examiners who are trained in identification of pebrine spores, moth examination procedures, acid treatment of bivoltine eggs, preservation of eggs and disinfection are arranged.

Deployment of staff for different functions in a 15 lakh capacity grainage is given below for guidance:-



PROCESS OF EGG PRODUCTION

SILKWORM egg production is a technical job and unless the techniques are systematically followed, one cannot assure the quality of eggs produced. Handling ol cocoons, moths and the silkworm eggs at different stages require careful attention.

1 echnicians and labourers must be properly trained in following the techniques. These methods must be suitable for large scale production in grainages. The aim of the grainage is to provide ideal conditions as far as possible, for production of quality eggs. Various processes and techniques of egg production involved are described in this chapter.

a) **Di.sinfection**

Before the cocoons are received in the grainage the rooms are cleaned and disinfected. The procedure for disinfection was described earlier. In grainages of Karnataka always small batches of cocoons are

processed. This is because the farmers prefer fiesniy prepared eggs and not those stored in cold storages. In such conditions it is difficult to disinfect the grainage very often before each lot. However, when demand for silkworm seed is very low, disinfection of the grainage must be conducted.

In West Bengal, Dehradun and Jammu & Kashmir conditions where demand for silkworm eggs are specified for a season disinfection can be taken up before each season as a rule.

b) HybridDisease Free Layings Production

The grainages produce hybrid seeds for production of commercial cocoons. The hybrids have shorter larval duration, better survival rate and are richer in silkcontent than the pure races. Sericulture is one of the few industries where hybrid vigour has been fully exploited. Japanese were the first to realise the advantages of rearing hybrids for silk production

Karnataka state in the country was first to adopt hybrid silkworm rearing in 1932. Multivoltine pure races of Mysore and Hosa Mysore are crossed with bivoltine races to produce hybrids in Karnataka. Mysore race cocoon is oval in shape, flossy in nature and greenish in colour.

Bivoltine cocoons are used as male components for preparation of hybrids. These are generally white in colour. Bivoltines are classified into Japanese breeds, Chinese breeds and European breeds. Japanese breeds spin peanut shaped and compact cocoons with grains and 'are white in colour. Chinese breeds are oval in shape, less compact as compared to Japanese races, with grains and

spin white cocoons. European races are similar to Chinese races but are dull white in colour. In Karnataka four bivoltines vi/., Kalimpong A, NB-both oval races and NBiKand NBjDrboth constricted races arc used for preparation of hybrid seed.

In West Bengal hybrids of Multivoltine Nistari and bivoltine males are used. Nistari spins oval and more compact cocoon than Mysore, race. Cocoon is golden yellow in colour and is flossy. Recently a new race ol silkworm viz.. "G" race is being reared. 1 his is superior to Nistari in silk content.

In Dehradun of Uttar Pradesh and Jammu & Kashmir hybrids of bivoltines between Chinese female (o\al cocoons) and Japanese males (constricted cocoons) and their reciprocal combinations are used for commercial cocoon production. The races used are:

Jammu & Kash mir

Oval	Constricted
Changnang	**J** 112
Yakwei	**J** 122
C 108	**B 40**

DEHRADl N OF UTTAR PRADESH

Oval	Constricted
C 108	**J** • 112
C 112	**J** 122
YS 3	NB4D:
SF 19	SH6

c) Pi Seed Cocoons

Production of l\ seed cocoons in seed areas and with selected seed cocoon growers was discussed in detail. Fo ensure supply of only Pi seed to the seed cocoon growers, the field staff of grainage must have intimate contact w ith farmers and study the conditions of their garden and then demand for seed. ThcN must frequently visit the farmers house and provide technical guidance for growing seed cocoons. They must maintain records of each of the seed cocoon lots under progress and record their observations in the pass book or inspection card of the farmer. They should examine the worms periodically to ensure that the crops are free from F'ebrine disease and closely watch the progress of worms at every .stage of their growth. 7 hey must also conduct pupa test. 1 hey should certify the lots for their fitness for seed cocoons, their quality and freeness from diseases. Those who are incharge ol procurement and supply of seed cocoons to grainages must have a good knowledge of the Picocoon crops under progress with the farmers.

The egg producers can purchase the seed cocoons on the fitness certificate of the extension officer of the seed area. The following norms are followed for purchaseot seed cocoons;

1) Purchase only such cocoon batches which have been closely watched by the extension staff and health certificate affixed on inspection card.

2) Gut examination of the pupae must be conducted before purcha.se.

3) The seed cocoon crop must be healthy and free from tliseases. Diseased cocoons like those infected with Muscardine, Grasserieand Pebrine should never be purchased, even if they show very low percentage of incidence. Muscardine and Grasserie affected cocoons lead to high melting at the grainage level.

4) Batches of cocoons showing even a slight incidence of Pebrine during pupa test must not be purchased.

5) The number of live pupae at the time of purchase should not be less than 90%.

6) Melted cocoons if any should be sorted out at the cocoon market.

7) Batches of cocoon not conforming to the characters of the race should not be purchased.

8) Crops showing an average yield of cocoons and above, as fixed by the norms only should be purchased. Norms are fixed from time to time considering seasonal conditions of rearing. Norms are lower in summer and higher in favourable seasons. In temperate climate of Dehradun and Jammu & Kashmir, norms are fixed for spring, late spring, autumn and late autumn crops.

9) Do not purchase cocoons which are with very heavy pupal weight. Heavy pupae lead to high melting at grainages.

10) Rates are fixed for the standard cocoons as per norms for different seasons.

Rates for the farmers batches are fixed in comparison with the rates fixed for standard cocoons as follows:

RalCN for Mandard cocoons X No. ciKiions kj; in standard

No. ol c<KO()ns with li\c pupae Kg of the farmers
- Rale lived for the farmer's cocoons.

12) Purchase officer must certify for the quality of cocoons and' its disease freeness. Having marketed the cocoons in the cocoon market, signature of the market officer is affixed and recorded.

13) Payment to the farmer is made through cheques to avoid confusion.

14) Details of the rearer, quantity of cocoons, race, spinning date, rate at which they are purchased and total amount paid at cocoon market where cocoons are purchased are recorded and sent to the grainage along with cocoons.

Generally when multivoltine and bivoltine cocoons are purchased for preparation of multivoltine and bivoltine hybrid seed, bivoltine with a spinning date only a day earlier to that of multivoltine is purchased. This is necessary as bivoltine pupae take 11-12 days to emerge from spinning date, while multivoltines take 10 days. Similar adjustment of spinning date is made for other races also considering the duration of pupae of the breed involved in the preparation of hybrids. Seed cocoons are sold in seed cocoon markets in seed areas (Fig. 43).

Cocoons should be transported to the grainage loosely packed in plastic crates or bamboo baskets.

d) Cocoon Arrangements

As soon as the cocoons arrive at the grainage, they are checked for their quality and quantity as per the details received from the cocoon markets. The cocoons are once again tested fordisease. From each batfh of cocoons from the rearer, about 20 pupae are collected and gut examination is conducted for Pebrine disease (Fig. 44).

For this purpose, the pupa is cut ventrally just below the wing buds by a pair of scissors by holding the pupa between the thumb and fore finger in left hand. After cutting, the pupa is pressed gently. The mid gut portion oozes out as a brown body from the cut portion. This mid gut is collected by a pair of forceps in the right hand and transferred to a porcelain moth crushing set. This is crushed with a drop of Potassium hydroxide. The fluid is taken as smear on the slide and covered with a piece of cover glass. This smear is examined under the microscope with 600 times magnification. If the stock is suffering from Pebrine one can see Pebrine spores clearly visible as shining oval bodies. Of the 20 pupae tested even if one pupa shows a few spores in the smear, the entire batch of cocoons from the rearer is rejected and sent to market. Such cocoons should never be used for preparation of silkworm seed under any circumstances.

Laterabout lOmaleand 10 female cocoons are weighed and their cocoon weight, shell weight and silk ratio are recorded to confirm the quality.

All these observations are made to make sure that the cocoons are free from any disease and to check transovarial infection of Pebrine. Egg producers are thus assured of processing the cocoons of good quality. The grainage staff affix the following certificate:-

i) Pupa test of the lot conducted and found free from disease.

ii) Quality of cocoons assessed and cocoon weight and shell weight recorded.

iii) Cocoons were weighed and taken to stock in seed cocoon register in page Number.....

sd sd.

Officer inchargc of grainage

Technician Inchargc of Egg production

e) **Sorting of Cocoons**

After assessment, the cocoons are stored in bamboo trays of 1.06 metres or *V/i'* diameter arranged in stands. Later they are analysed for presence of melted cocoons. For this purpose about 200 cocoons are taken as sample from each batch. Good, flimsy and uzi infested cocoons are sorted out and recorded. Batches of cocoons showing higher percentage of melting than the norms fixed are sent to cocoon market for sale as reeling cocoons. Processing such batches of cocoons leads to poor recovery of silkworm eggs. In addition, processing such cocoons are laborious and not economical.

The cocoons are then sorted out. Flimsy cocoons, deformed cocoons, melted cocoons, irregular shaped

cocoons and uzi infected cocpoons are removed and only good cocoons are selected for seed preparation. All bad cocoons which are unfit for seed preparation are stiffled in hot air chamber or sent to cocoon market for sale and sale proceeds taken to account. If not, such cocoons give foul smell and contaminate the grainage. Further such cocoons attract dermested beetles which also eat healthy moths in the grainage.

[f) **Arrangement of Cocoons**

Good cocoons selected are arranged in a single layer in bamboo trays which are of 105 cm. diameter. Each tray can hold 1,000-1,200 multivoltine cocoons or 800-900 Icbivoltine cocoons (Fig. 45). Over crowding of cocoons leads to pupal mortality.

g) **Sex Separation**

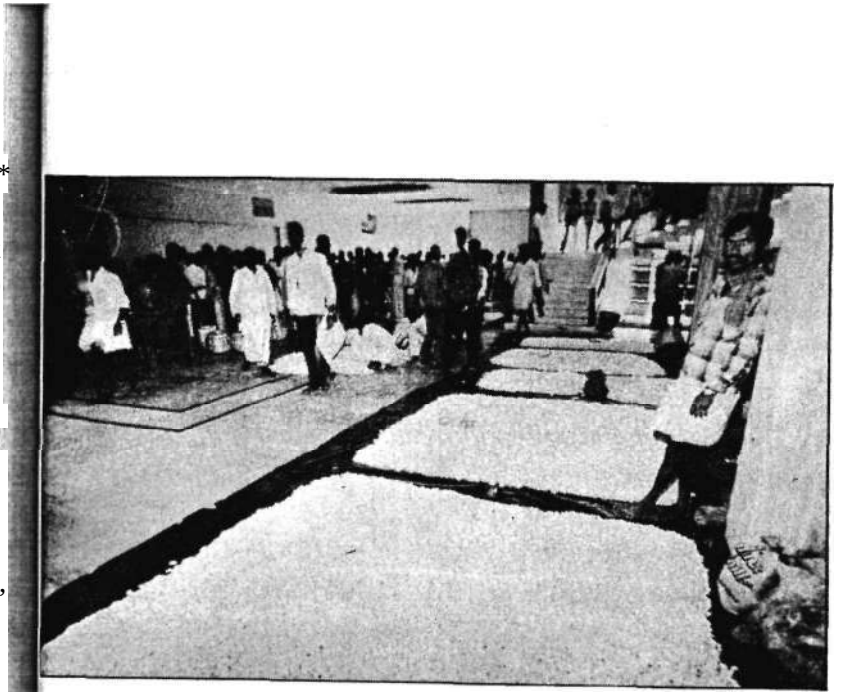
Separation of pupae according to their sex and fi isolating them is very essential to ensure production of hybrids. If not the hybrid seed produced may have pure race seeds also due to the moths pairing before picking them. Bivoltine cocoons are cut at an end and the pupae are collected in plastic basins for sex separation. Cutting .of cocoons in multivoltines such as Mysore race and I Nistari for sex differentiation is difficult because of their flimsy nature, small size and the pupa occupying a major portion of the cocoon. It is also observed that in Mysore race always males emerge early, and after a time gap of about 30 minutes females start emerging. This specific advantage is utilised in the grainages of Karnataka by tartifically illuminating the room early and picking the s-males.

Where bivoltine hybrids are prepared, the cocoons are* cut on one end, roughly at 1,5th of the length of the cocoons so that the pupa inside is not injured (Fig. 46). It is estimated that one labourer can cut about 2,000 cocoons/ hour. However, an experienced labourer can cut more number of cocoons. For cutting bivoltine cocoons, now a days automatic cocoon cutting machines are devised. Here the cocoons arrange themselves in verticia| position in a row on a compact conveyor belt. They are tightly held and pushed towards a circular rotating blade. The cocoons are cut at one end. They are allowed to fall against a wind force from a fan. The shells which are light, are separated and pupae falls on a conveyor belt and are collected separately.

When sufficient pupae are collected in the basin ihe> are taken into a separate room for sex separation. Vlaicii pupae are small in size with tapering abdomen and carry Q^ mark on the ventral side of 8th abdominal segmenf..! Females are bigger in size have stumpy abdomen and ** carry 'x' mark on the ventral side of the 8th abdominal segment. These can be identified by visualinspection(Fig.. 47). An experienced labourer can separate about 1,000^ pupae into males and females in an hour. Sex separation' is conducted within a day or two of the arrival of cocoons • at grainage.

Generally the females are heavier than males. Realising.! this advantage sex separating machines are devised. However, since the pupae of intermediate weights cannoti be separated accurately, error is more in this machine.'!

Cutting of bivoltine cocoons has specific advantage in| that moths can emerge easily. If not, due to compactness* of cocoons and their rich silk content, the moths cannot



Kig. 4.^ A \ lew of a seed cocoon market

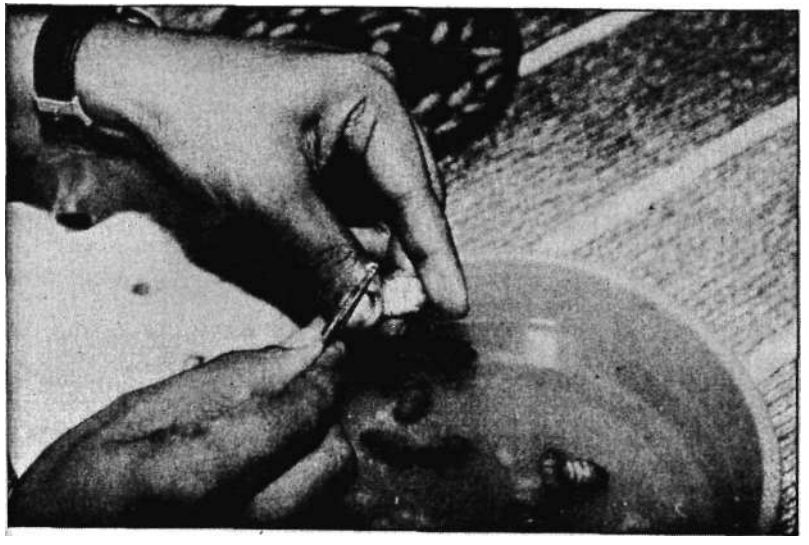


Fig. 44 (iut extraction from pupae for examination

Fig. 45 Seed coccons arranged in bamboo trays in a grainage

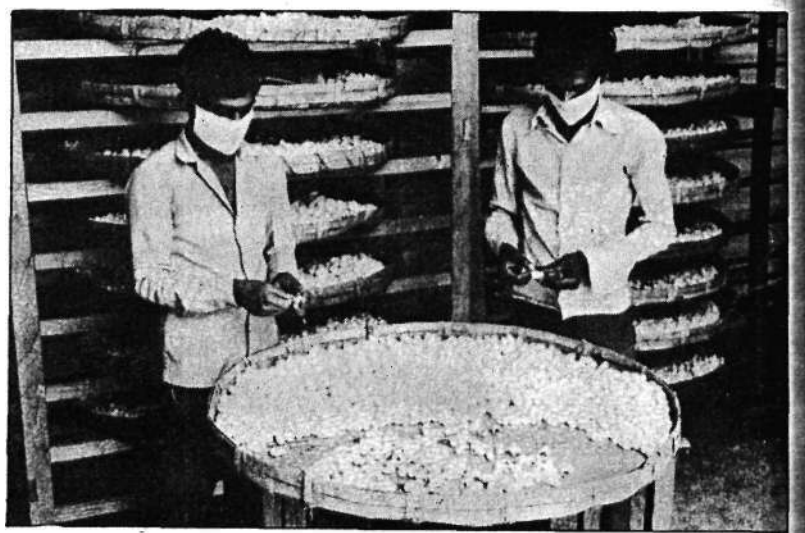
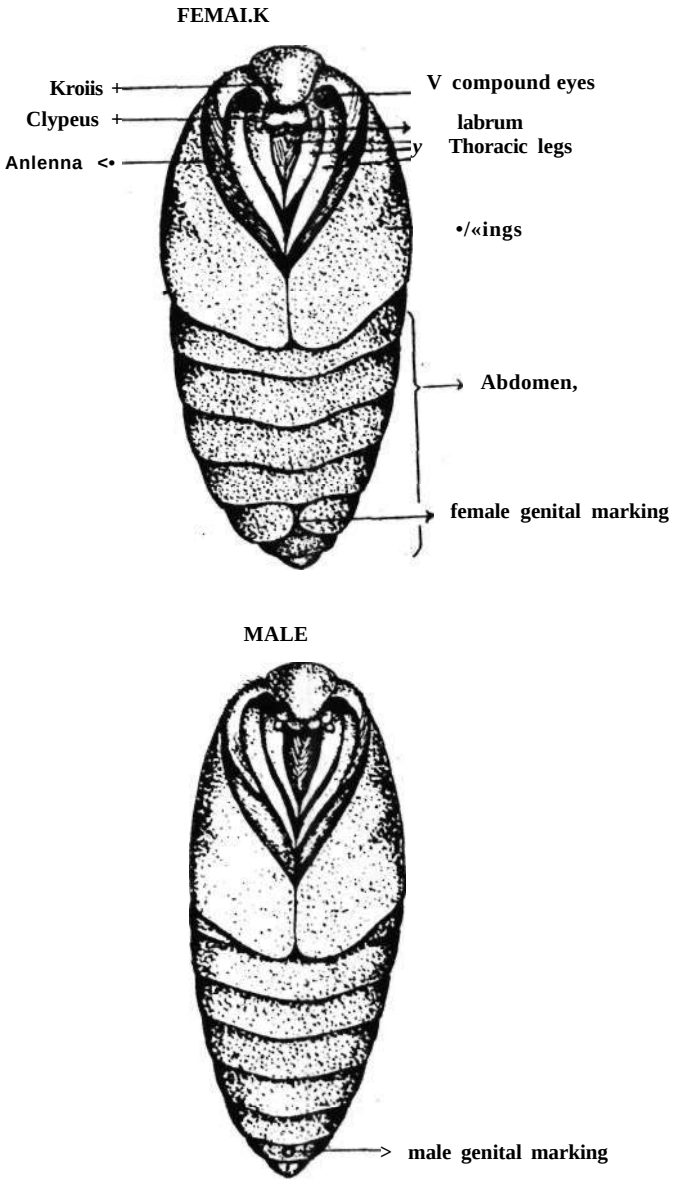
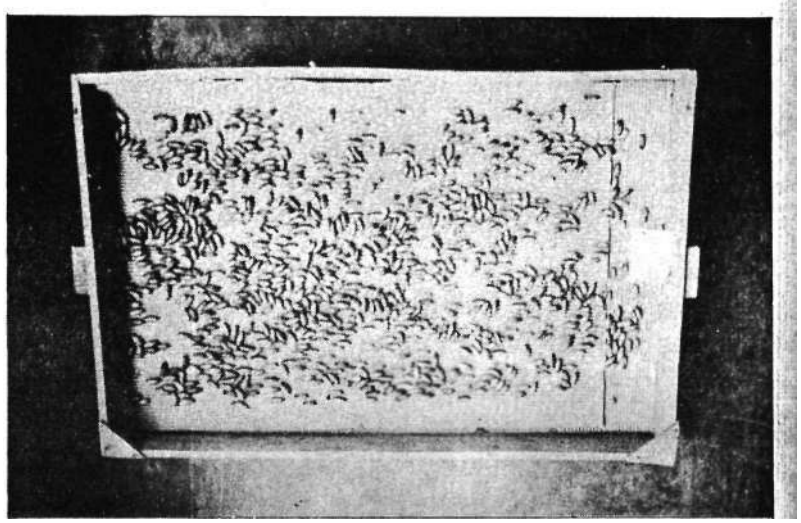


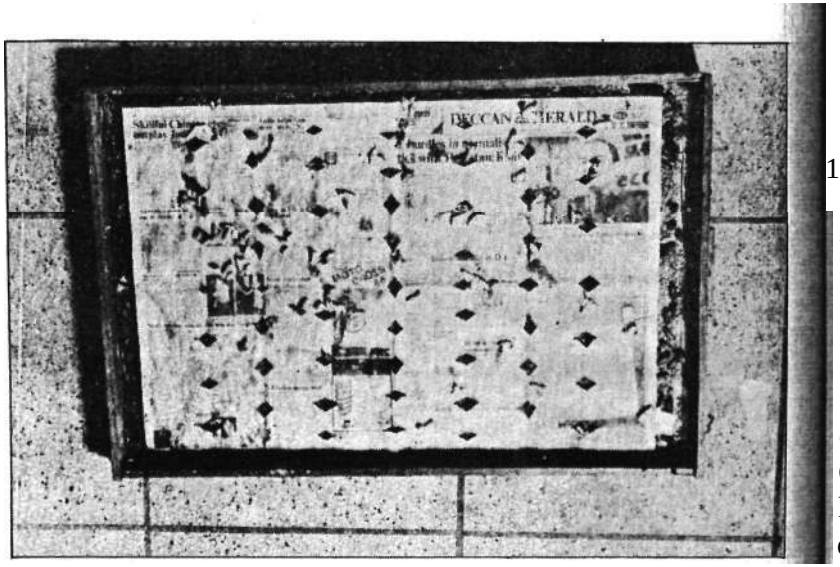
Fig. 46 Bivoltine cocoons cut for sex separation



Fill. 47 Sexual dimorphism



I-ig. 4Ka Ananyenienl ol pupa on corrugated sheet



lig. 48b I'upae co\cied with perloraled paper lor easy emergence

emerge out of cocoons on their own. The pupae that are separated by sex are kept in separate rooms properly labelled. They are kept in wooden or bamboo trays on corrugated board so that they are not disturbed when the trays are moved. Many a time, the pupae are stored in paddy husk in trays to protect them from shock.during movement of trays. The pupae are covered with plastic frames and a paper sheet with holes of 2 cms td 3 cms for easy emergence of moths and their picking(Fig. 48a & b).

The multivoltine and bivoltine cocoons or their pupae f;are stored in cocoon storage rooms, where a temperature !of25''C± IOC humidity of759c-80% is maintained. High I temperature and low humidity result in high pupal 'mortality and poor emergence of moths. Even the moths that emerge in such an environment are deformed and have crumpled wings and are not fit for seed preparation. High temperature of 30°C and above cause male sterility and unfertilised and dead eggs are laid by females. Hence in tropical conditions specially in summer, air conditioners with facilities of humidifiers to increase humidity are installed. The cocoon storage room is 11 always kept dark to check irregular emergence of moths.

h) **Emergence of Moths**

Moths generally emerge on 10th day of spinning in multivoltine and 11 th or 12th day in bivoltine. Emergence continues for three days. As mentioned earlier the cocoon and pupae preservation rooms are kept dark. On the expected day of emergence, lights are put on during early hours of the day. The time of providing illumination depends on the quantity of layings prepared on the day and the convenience of work load. If emergence of large

number of moths are expected, lights are put on early in the morning around 3 am to facilitate a second picking of moths later. If the emergence expected is less, then, it is advisable to put on light at 5 am. The moths are picked by trained labourers (Fig. 49).

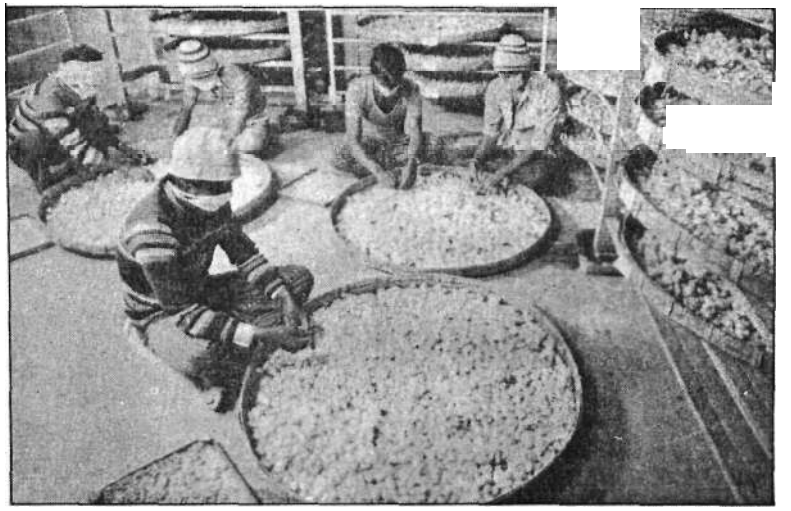
Males can be identified easily from the females. They have a narrow abdomen and carry a pointed trident chitinous penis which is visible when abdomen is pressed. Male moths are very active and smaller in size'when compared to females. 1 cmakv arc bulky with heavy abdomen and 2 paded ovipositor at its end. Females are lethargic and do not crawl quickly as males.

In Mysore seed cocoons, males specially emerge early and are picked. In bivoltines and in multivoltines Nistari and Hosa Mysore races emergence of males and females, are almost simultaneous.

Male and female moths from the pupae kept in different rooms, are collected and stored in moth crates separately. Specific coloured crates are used for picking male and female moths of different breeds. In advanced, sericultural countries colours are sprayed on moths to' identify the sex and breeds. After one or two picking of moths the rooms are kept dark again to delay the further emergence of moths. Moths have a tendency to pair immediately after the emergence. While picking of moths, if ther§ are any moths of the same batches self paired i-.e. pairing of males and females of the same pure race, such pairs are kept separately to avoid mixing with hybrid dfls.

(i) **Pairing**

The male and female moths are checked after picking and collecting them. Moths with deformed wings,.



liy. 49 Picking ol inotiis in a {jrainagc

unhealthy moths, those with deformed abdomen and antenna are rejected. Only healthy male and female moths are picked. The females of desired breed or race are spread on a wooden tray with newspaper at the base. Male moths of the other race are sprinkled over the females to prepare hybrids. About 300-400 females can be accommodated in wooden tray of size 60 x 90 cm and about 400-500 males are put into it. Within 20-30 minutes all the healthy females couple with healthy males. Extra males are picked and used for pairing in another tray.

Coupled moths are transferred to trays of 60 x 90 cm and covered with cellules, so that they are not disturbed. One tray can hold about 200 coupled moths covered with cellules. The trays containing the coupled moths are arranged one above the other like chawki trays in the pairing room. The temperature of 24001100 and humidity of 75% are maintained. The room is kept dark and the moths are kept undisturbed for 4-5 hours. During this time the male has ejaculated sufficient seminal fluid and sperms to fertilise 400-500 eggs in the female. After 4-5 hours of copulation, the male is removed mechanically. The male moth is held by the thumb and the middle finger, pressing the female lightly by the fore finger, the male is slightly pulled.

The males are separated and stored for 2nd coupling with another female if required. They are stored in crates inrefrigeratorsata temperature of 700 to lOoC. Males can be stored for 3-4 days. While using males for second time they are brought to room temperature from refrigerator for 20 minutes and used with 2nd female. Male should not be used for more than two times underanycircumstances. If used for more than two couplings it results in female moths laying less number of eggs or unfertilised eggs.

After separating the males, the females are allowed for few minutes and tapped to induce them to pass liquid excreta. Later the females are picked and allowed on egg sheets, each covered with a black cellule. This helps in keeping the moths undisturbed.

These egg sheets are arranged in trays of 60 x 90cm. Each egg sheet consist of 20 squares. Each female moth is kept in a square and covered with cellule for egg laying. Eight such sheets can be arranged ina tray of 60x90 cm in one tier. It is possible to keep two tiers of egg sheets in a tray. After arranging the moths in the trays they are stored one above the other like chawki trays in Tows in oviposition room. This room is kept dark by keeping the windows "closed and painting with black colour. Black curtains must be used for the windows and doors for preventing light. The temperature of 24"C+1"C and humidity of 80% are maintained in oviposition room. This is very essential for good egg laying. If humidity is less the gummy substance secreted by the female gets dried up on the ovi positiorand obstructs egg laying. This results in less number of eggs laid by the moth, as most of" the eggs remain-inside the body. To maintain humidity, humidifiers are used. Wherever there is shortage of';; electricty to run the humidifiers, wet gunny cloths are:' hung in the room and sand beds made wet are arranged. It is essential to provide air conditioners and humidifiers (and to run them even by providing diesel electricity generating sets specially in summer months.

Moths are kept in oviposition *loom* for 24 hours by, providing optimum environment (Fig; 50a & b). Females lay all eggs numbering about 400 500 in muHivoltines, and 500-600 in bivoltines, within 24 hours.

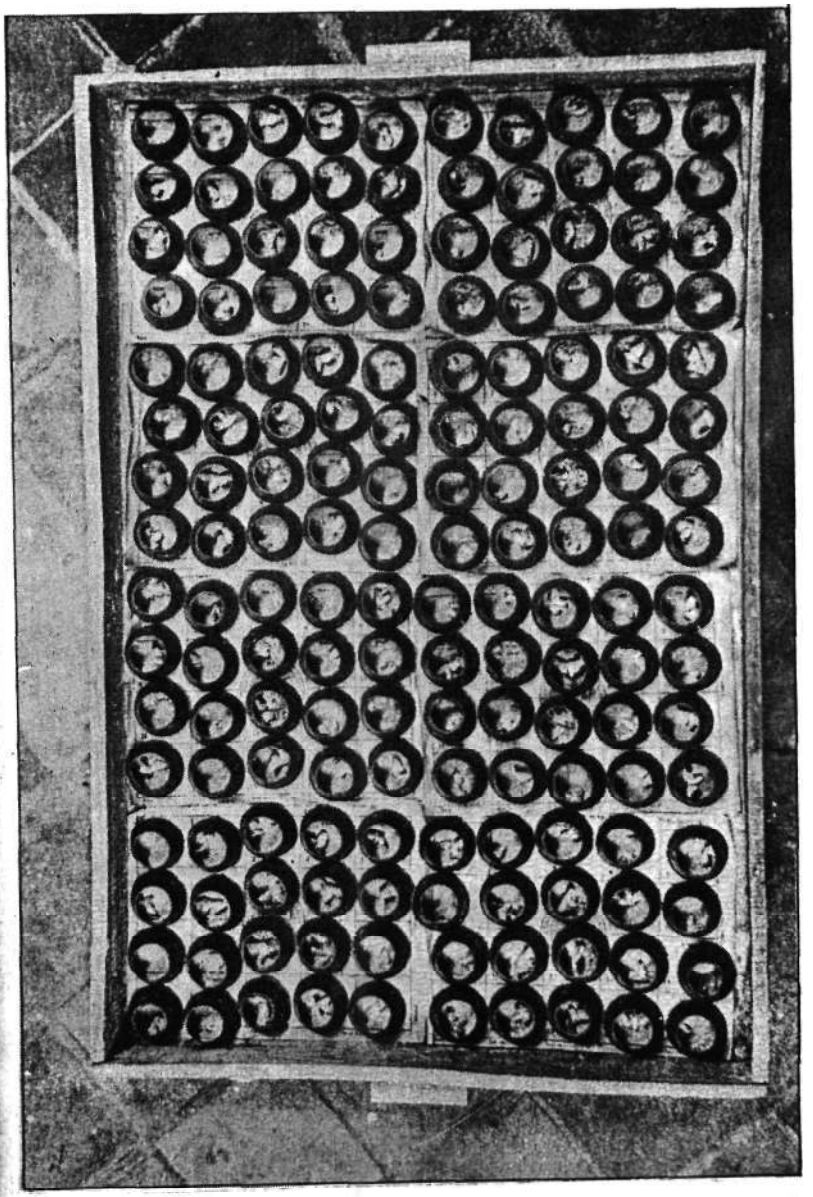


Fig. 50a Oviposition

F-ig. 5()b Moths arranged lor o\iposition in grainagcs

|j) Fertilisation

To understand the process of fertilisation it is necessary |to study the male and female reproductive system of the i moths.

|i) Male Reproductive System

Male reproductive system consists of a pair of testis, triangular in shape and located in the abdomen (Fig. 51). Each testis has four follicles each having an apical cell. Attached to it are spermatogonia! cells. Apical cell provides nutrition to the spermatogonia! cells. These multiply by mitotic division and later these group of cells descend down towards the lower side of the testis. These are spermatocytes. They undergo reduction division by meiosis. These are now called spermatids, they soon get modified as spermatozoa having a head with acrosome small neck and a tail piece. They are motile. Each testis ^opens into sperm duct. The two sperm ducts open into 'Seminal vesicle with accessary gland, which secretes the seminal fluid. Sperms are stored in the seminal vesicle. An ejaculatory duct leads from the seminal vesicle and ends in a chitinous tridented penis. The penis is l<ept hidden in male reproductive organ which carry hooks called harpes.

|i) Female Reproductive System

The female reproductive system consists of two ovaries Occupying major portion of the abdomen. Each ovary [consists of four ovarioles (Fig. 52).

Each ovariole has a spindle shaped apical cell. Below Ilie apical cell, oogania! cells are seen. Each ooganial cell descends downwards and divides to form a group of 8

cells. Of these, one develops into an oocyte and the remaining differentiates into nurse cells. These nurse cells help in depositing yolk in oocyte. Soon these groups of cells get separated and descend down the ovariple These are now surrounded by follicle cells. Soon the nurse cells degenerate and disappear. The egg nucleus moves to a side. The follicle cells now secrete the chorion or egg shell. Now the egg cell is loaded with yolk which is rich in fat and protein required for the growth of the embryo at a later date. It is covered by hard chorion. Chorion has a minute aperature, the micropyle.

Each ovariole produces 60-70 eggs or even more. The eggs are arranged in a linear pattern one behind the other in the ovaries. Four ovarioles of each ovary open into an oviduct. The two oviducts open into a common oviduct.; Just at the upper portion of the common oviduct is a bag like structure, the spermatheca. Opening into the common oviduct is a bag like structure the bursa copulatrix. This bursa copulatrix opens independently outside also below the 8th abdomen. Into the common oviduct a pair of sickle shaped brown accessary glands open. These are responsible for secreting gummy substance. The common oviduct opens into a ovipositior which has three soft structures. Below this ovipositior is the opening of the female reproductive system.

During copulation the male ejects sperms with seminal fluid into the bursa copulatrix through the penis.

After removing the males, the sperms stored in the bursa copulatrix supply the sperms in small quantities at periodical intervals into the spermatheca. As the unfertilised eggs descend down the common oviduct, the spermatheca contracts showering the sperms on the egg'

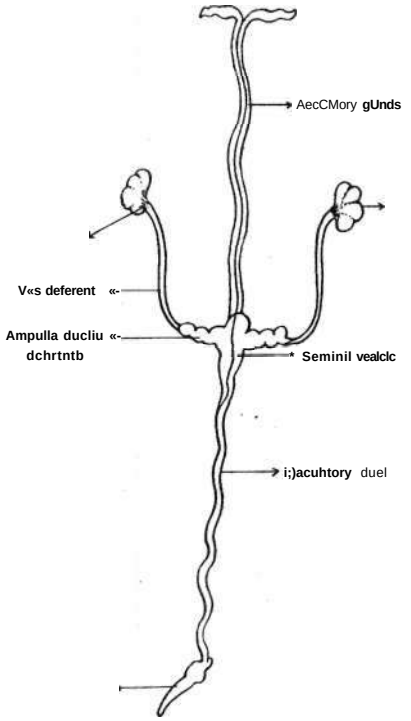


Fig. 51 Male rcproduclixe system

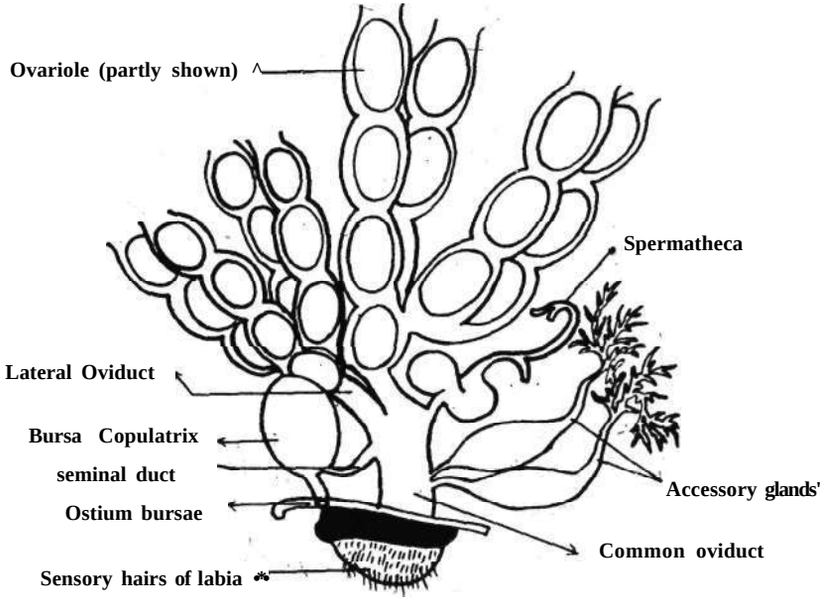


Fig. 52 Kemalc reproductive system

and near the micropylar aperture of the egg. Immediately the sperm enters from the micropylar aperture of the egg and penetrates the egg membrane or the vitelline membrane. The sperm nucleus now lodges on one side of the egg.

The egg descends down to the accessary gland region where it is coated with the gummy substance. Later the egg descends to the female reproductive opening below the ovipositior. The pads of the ovipositior softly deposits the eggs on the egg sheet, while the sensory hairs on the tip of the ovipositior helps in depositing the egg one by the side of the other. Soon the gummy substance dry up adhering the eggs firmly on the egg sheets.

Within 30 minutes of egg laying, the egg nucleus undergoes meiotic division and rejects 3 polar bodies and within minutes the sperm nucleus unite with the egg nucleus and fertilisation takes place. Soon the fertilised nucleus start multiplying and develop into a larva in the egg in 10 days.

The egg sheets along with the moths are taken to moth examination hall after 24 hours of egg laying. They are arranged for crushing the moths and their examination for diseases.

|k) Moth Examination

The eggs should necessarily be free from Pebrine idisease. This is a deadly disease, because it is transmitted not only by contamination but also by transovarial transmission from the mother moth.

In transovarian infection the pathogen of the Pebrine ^protozoa living as a parasite in the ovary, get deposited in

thej yolk during egg formation. Thus the egg is already infected by pathogen before it is laid.

In gFainage only the transovarian infection is checked by the mother moth examination. If a mother moth shows Pebrine not only that particular moth but the entire group of moths, eggs produced by them and the batch of cocoons are destroyed as a safety measure. This is necessary as a transovarian infection not only affects group of larvae it has produced but spreads the disease to others through contamination. Pebrine may spread to other houses in the village as an epidemic. •

Hence, examination of the mother moth for identifying and destroying the pathogen is an essential programme in a grainage. There are three methods of moth exapiination ;| followed. They are:-

i) Individual Moth examination
ii) Sarnple Testing
iii) Mass Examination of moths

i) Individual Moth Examination

Individual moth examination is ideal to check the disease but laborious. In this case the moths on individually numbered squares on the egg sheet are considered (Fig. 53). Individual moth is taken from the egg sheet and crushed in a moth crushing set. The moth crushing set consists of 10-20 cavities (mortar) and pestles. Each moth is crushed by hand. A drop of potassium hydroxide solution is added to the crushed fluid. A drop of crushed fluid is taken on a glass slide. A cover slip is placed over the drop of fluid and a smear is prepared. This is observed under a microscope with 600 magnitication (i.e. eye piece 15 x an objective 40). The Pebrine spores are visible'as sliinning oval bodies (Fig, 54).

If even one moth out of 10-15 thousand moths of a |. batch of cocoons show Pebrine the entire lot is rejected. Individual moth examination is a very laborious method. A moth examiner can examine about 200 srnears a day of 8 hours. This method cannot be practiced in big commercial grainages of Karnataka or West Bengal due to the shortage of time between egg laying and disposal. Where bivoltine hibernated eggs are produced, such as in Jammu & Kashmir and Dehradun this can be followed. In these areas moth examination can be conducted at I leisure. Individual moth examination must be practised in egg production ot pure races.

ii) Sample Testing

In this method about 20% of the emerged moths picked at random are examined. Four moths picked at random irom an egg sheet of 20, which forms 20% are examined for Pebrine. In this case instead of crushing individual motns, two moths are crushed together. A drop of fluid is ^ taken on the glass slide, covered with cover slip and is exarhined under the microscope. Even if any moths show Pebrine, the entire lot of cocoons and moths are rejected This method is generally in vogue in India.

iii) Mass Examination of Moths

This is a quick and dependable method of moth I examination for Pebrine disease and can be practiced in commercial grainages (Fig. 55). In this case saniiples of

moths are drawn considering the number of moths in a lot to be examined. Suitable sampling Technique is devised as followed in Japan. The same sampling method is tried in a number of trials and found suitable for adoption in India. The methods for drawing the sample moths considering the number of mother moths emerged in a batch is given in page 107

The moth examination unit consists of:-

(a) Hot air oven to dry the moth at 70°C±5°C.

(b) Moth crushing machine electrically operated with 4 mixies having wet grinding blades. The speed of the mixies is 10,000 revolutions per minute. A tilting arrangement is made in the machine to pour the fluid into funnels. It also consists of a funnel stand having 4 funnels and four tubes to collect the filtered fluid. The machine has facility for automatic washing of cups.

(c) Centrifuge has a head to carry four or eight tubes of 80cc capacity and having speed of 3,000 rpm.

(d) A cyclo mixer to shake the sediments for a homogenised fluid.

(e) A Binocular microscope having a minimum facility of 600 times magnification with an eye piece of 15X and an objective of 40 X.

After 24 hours of egg laying or oviposition, samples of moths are drawn considering the number of moths emerged. Each sample consisting of 30 moths, are kept in perforated paper covers after marking the date, lot number, sample number, etc. They are stored in hot air oven and dried at 70°C±5°C for 6 hours. After 6 hours of

Fig. 53 Individual moth examination

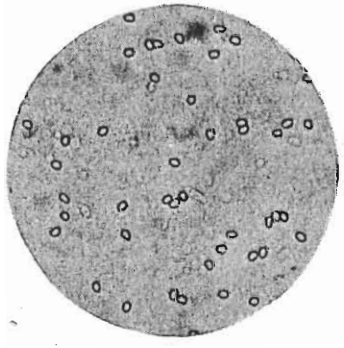
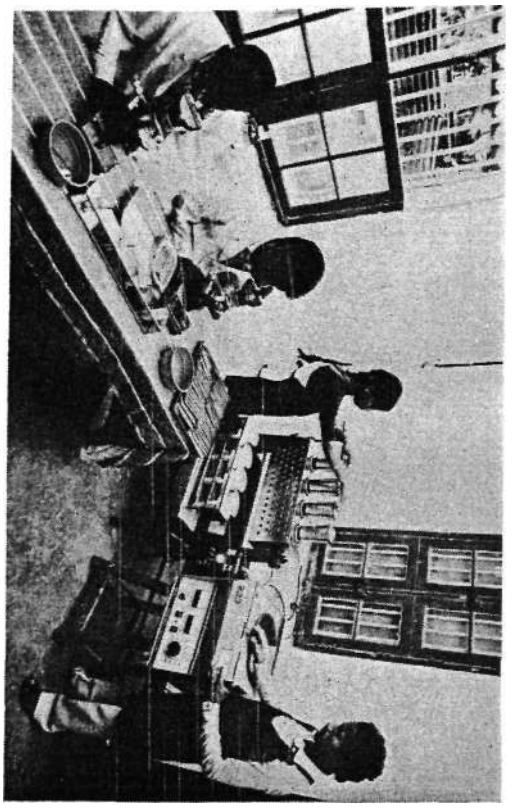


Fig. 54 Pebrine spores



Selection of female moths for examination

Size of Batch (No. of female moths emerged)	First examination			Second examination			Reject the lot if following samples show pebrine
	No. of moths to be examined	No. of cups	No. of smear showkig pebrine	No. of moths to be examined	No. of cups	No. of smear showing pebrine	
.190 or below	390	13					1
391 to 500	390	13					1
501 to 600	450	15	1				I
601 to 700	480	16	I				I
701 to 800	570	19	2	105	4	2	2
801 to 1.000	620	21	2	130	5	2	2
1.001 to 2.000	755	26	2	195	7	2	2
2,001 to 3,000	865	29	3	500	17	3	3
3,001 to 4.000	915	31	4	815	28	4	4
4,001 to 6,000	955	32	5	1,140	38	5	.5
6,001 to 10,000	990	33	6	1.500	50	6	6
10.00! to 30.000	1,030	35		1,620	54	6	6-
30.001 & above	1.060	36	6	1,730	58	6	6

drying the temperature in the oven is maintained at SO°C to avoid accumulation of humidity and putrification. These batches are examined next day.

30 dried moths are put into each mixiecup. Tothis90cc of 0.5% potassium carbonate solution is added. The material is ground for two minutes at 10,000 rpm in the mixie. This helps in massarating moth tissues. The fluid is allowed to settle for 2 minutes and fihered by using an absorbant cotton filter. This helps in removing scales and other materials. The fluid istaken to a centrifuge tube and centrituged at 3,000 rpm for 3 minutes. After centriluging, the supernated solution is rejected. To the sediment which is now a thick paste, a few drops of 2% potassium hydroxide is added. It is properly mixed by keeping the tube overa cyclo mixerforabouta minute. A drop of solution is taken on a microslide and smear is prepared by putting a microcover slip. This smear is examined under the microscope carefully. Atleast 2 smears are examined from eacn cup and each smear is examined at least in five fields.

In this method if in the first test, even a single sample shows Pebrine spore, a second sample as indicated is examined. Of the total examinations if the number of samples showing Pebrine is less than indicated in the last column, the batch is taken as free from Pebrine. This method is quick and effective. This procedure is regularly practiced in Japan. In this method the number of smears examined is less, than the first two methods. Hence it is possible to examine the smears clearly and without any urgency.

This method of examination can be practiced both in live moth examination and ,dry moth examination. Dry

moth examination is more effective in Pebrine detection than live moth examination.

In Jammu & Kashmir and other univoltine areas the moths arc allowed to lay eggs in cloth bags. These moths are allowed to dry in natural course for a few months as the bivoltine eggs are allowed to hibernate. The moths are crushed and examined at liesure.

I) Washing of Eggs

After moth examination, multivoltine hybrid dfls are checked for poor layings. Poor layings are those where the number of eggs in the laying are much less than the standard or norms fixed for a dfl. These are scrapped and removed. Only sheets with standard layings after removing the poor layings and dead layings are soaked in 29f formalin solution for nearly 20 minutes. This helps in surface sterilisation of eggs and Heeps the eggs free from Pebrine infection. They are again washed in water and allowed to dry and accounted. The certificate of disease freeness of seed is affixed. The egg sheets carry the name of the grainage, hybrid combination, date of egg laying, signature of the moth examiner and the number of good dfls on the sheet. These eggs are now ready for sale to farmers.

In case of bivoltine, the eggs generally undergo hibernation, within 48 hours of egg laying. Hence the bivoltine moths arc allowed to lay eggs on thick sheets which can withstand acid treatment. The moths are examined and acid treated within 20 hours. To break diapause, they are treated with hydrochloric acid having specific gravity of 1.075 at I5"C temperature, heated to 46.I"C and dipped for 5 6 minutes depending on the

hivoltine race. The procedures of handling bivoltines will be discussed in detail in the next chapter.

In case of bivoltine hybrids for hibernation, the moths ^re examined leisurely. Dfls are later examined, poor layings are removed. Healthy layings are washed in formalin and sent to cold storage for preservation. The process of hibernation of bivoltine dfls will be discussed later.

m) Prijoaration of Loose Eggs

Supply of eggs in loose form packed in egg boxes has a specific advantage. It has a known weight of eggs containing a defined number of fertilised eggs. The procedure for loose egg preparation is as follows:

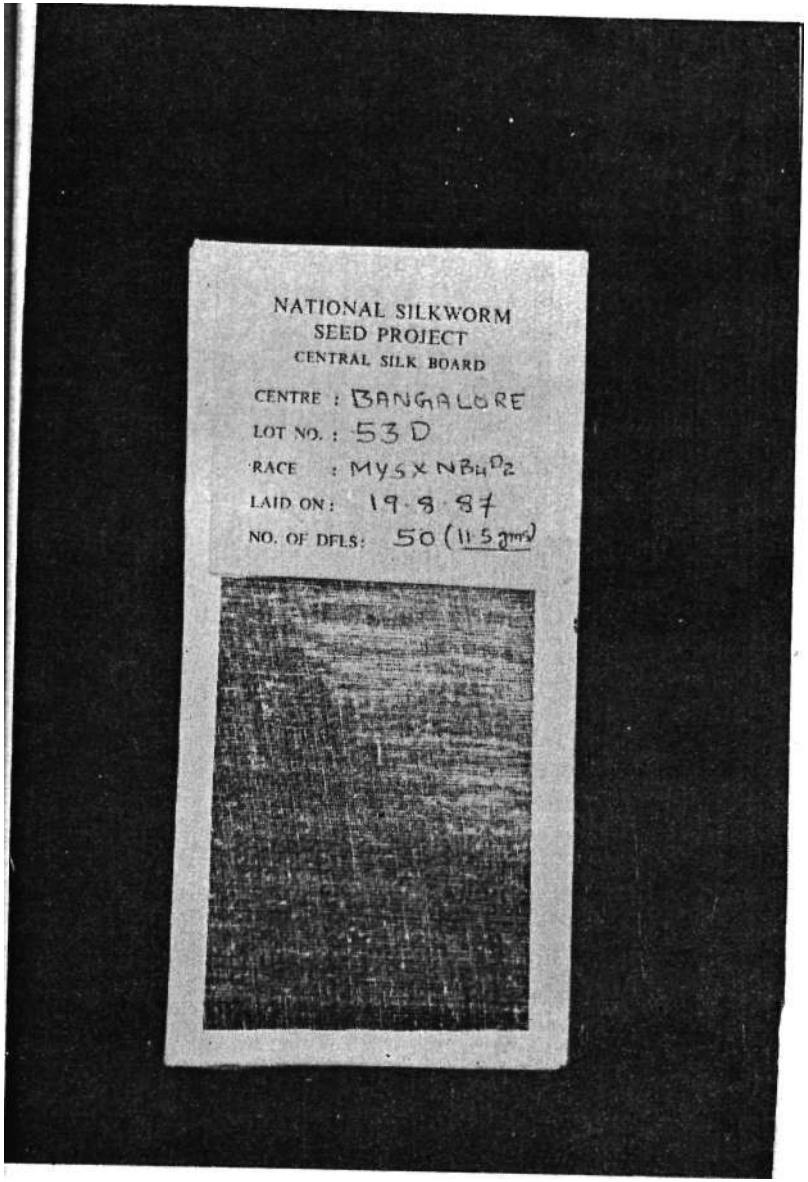
1) About 30gmsof gum is added to one litre of water and mixed thoroughly.
2) The craft paper of 60x90 cm is coated with a thin layer of gum and dried.
3) These craft sheets coated with gum are spread in tray of 60x90cm.
4) Female moths after decoupling are allowed to urinate.
5) Moths are arranged on the gummy sheet in the tray and covered by cellules.
6) The trays are arranged in the oviposition room and moths arc allowed to lay eggs undisturbed for 24 hours.

7) Next day moths are examined by methods described earlier. If Pebrine is noticed the lot is rejected.
8) After examination the sheets are washed in cold water and rubbed by hand to separate eggs. Eggs get loosened. The sheet is removed and eggs collected.
^ These eggs are dipped for 10 minutes in 0.5% bleaching powder solution (5 gms of bleaching powdei in I litre of water). This helps in further removing the gum and avoids formation of clumps of eggs.
10 They are washed and put in salt solution of specific gravity of 1.08 at room temperature. The fertilised eggs having higher specific gravity sink in the solution. The floating dead eggs with low specific gravity are rejected.
11) The good eggs are washed in 2% formalin solution for 20 minutes.
12) The eggs are again washed in cold water and dried in shade.
13) They are packed in egg box (Fig. 56). Each box contains about 20,000 eggs. The boxes carry the details of the race, date of egg laying, quantity of eggs and the name of the grainage.
14) In multivoltines a gram of eggs contain about 2,000 eggs while in bivoltines it is 1,800 eggs/gm.
15) A kilogram of bivoltine cocoons yield about 55 gms of silkworm eggs. But in multivoltines a kilogram of multivoltine cocoons and about 0.7

kg of b^ve^tine cocoons yield about 55 gms of Multi X Bivoltine hybrids. This is because the bivoltine females and multivoltine males are rejected. In case, reciprocal crosses of bivoltine females and multivoltine males are used an additional recovery of 20 gms of silkworm seed is expected.

n) **Disposal of Dfls**

Dds produced in the grainagcs are generally sold in the evenings to avoid transporation of eggs in hot mid days. The layings are to be packed in bags with holes and with wet cotton to maintain humidity.



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Chapter-X

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PRESERVATION AND HANDLING OF SILKWORM EGGS

GR AINAGES generally produced two types of silkworm eggs, viz., mliltivoltines and bivoltines and their hybrids in tropical areas and bivoltines and their hybrids in temperate climate. However to understand the various aspects of the handling of silkworm eggs, it is essential to know the embryology of silkworm eggs.

Embryology

The eggs as they descend down from the ovi-duct of the mother moth, are sprinkled with the sperms. Soon the sperms enter the egg through a minute aperture *'Micropyle'*. Eggs descending further down are coated with a gummy substance secreted by the accessary glands. The eggs adhere to the egg sheet as they are laid due to the gummy substance.

Soon after entry of the sperm into the egg, it looses its shape and the sperm nucleus lodges itself on the anterior side. Egg nucleus undergoes reduction division. Three polar bodies are thus produced and thrown out. Egg

nucleus is now ready for fertilisation. The sperm nucleus fuses with the egg nucleus to form a zygote nucleus. This soon undergoes repeated division. These nuclei migrate to the periphery, arrange themselves in the form of a single layer called the *'Blastoderm layer'(¥\g.* 57) which assume cellular nature. Some nuclei in the yolk form vitello phages or yolk cells and supply nutrition to the blastoderm layers. Soon one side of the blastoderm layer becomes thick with large cells and identifies itself as the *'Germband'.* Germband formation generally takes place by 20-24 hours of egg laying of oviposition in normal conditions both in multivoltines and bivoltines. In case of bivoltines, the mother moth during its process of egg production, deposits hibernating substance which checks the growth of the embryo. In multivoltines, due to lack of the diapause material, the embryo continues its development and hatches in 10 days under normal conditions.

Soon the germband enlarges and develops into a spoon shaped embryo. Anterior cephalic lobe and posterior caudal lobe are formed. The embryo slowly sinks down and the blastoderm cells grow on all sides and cover it. The outer layer is distinguished as serosa and the covering ventral layer of the embryo, the amnion. The germband on the upper side develops a longitudinal depression. This is called the primitive streak. Below the primitive streak spherical cells develop to form mesoderm. Some of the cells of primitive groove migrate deep into the embryo to the endoderm. The primitve streak deepens. At the anterior end a blastopore is formed. At this stage hibernating eggs undergo diapause. Multivoline eggs continue to develop and eggs hatch as larvae on tenth day.

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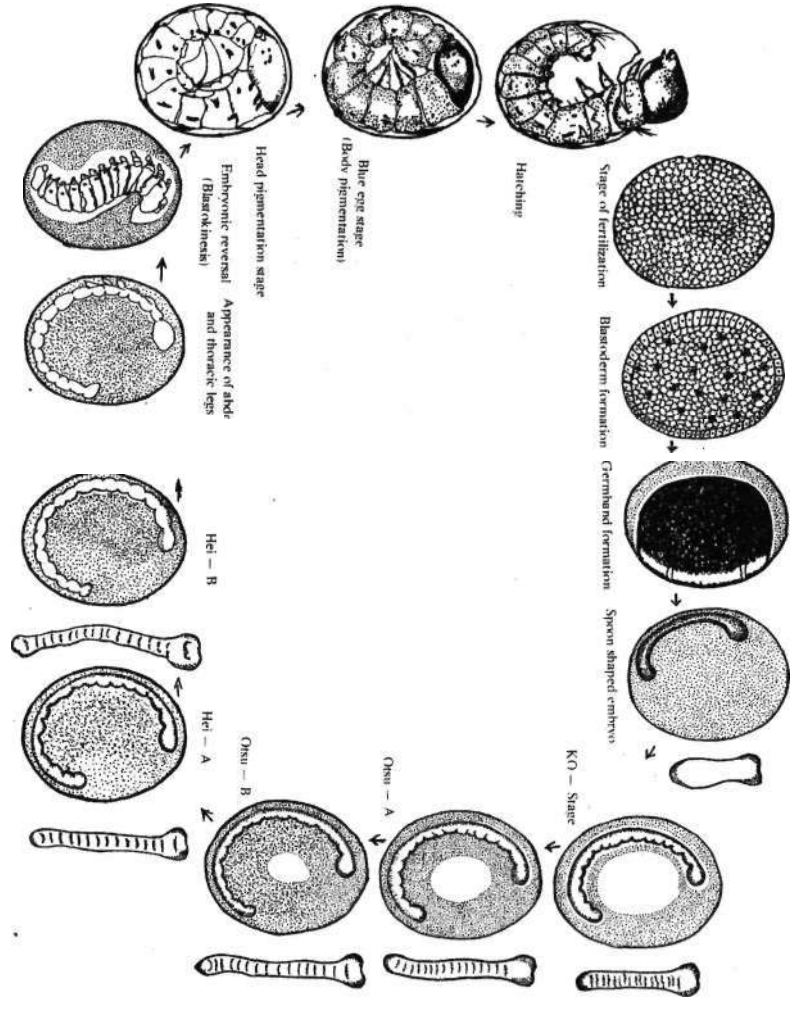


Further growth of the embryo leads to the segmentation of the body. This is called diapause II stage. Soon the body of the embryo develop ^ head lobe and embryo develops 18 segments. This stage is identified as *'KO-stage.'* The head lobe starts enlarging and segmentation becomes more clear. This is *'OTSU-A stage.* 'The embryo further grows in length and develops head lobe. As further growth continues the length of the embryo increase, the head lobes expand. Stomodaeal depression becomes clear. Body segments get demarkated. At posteriorend the proctedeal depression is also visible. This is called *'HEI-A stage.'JUt* segmental nature of the body becomes more clear and the embryo develops to the rnaximum length to occupy 75% of the periphery of egg. 1 his stage is the longest embryonic stage. At this stage 4 segments of the head, 3 of thorax and 11 segments of the abdomen are clearly visible. This stage is identified as *' H El- B Stage.* 'This is the time for double refrigeration of bivoiline silkworm eggs.

Soon the cephalic segments start fusing and cephalic appendages expand vi/., labral. mandibular and maxillary appendages dc\ciop. On thoracic segments rudiments of legs appeal, last anal segment fuse. The thoracic appendages develop as rudiments. Each of the abdominal segments also develop rudimentary appendages. Later only those abdominal segments i.e., 3, 4, 5, 6 and 9 segments form abdominal legs. The fore gut, mid gut and hind guts are formed and differentiated into different parts. Malpighian tubes are seen developing. From this time onwards the embryonic growth is very fast and the embryo develops the head, thorax and abdomen. Segmental nature of the embryo is clearly visible. Now the embryo with its ventral side lacing the periphery of the

egg turns so that the ventral side with its thoracic and abdominal legs face the inner side of the egg. This is called the *'Blastokinesis stage.* 'This is a very crucial period of the embryo. Blastokinesis takes place on the fifth day of egg laying.

Soon the cephalic lobe fuses to form the head and it develops eyespots, mouth parts etc.. Similarly, the thorax develops thoracic legs and the abdominal segments in the posterior region mostly fuse. By this time the silk glands are seen developing as invagination ort'the side and the embryo reaches 6th or 7th day. The spiracles are seen developed as tiny dots. Chitinisation of head takes place and develops pigments by the 8th day of egg laying. The head appear as dots from outside the egg. This is eye spot stage. This is the right time for disinfection of rearing house with formalin. Soon hairs develop on body and the eggs acquire blueish colour on the 9th day. This is the blue egg stage. This is the time for arranging equipments in the rearing house and maintaining the temperature for brushing and chawki rearing. By this time the embryo has developed into a larva by utilising all the yolk particles of the egg. On the lOth day the larva cuts open a portion of the egg by eating the chorion and comes out of the egg.

The multivoltine eggs, after egg laying are kept in the incubation room at a temperature between 23 -25"C for 10 days till hatching. Incubation of eggs helps in uniform growth of embryo.

In bivoltines the eggs are treated to make them hatch in 10 days or stored in the cold storage for release at later stages. The crucial period of acid treatment and subjecting the hibernating eggs to refrigeration, intermediate care etc., are related to the specific stages of

growth of the embryo. Growth of embryo varies at different temperatures. Hence it is always safe to preserve hibernating eggs by studying the embryonic growth. A simple technique of staining the eggs to identify the different stages is given below:-

A sample of .eggs are taken in a test tube, bottom of which is cut open and tied with a muslin cloth. Loose eggs are taken in the tube and immersed in 2% - 3% potassium hydroxide solution, which is kept almost boiling for 10-15 seconds (heating of potassium hydroxide is stopped before dipping the eggs). Immediately the tube is taken out. Embryos are transferred to a petridish of warm water at *60'^C.* The warm water with embryo in the petridish is thoroughly shaken with a squirt. The embryos separate themselves from the yolk material and float. One must be very careful in identifying the embryo particularly during the early stages. Any delay make the embryo to dissolve in hot water. Embryos are picked by a brush and transferred to 50% alcohol. They are stained with borax carmine. If the embryos are over stained, it is removed by acid alcohol i.e., a few drops of hydrochloric acid in 50% of alcohol. These are mounted on the slide and observed for the stages of growth of embryo.

1 Preservation of Bivoltine Silkworm Eggs

In temperate countries and univoltihe and bivoltine areas of Jammu & Kashmir and Dehradun of India, bivoltine eggs are preserved for hibernation for use in spring and autumn seasons.

The eggs that are prepared in spring are kept in room temperature of 250C with humidity of 75%-80% till October to November. During this period the

temperature should not go.higher than 30"C and not lower than 20"C. Such adverse conditions result in dead eggs. Hence in summer when temperature is high they are necessarily kept at 25"C by air conditioning the rooms. During this period the eggs reach diapause stage. The natural temperature in November in temperate zones reach 20°C. They are allowed to be kept in natural temperature which falls gradually to 10"C by December. In temperate zone this time is utilised for loosening the eggs from sheets. If they are left in such natural conditions for long they start hatching irregularly leading to unseasonal hatching. Mulberry is not available during winter for rearing irregularly hatched worms. In order to ensure that all eggs hatch on time for rearing later in spring, it is necessary to subject the eggs to low^ temperature of 7.5°C-5"C for 50-60 days. The eggs are generally kept in refrigeration or cold storage at *5"C.* from December to February. This helps in break of diapause and in checking the growth of those embryos which have completed early diapause. By middle of February, the eggs are transferred to 2.5"C-00C for 40 to 60 days. This cold storage at 2.5'^C helps in checking the growth of embryo. At end of March or beginning April the eggs are kept at lO^C to 15"C for a short period and released for incubation or further cold stored at 2.50C till release at a later stage.

Preservation of hibernating eggs is discussed in detail in Chapter XIII.

In Karnataka, Tamil Nadu and Andhra Pradesh, bivoltine females are crossed with muUivoltine males to prepare hybrids. The preservation and treatment of these hybrids are similar to bivoltine hybrids.

Preservation of MuUivoltine Eggs

MuUivoltine eggs generally hatch on tenth day of egg laying. However in tropical countries, in summer the hatching takes place on nirith day itself because of high temperature. Even though the programme of production of dfls in a grainage is well planned, considering the seasonal conditions it is likely that the demands may slacken. In such a situation if muUivoltine eggs are not taken care to be cold stored, they hatch and are not useful for rearing. Hence it becomes inevitable to preserve the eggs. MuUivoltine eggs are stored at 5"C for 15 days safely. As in the case of bivoltine, the eggs are to be stoVed within 48 hours of egg laying. This is because the early Stage enibryos, say upto longest embryo stage are resistant to cold temperature. Even though it is said that the eggs can be stored for 15 days it is recommended to keep eggs in cold storage for 7-10 days only.

MuUivoltine eggs kept in oviposition room at 25"C are subjected to moth examination by next day morning. The defective eggs, poor layings etc., are scrapped. They are dipped in 2% formaldehyde solution for 20 minutes and washed thoroughly. They are dried before 5-6 pm and are kept in cold storage by 8 pm. After removing the eggs from cold storage they are kept in IS^C for a few hours before release to normal room temperature. It is advisable to wash eggs once again in 2% formalin before subjecting to incubation or sale to farmers.

ACID TREATMENT OF BIVOLTINE SILKWORM EGGS

BIVOLTINE moths lay hibernating or non hibernating eggs, depending on the environmental condition such as temperature, light and humidity at the time of incubation and rearing. However, these hibernating eggs, left undisturbed, undergo diapause. This is due to the secretion of hibernating substance in the egg during its formation. Unless this is dissolved, the embryo cannot continue its growth. Hence various techniques have been evolved to break diapause and to hatch bivoltine eggs in 10-12 days from oviposition. Treating silkworm eggs with hydrochloric acid is one of the common methods adopted for this purpose. It is effective in breaking diapause, only when eggs are treated before they enter diapausing stage. This treatment is not effective at later stages and leads to improper hatching. Generally, at normal room temperature the embryo develops *"Germ Band" in* 20 hours of egg laying. Optimum time of acid treatment for artificial hatching of bivoltine silkworm eggs is before this time.

The oviposition room is kept between 23"C-25"C and humidity of 70%-80%. The room is kept dark to hasten the moths to lay maximum number of eggs by 6-8 hours of decoupling of the male moths. Hence, generally this time is taken as the starting point for determining *'Egg laid on time'* or oviposition time. For eg: if the moths are coupled at 8 am they are decoupled and kept at oviposition room by 12 noon, maximum number of eggs are laid by the moth between 6-8 pm. Thus 8 pm is considered as 'oviposition time'for commencement of the growth of the embryo even though the eggs are collected next morning. Considering this period, the eggs are to be acid treated before 20 hours i.e., by 4 pm next day. Similar time schedule can be drawn considering the time of decoupling.

There are two methods of treating the hibernating eggs with hydrochloric acid (HCl) viz.. Hot acid treatment and treatment at room temperature.

Hot Acid Treatment

In hot acid treatment eggs are dipped in hydrochloric acid having specific gravity of 1.0642 at 46'^C. It is always necessary that specific gravity of hydrochloric acid is properly maintained. For this purpose, good quality of hydrochloric acid is required. Generally, the hydrochloric acid available in the market has specific gravity of 1.18 at 15"C. There is correlation between the temperature and the specific gravity of hydrochloric acid. When the hydrochloric acid is heated specific gravity falls. For eg. hydrochloric acid of 1.18 specific gravity at IS^C when beated to 46"C will have specific gravity of 1.1595.

It is necessary to adjust proper specific gravity of the acid before starting the treatment. For eg. to get hydrochloric acid of specific gravity of 1.0642 at 46"C, the specific gravity at 25"C (room temperature) should be 1.0715. If the room temperature is 28"C then the specific gravity of hydrochloric acid to be used for treatment should be 1.0704 to get an ideal specific gravity of 1.0642 when heated to 46"C. Hence it is always necessary to adjust the specific gravity considering the room temperature before they are heated for acid treatment.

It is difficult to maintain the specific gravity of acid very accurately when heated. It gets altered due to various processes such as dipping eggs in water, water content on the egg sheets etc. Hence, in practice acid upto a specific gravity of 1.071 at 46"C can be used. Hence, it is not necessary to adjust specific gravity accurately to 1.0642, for acid treatment. In practice specific gravity of acid ranging from 1.071 -1.076 at normal room temperature of 25"C can be safely used for hot acid treatment. The adjustment of specific gravity at room temperature is given below for guidance.

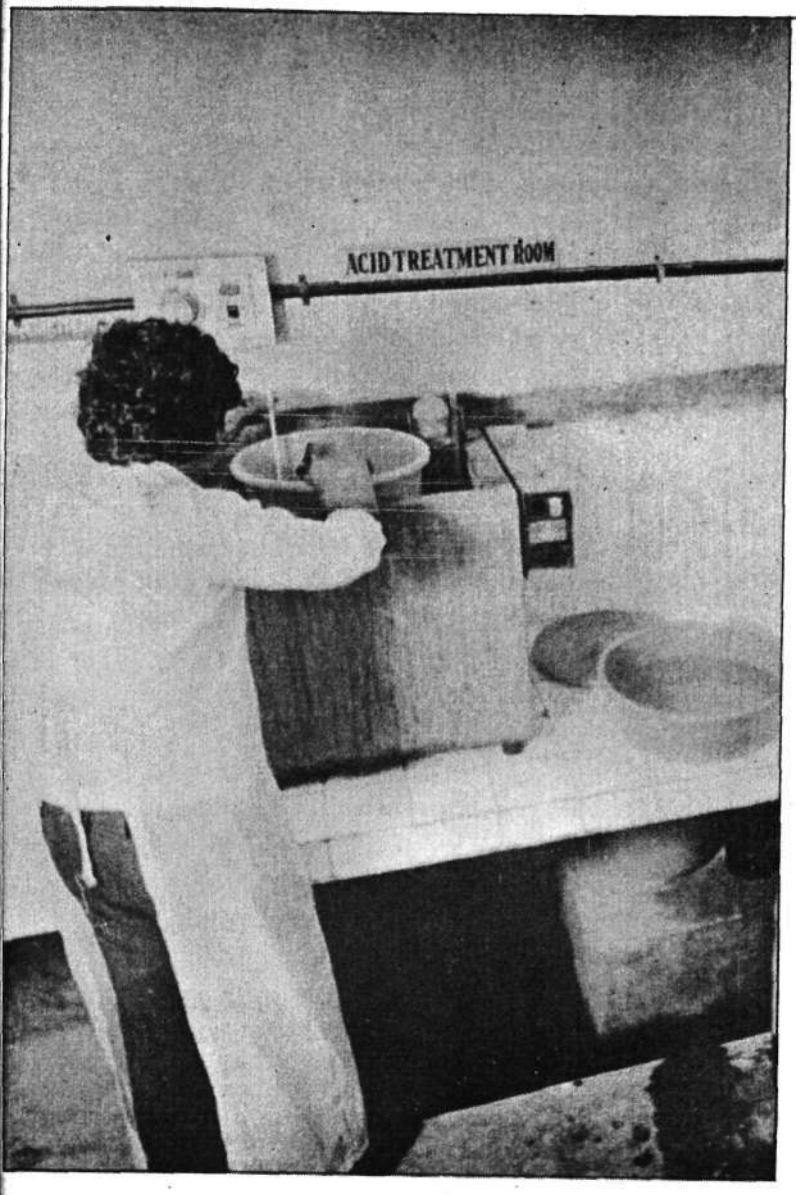
Acid adjusted for specific gravity at the room temperature mentioned above is heated to 46"C for acid treatment of silkworm eggs (Fig. 58).

Hydrochloric acid is not heated directly. Hot acid baths specially made for this purpose are available in market. The principle adopted is to heat the acid kept in a container in a water bath indirectly. Heating the water outside the acid container in the bath helps in maintaining the temperature of acid for longer duration for acid treatment. Generally it is observed that when fresh acid only is used, the acid treatment is not complete and leads

Fcmperaturi;	Spc ific Gnivily	Specif ic tiravity ɹ 46'f	Fit for Acid Treatment
1 *yc*	1. X	1. 1595	Not Kit
25"C	1 (1^15 1.0764	1.0642 1.06X9	Fit
26"C'	1.071 1 1.0760	-	-
27"C-	l.()7(IX 1 (l7.S7		
2S"C	1.07(14 1 (TSl		-
29"t'	1.0701 1 o".';o		-
Mrc	l.Or.47 l.o:'46		-
M"t	1 (1691 1 0"4^	-	
32"C'	1.0640 I.O'^"*		-
.VV'C	1,06X7 Id"'.*^		-
.W'C	l()6«.l 1.07'::		-
U"C	1.06X0 i.07:s		-

to hatching problems. W hen this is noticed, some old hydrochloric acid a!read\ used (or acid treatment is mixed with fresh acid and used.

Before dipping the eggs in hydrochloric acid, it is necessary to dip the egg sheets in *2' I* formalin for about 2 5 minutes to make the cgg.s adhere firmly to the egg sheets during hot acid treatment arid to surface disinfect the eggs against Pebrine. I he eggs are dried. They are later dipped in hydrochloric acid of the same specific gravity as that used in treatment for 10 seconds and later acid treated. I his helps in maintaining the concentration and specific gra\ity of the HCI during treatment of silkworm eggs, if this is not followed the water content ma\ add to the hot *HC*\ and specific gra\ ity of hot acid is altered. v\hich affects hatching. I or acid treatment of loose eggs perforated containers are used for dipping in hot acid.



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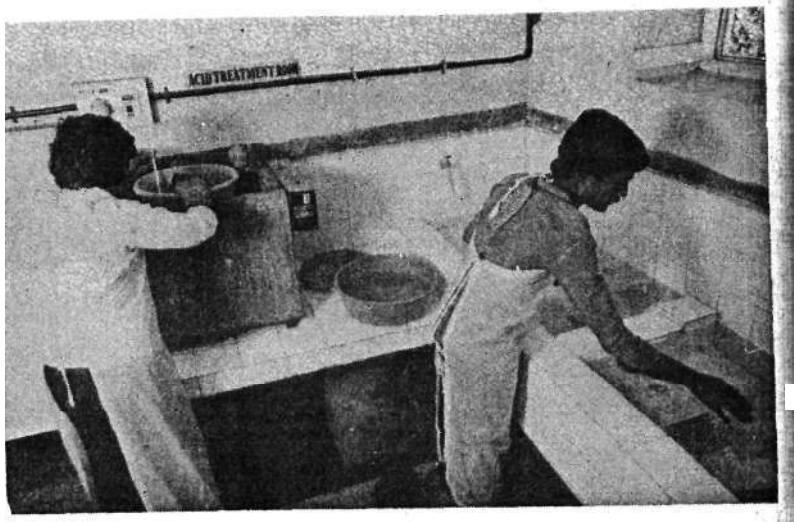


Fig. 59 Egg washing

Duration oi aeid treatment is related to the breed of silkworm eggs treated. One has to determine by trial and error basis the optimum duration suitable I'ora particular breed or the eombination ol breeds. Duration of acid treatment lor 3 broadly classified silkworm breeds is given below as standards:

Japanese race	? 6 minutes
Chinese race	4 5 minutes
European race	6 7 minutes

While treating the h\brids the duratron of dipping of eggs is determined as the mid \alue of the duration of the two parents. "

Care should be taken not toe,\ceed the duration of acid treatment, as the eggs get killed and damaged. It is necessary to use a ..proper alarm timer during acid treatment to a\oid damage.

After aeid treatment, the eggs are washed in running water immediatel). st) that IICI is completely removed Ihig. 59). Traces of HCl lelt o\ei on the egg card leads to death of the eggs. Hence, care should, be taken to repeatedly wash the eggs in running water to remove HCl. I o check presence of HCl on the eggs, the eggs are tested ,^^ut the tip of.the tongue. If HCl is present onecan feelsour taste of the acid, litmus paper is also used to check the presence of the aciil on the eggs.

[Room Temperature Acid Treatment

9W^ In this method the acid is used at room temperature. '.Hwiihout heating.

For room temperature acid treatment, the eggs laid in oviposition room at 25"C arc subjected to treatment between 15 20 hours of'o\ iposition time.'The principle is that room temperature acid treatment is useful for treating embryos of earlier stage than those used in hot acid treatment. Further, the eggs are likely to get separated from the egg card and the unfertilised eggs crumble, which help in their removal. But in tropical countries it is observed that some times bivoltines lay both hibernating and non hibernating eggs on the same sheet. This is due to the environmental conditions at which the silkworms are reared, in such conditions the non -hibernating eggs crumble in the room temperature acid treatment method. This is one of the reasons for this method being not popular in these parts. Further, the duration of treatment is longer in room temperature acid treatment method, ajso it requires more space and more acid for treatment of eggs.

The proper concentration HCl for room temperature acid treatment is hydrochloric acid of I.I 10 specific gravity (209r HCl) at 15»C or 1.105 to 1.109 at room temperature. The duration of acid treatment is related to 'oviposition time' as given below:

()\ il'osition	Durallon ol Dipping		
lime	24"C	:7»c	29"C"
10 hours	N) 70 minutes	40 71) mmules	
15 hdurs	N) SO minutes	60 XO minutes	20 *S)* minutes
20 hours	60 KKI minutes	60 80 minutes	40 .S) minutes
^'^ hours	60 100 minutes	60 *no* minutes	• 40 50 minutes

The eggs are first treated with *2<:i* formalin solution before they are treated with acid. They are dried and dipped in the acid at room temperatures mentioned above for a specific duration. Alter acid treatment the eggs are washed in running water to remove acid. Washing in water generally takes a longer duration as the egg sheet has absorbed acid. Hence, care must be taken to remove all traces of acid by repeated washing. Any trace of acid on the egg sheet is likely to effect hatching of eggs.

in Karnataka bivoltine X multivoltine hybrids are being produced to reduce the cost of production of dfls and to effectively utilise the bivoltine females and multivoltine males which were rejected till recently; These hybrids are acid treated by hot acid treatment similar to bivoltine hybrids.

COLD STORAGE AND ACID TREATMENT OF SILKWORM EGGS

IN order to postpone hatching over a period not as long as regular hibernation or not so early as by acid treatment, a technique of cold storing (chilling) the eggs and acid treatment in combination is followed. For this purpose the advantage of the early embryonic period having resistance to low temperature of cold storage is utilised. Hence to adopt this technique it is essential to cold store the eggs at a specific period. Further the concentration of HCl, temperature and the duration of the acid treatment vary. Techniques involving combination of cold storage and acid treatment are adopted depending on the need of eggs after long duration or short duration.

a) **Acid Treatment After a Longer Duration of Chilling**

(i) For chilling for 40-50 days the following procedure is adopted:-

The eggs are allowed to be laid at 25"C and humidity of 70%-80%. These eggs are continued to be kept in same condition upto 42 to 50 hours. These are collected when the eggs change to reddish brown colour and when embryo has reached the spoon shape. They are stored at 15°C for 6 hours. Later they are transferred to cold storage at 5"C for 40-50 days. Care should be taken to maintain a humidity of 70% to 80% in the cold storage. This helps in all eggs reaching a uniform period of diapause. The eggs are released from the cold storage and kept at normal room temperature for 3-6 hours. This helps in checking of sudden exposure to high temperature. These eggs are subjected to acid treatment. The HCI used for this purpose must have a specific gravity of 1.100 at IS^C (about 20% concentration). Its corresponding specific gravity at different room temperatures is given below:-

Temperature	Speclfic Gravity
250C	1.095
260C	1.095
270C	1.095
280C	1.094
290C	1.093
30"C	J.093
310C	1.092
320C	1.092
330C	1.092
340c	1.09!
350C	1.091

The acid whose specific gravity is adjusted to above temperature is heated to 48"C. The duration of dipping silkworm eggs in acid varies according to the silkworm breeds. The general standard is as follows:

European race	6-7 minutes
Univoltine Japanese race	6-7 minutes
Bivoltine Japanese race	5-6 minutes
Univoltine & Bivoltine Chinese races	5-6 niinutes

The duration for dipping the hybrid eggs is in between the two pure races.

The procedure of acid treatment viz., dipping the eggs in 2% formalin solution for 2 minutes and drying them followed by dipping the eggs in the acid of the same specific gravity, before dipping in hot acid is also followed inni this technique.

After treatment of eggs in hot HCI at 48"C, they are washed in running water to remove the traces of acid. They are dried and kept in incubation room till hatching.

(ii) In case, the hatching is to be delayed beyond 60 days the following procedures are followed:-

Eggs of 40-50 hours old, from oviposition, and kept at 250C and humidity of 7091-80% are transferred (i.e., when they have just advanced from spoon shaped embryo) to cold storage of 50C and humidity of 70%-80% and kept for 40 days. Later they are stored at 2.5"C for 20-30 days as desired. They are brought back to normal room temperature for 3-6 hours and acid treated with HCI of 1.100 specific gravity at 150C heated to 480C. 5-7 minutes dipping time is followed as in the previous case depending on the silkworm breeds.

b) Chilling for a Shorter Duration & Acid Treatmeili

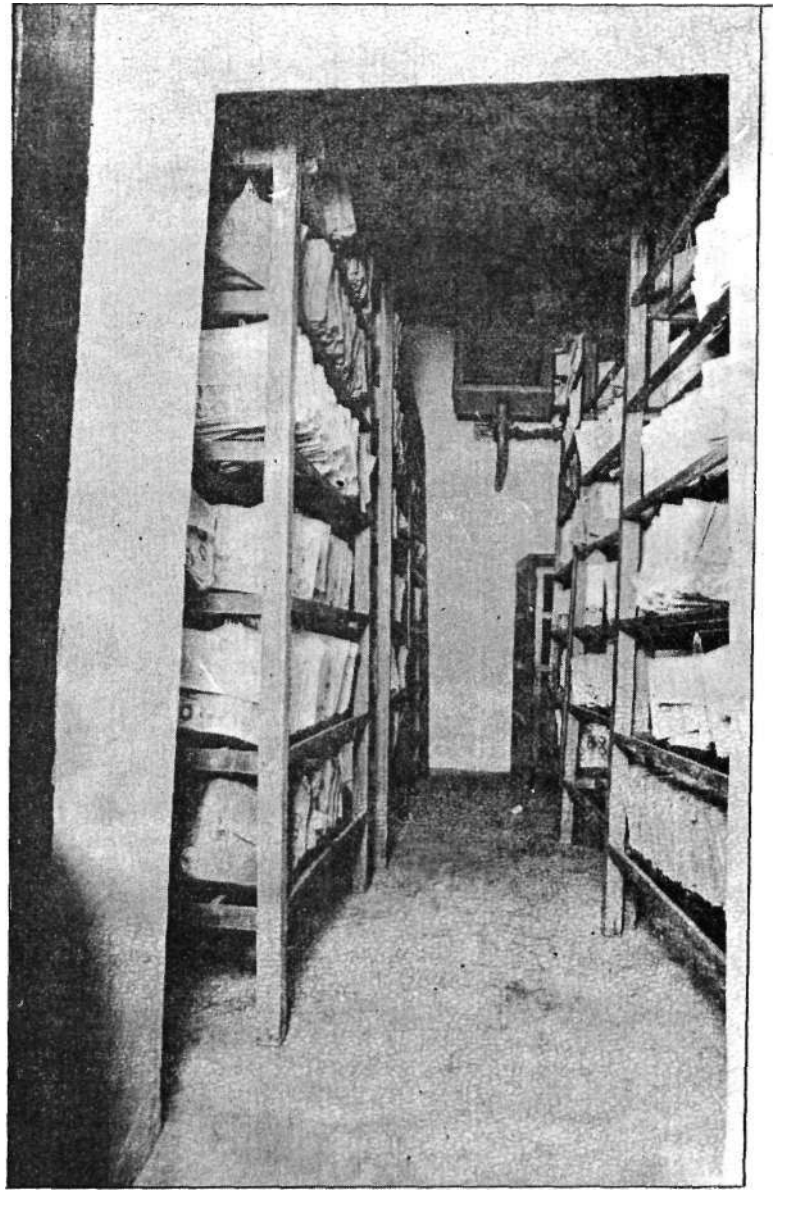
Eggs laid at 25"C and 70%-80% humidity are continued to be kept at that temperature. When they are 30-35 hours old after oviposition i.e., when they have passed germband formation and before reaching spoon shaped embryo, they are transferred to IS^C for 6 hours. By this time eggs turn reddish in colour. They are stored at 5"C and 70%-80% humidity in cold storage for 25 to 35 days. They are released from cold storage and kept at room temperature for 3-6 hours, later they are treated with HCl of 1.100 specific gravity at ISOC, heated to 480C, 5-7 'minutes dipping as in the previous case.

(c) **Cold Storage of Acid Treated Eggs**

Silkworm eggs which are acid treated by the general method at 46"C of HCl of 1.0715 specific gravity are cold stored for 10-20 days only, as in case of multivoltine eggs. In this case, it is better to keep them in cold storage at 5"C (Fig. 60). But it is always advisable to check the stage of the embryonic growth by borax carmine staining technique. The optimum time for cold storage of acid treated eggs is when the embryo has developed the appendanges. If, it is delayed it leads to death of the embryo, and poor hatching.

By adopting the various methods of cold storage and acid treatment of eggs described above, the programme of brushing can be adjusted from 10-80 days. |,

The technique of cold storage and acid treatment are very well adopted in Japan for cold storage of eggs prepared in autumn and late winter and released for hatching in spring. ^q



tig. 60 Inside \ icw ol a cold storage

HIBERNATION OF BIVOLTINE SILKWORM EGGS

GENERALLY bivoltine silkworm eggs are subjected to cold storage so that they can be used for rearing at later period. The eggs produced in spring can be used for next spring or next autumn or next summer, by adjusting the duration of keeping eg^s at normal temperature after oviposition and cold storage. They can be released for rearing as and when required.

There is correlation between duration of the aestivation (the number of days preserved at high temperture) and refrigeration. The details are given below:

Relationship Between Days Preserved at High Temperature (25"C) and Low Temperature (S^C)

No. of days preserved at high lemp crulurc	5	10	20	40	60	SO	100
Shortesi cold storing days for W, hatching	79	X7	K7	K9	*W*	105	IIM	124	1.14
Longest cold storing days for WV hatching	1-I9	165	I6«	I7K	191	*H)2*	196	161	145
Effective cold storing pcriod.(days)	61	79	82	90	96	9K	7K	.IS	12

Realising the above principle bivoltine eggs are preserved in cold storage for different periods for spring and autumn rearing in temperate climate. Similarly by coordinating the duration of keeping eggs at room temperature and the duration of cold storing, bivoltine eggs can be released in tropical conditions whenever required for brushing.

a. **Preservation of Eggs Prodiiced in Spring for Next Spring**

In Japan hibernating eggs prepared in June are stored at a temperature of 23"C-250C for 60 days till August. They are kept in room temperature which naturally falls gradually from September-October to 2{)"C. If the temperature does not fall, the temperature in the room is maintained at 20<'C by use of air conditioners. From October winter sets in and temperture naturally starts falling. In November when the natural temperature is rS^C to IQOC the eggs on the sheets are washed and the loose eggs are stored in boxes. The natural temperature falls to S^C by December. During December-February i.e., for 60 days the eggs are cold stored at 5"C. The eggs are transferred to cold storage at 0"C-2.5"C for 40 to 60 days. During the end of March they are kept at 10"C-I5"C for a short period and again kept at 2.5"C till release for rearing in May (Fig. 61).

b. **Preservation of Eggs Prepared in Early Autumn for Next Spring Rearing**

In temperate zone early autumn eggs are generally produced in August. They are kept at 20°C from late September to middle October. They are washed in November and kept in natural temperature which gradually falls to S^C in December. They are stored at 5"C during December and February. From February.to end of March they are kept for about 40 to 60 days at 2.5"C. They are transferred for 4 to 5 days to lO^C-lS'iC and again kept at 2.5"C till release in May for incubating for jspring rearing. (Fig. 62).

c. **Preservation of Eggs Produced in Late Autumn (October-November) for Spring Rearing**

A programme of hibernation and for release of eggs for spring in May is drawn by considering the relationship between the period at which the eggs are kept at 25"C before refrigeration and duration of cold storage. Considering these aspects and the date of requirement of hatching, schedule for preservation of late autumn silkworm eggs is drawn. Generally the eggs are kept for 10-20 days at 250C. FromMovember the temperature is reduced gradually. The eggs are kept at 5"C from middle December to February (50 to 60 days). They are transferred to 2.5"C for 60 days from February to April till they are released for incubation by the end of April or beginning of May as required (Fig. 63). The humidity is maintained at 70-80% throughout. In this case it is

advisable to acid treat the eggs to get good hatching. For this purpose, after eggs are taken out of cold storage, they are kept for 1 day at 10°C and 1 day at 15°C and then acid treated. They are kept at 15°C for 2–3 days before release for incubation.

d. For Eggs Produced in Early Winter

In Japan, the parent seed is produced in early part of winter earlier to the commercial seed. The eggs are required to be kept in cold storage for 100–150 days for preservation. In such cases where eggs are to be hatched in following April or May the eggs are kept at 25°C and humidity of 70%–80% for 7–10 days. These are kept at 25°C, 15°C and 10°C for 2–3 days each, and then cold stored at 5°C till March. By end of March they are kept at 2.5°C till April end. They are taken out of cold storage 15 days earlier to starting of rearing and kept at 10°C–15°C for a day. They are treated and kept for incubation.

e. Hibernated Eggs produced in Spring for Next Year Summer or Autumn Crops

Eggs prepared in July i.e., spring are allowed to hibernate. They are kept in room temperature of 25°C till September–October. When the temperature naturally falls to 15°C they are kept at 5°C in December and 2.5°C in January. They are later stored at 0°C from February to May. In May they are temporarily kept in 15°C for 4 to 5 days. This helps all the embryos to reach 'KO' embryo stage. Again from June to August they are kept at 0°C–2.5°C. They are released for rearing in next year August for summer rearing. This is called double refrigeration method (Fig. 64).

Hibernation Schedule for Jammu & Kashmir State

Different schedules of preservation of Bivoltine silkworm eggs is followed for Jammu area and Kashmir area in India.

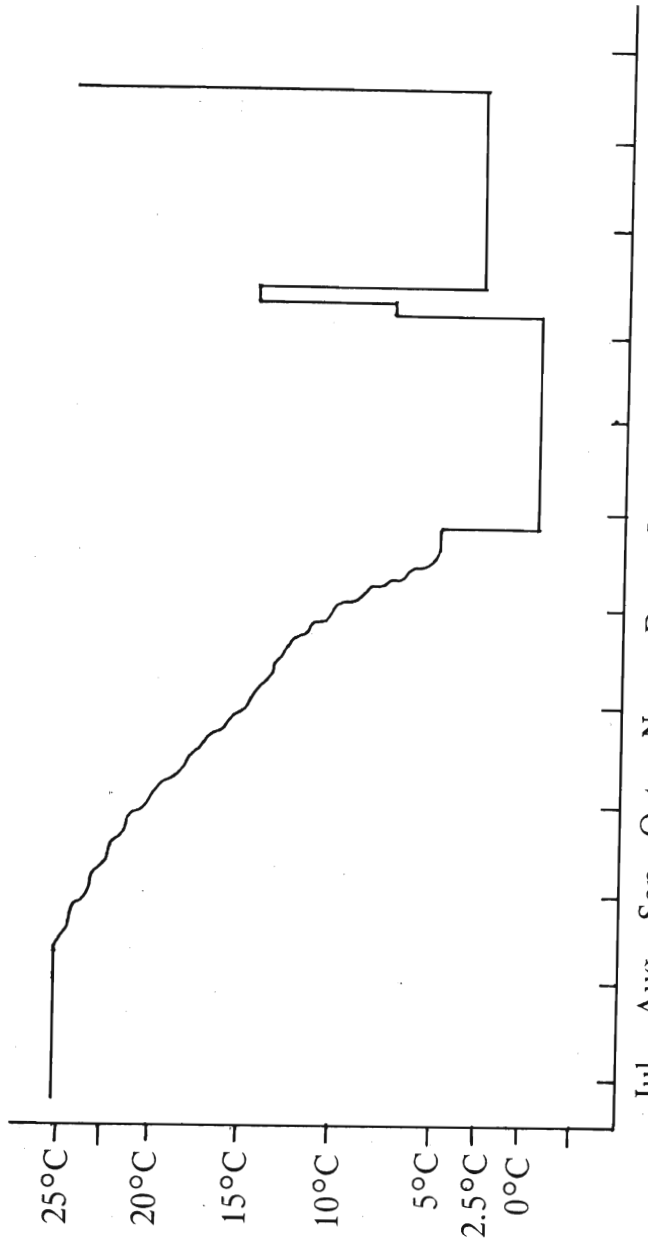


Fig. 61 Preservation of eggs produced in Spring for use in next spring season

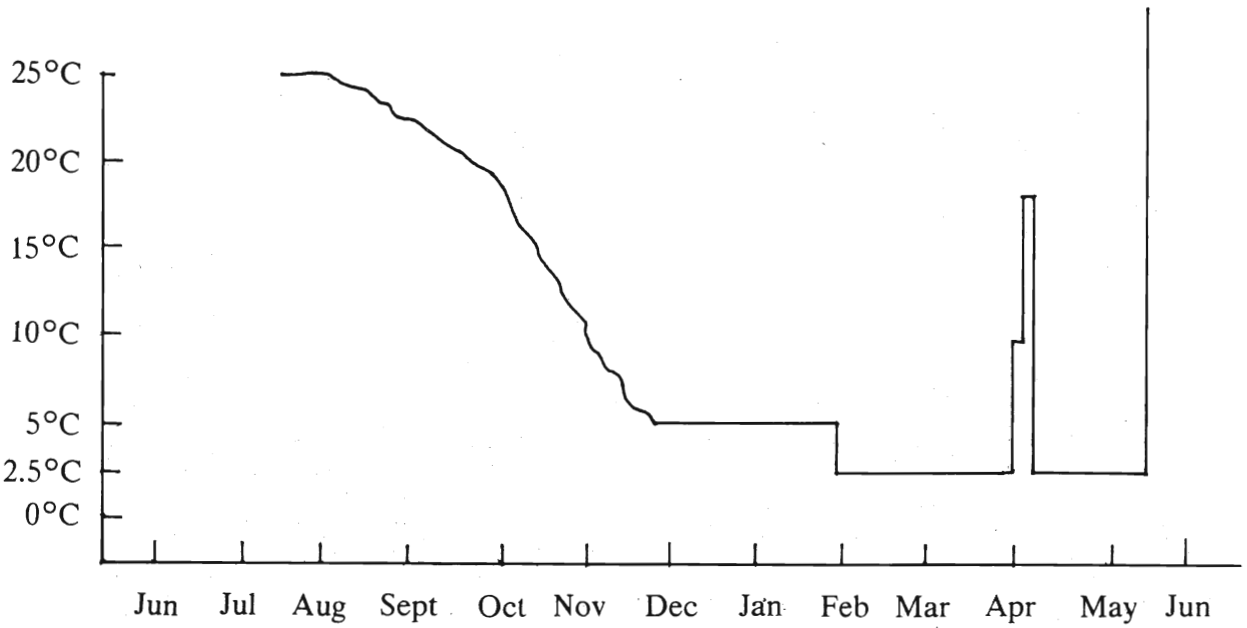


Fig. 62 Preservation of eggs produced in early Autumn for next spring season.

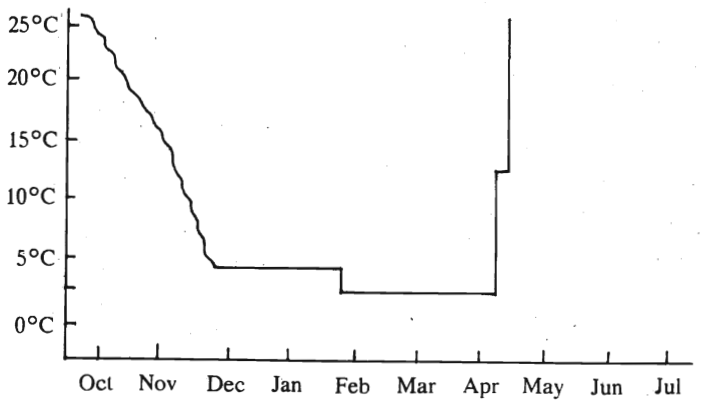


Fig. 63 Preservation of eggs produced in late Autumn for next spring rearing

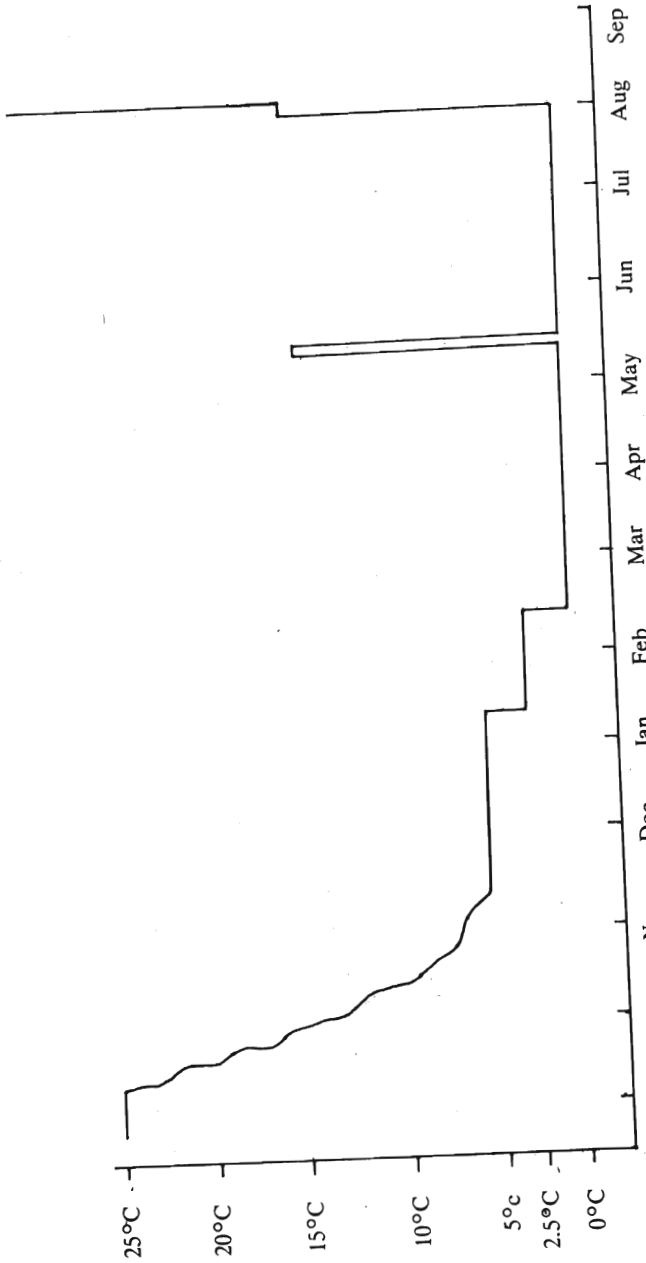


Fig. 64 Preservation of eggs produced in spring for next year summer or Autumn crops.

a. **Jammu Area**

Preservation of Spring Eggs for Next Spring Rearing in Jammu

Spring season in Jammu zone is much earlier to Kashmir zone (Fig. 65). Rearing of silkworms for spring starts in March and hybrid eggs are prepared in May, when the temperature in Jammu zone is hot. Hence the eggs are shifted to cooler areas like Batote. Here they are kept at natural temperature of 25°C to 26°C. This temperature starts falling in natural conditions slowly in July and August. The temperature reach 20°C in August and lower in September. The eggs are now transferred to cold storage at 5°C in November and kept at that temperature up to III week of December. From then and upto 15th–20th of February a temperature of 2.5°C is maintained in the cold storage. The eggs are kept at 15°C for few days, later they are released for incubation and rearing in March. Humidity of 70% to 80% is maintained throughout egg preservation.

b. **Kashmir Area**

Preservation of Spring Eggs for Next Spring in Kashmir

Spring rearing in Kashmir is conducted in May and eggs are prepared in July–August (Fig. 66). The eggs are kept in natural temperature in Srinagar. They are washed in November and kept in natural temperature which falls to 15°C to 10°C slowly by December. Humidity of 70% to 80% is maintained throughout the period. They are subjected to cold storage in January at 5°C and after 50–60 days, by end of February they are shifted to 2.5°C. This temperature of 2.5°C is maintained for 60 days, upto the end of April and released for incubation either at the end of April or the beginning of May as required. Care is taken to maintain 70% to 80% humidity throughout the period of cold storage.

c. Preservation of Autumn Eggs of Jammu Zone for Spring Rearing in Kashmir Zone.

Eggs produced in Autumn in Jammu Zone are also used for spring season in Kashmir zone which is in May. In such cases the eggs are produced in Jammu in the month of September–October, when the room temperature is around 25°C. They are shifted to cooler zones in Srinagar (Kashmir) and kept at room temperature. Humidity of 75% to 80% is maintained throughout the hibernation period. During November–December the temperature naturally starts falling. By January beginning they are subjected to cold storage at 5°C and kept for 50 to 60 days. They are shifted to 2.5°C from 20th February to the end of April for 60 days. They are released 15 days earlier to brushing and kept for 2 to 3 days at 15°C before the worms hatch in May in Kashmir.

d. Supply of Silkworm Eggs from Dehradun to Jammu and Kashmir

Now a days eggs are prepared in Dehradun area of Uttar Pradesh, to meet the demand of Jammu & Kashmir. Eggs prepared in Spring in Dehradun area are generally used for spring rearing in Jammu and those produced in Autumn are used for spring rearing in Kashmir Zone.

Soon after spring rearing in March in Dehradun, the temperature rises sharply in summer. It is dangerous to expose the eggs to a high temperature. Hence in summer they are kept in rooms where temperature and humidity are artificially maintained at 25°C ± 1°C and 70% to 80% respectively. They are sent to Batote in Jammu in August and kept at room temperature. The temperature naturally falls from 25°C to 10°C by November. They are kept at 5°C in November and schedule of preservation of Jammu area is followed.

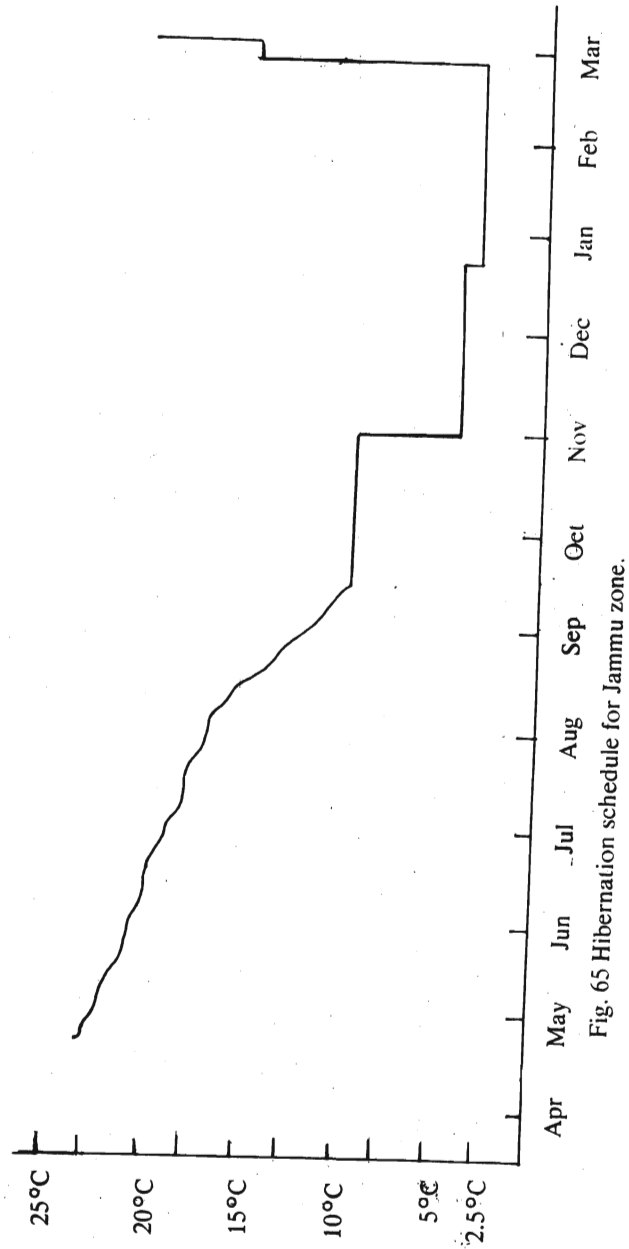


Fig. 65 Hibernation schedule for Jammu zone.

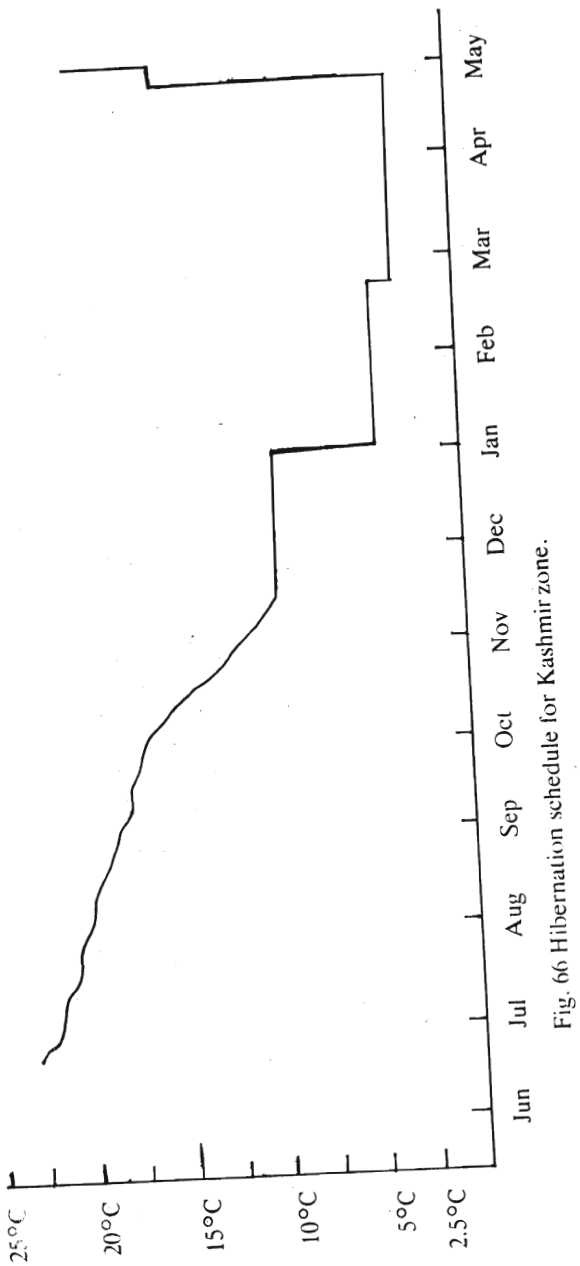


Fig. 66 Hibernation schedule for Kashmir zone.

Autumn eggs are prepared in October in Dehradun. The natural temperature starts falling to reach the temperature of 10°C–15°C in November as in Kashmir. Humidity of 70% to 80% is maintained throughout the period. They are transferred to Srinagar in Kashmir in December and hibernation schedule of Kashmir zone for spring rearing is followed in cold storage.

Hibernation schedules suggested above can be adopted for Assam and North East areas by slight change.

In tropical countries natural temperature available is not conducive for preservation of Bivoltine silkworm eggs. Further in tropical conditions of Karnataka where the climate is celubrious for silkworm rearing throughout the year, the bivoltine seed cocoons are required as the male component for production of Multi x Bivoltine hybrids at any part of the year, hence Bivoltine silkworm eggs produced in favourable months are required to be stored and released for periodical supply. For this purpose cold storages are specially designed to have facilities for maintaining different temperature, throughout the year. A model cold storage for tropical conditions consists of the following chambers: 25°C, 20°C, 15°C, 10°C, 5°C and 2.5°C. The humidity maintained is 70%–80%. The cold storage must also be provided with diesel electricity generators for continuous functioning of cold storage even during failure of electricity. Such cold storages are of fundamental necessity for a sound seed supply programme and should never be treated on commercial lines.

For tropical conditions of Karnataka hibernation schedules of 6 months and 10 months are followed as long term programmes.

e. **The Schedule of Cold Storage for 6 Months in Tropical Conditions is given (Fig. 67).**

Bivoltine female moths are allowed to couple by 9 a.m. They are decoupled at 12–Noon or 1 p.m. They are kept in oviposition room where a temperature of 25°C and humidity of 70% to 80% is maintained. Most of the moths lay eggs between 6 p.m. to 8 p.m. This is treated as time of Oviposition. Next day by 10.00 a.m. moths are examined and healthy eggs are washed by noon in 2% formalin solution for 15 minutes. They are washed in water to remove excess of formalin. The eggs on egg–sheets are dried and kept in room at 25°C and 70%–80% humidity. Eggs collected for 3–4 days are sent for cold storage. At cold storage the eggs are kept at 25°C for 20 days; 20°C for 15 days; 15°C for 10 days; 10°C for 10 days; 5°C for 50 days; 2.5°C for 60 days; 5°C for 5 days. They are later released for incubation. During cold storage humidity is always maintained at 70%–80%.

f. Preservation of Eggs for 10 Months (Fig. 68)

Two step refrigeration is followed for preservation of eggs for long duration of 10 months. Eggs are allowed to be laid at oviposition room maintaining 25°C and humidity 70%–80%. The moths are examined next day. Eggs of different groups are collected for 3 days and kept in 25°C and 70%–80% humidity. They are washed in 2% formalin, then washed in running water and dried. They are then sent to cold storage, where they are stored at 25°C for 40 days, 23°C for 20 days, 20°C for 30 days, 15°C for 25 days, 10°C for 25 days. They are subjected to refrigeration at 5°C for 60 days; 2.5°C for 50 days. They are released for intermediate care at 12°C–15°C for 3 days and cold stored again at 2.5°C for 30 days, 15°C for 2–3 days and kept for incubation.

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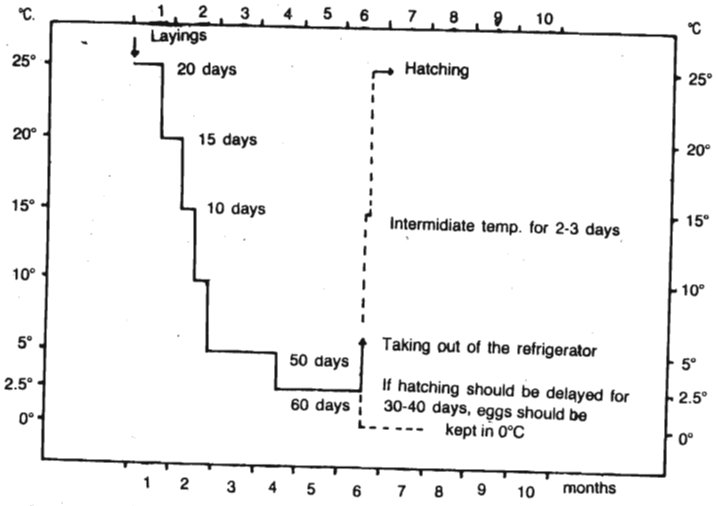


Fig. 67 Schedule of cold storage for 6 months in tropical condition

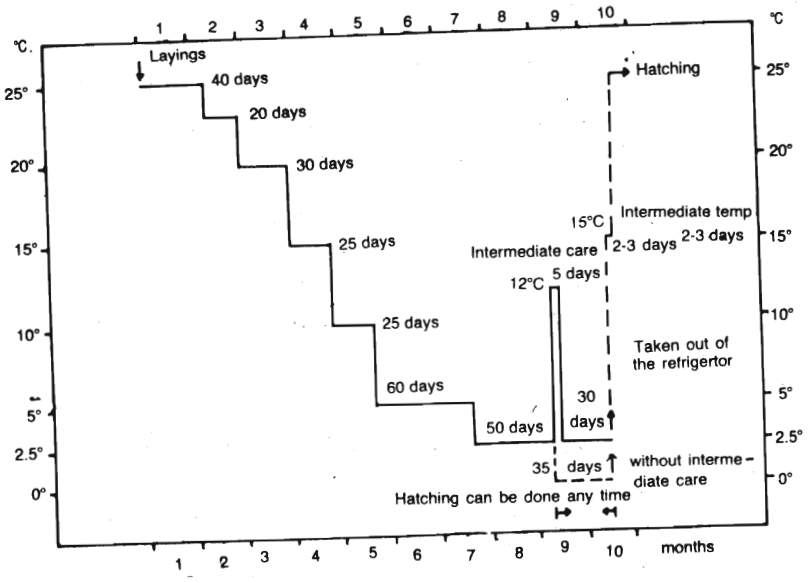


Fig. 68 Preservation of eggs for 10 months

PRESERVATION OF BIVOLTINE EGGS IN TROPICAL CONDITIONS

IN tropical conditions of Karnataka, bivoltine dfls can be made available as required by adopting chilling and acid treatment techniques. But the crucial period is time of "oviposition" which should be properly determined and environment of oviposition room should be maintained. These two factors control the development and growth of the embryo. In tropical countries, temperature is generally higher than that of temperate climate. If temperature in oviposition room is high, the embryo grow fast and within 20 hours they go into diapausing stage and acid treatment will be ineffective.

Oviposition Time

Generally in grainages of higher capacity, light is provided to force emergence of moths in the early hours of the day for production of multivoltine x bivoltine hybrids. During this course of action, the bivoltine moths

are allowed to couple for bivoltine hybrid or bivoltine x multivoltine dfls preparation at early hours say at 3-OOam or 4-OOam. After coupling for 4 hours i.e., by 8-OOam they are depaired and allowed to lay eggs. Moths start laying at 2-OOpm. They are to be acid treated at 10am next day i.e., by 20 hours after oviposition time. This gives very little time for moth examination, egg washing and acid treatment. Naturally, the treatment time is prolonged to 4 -5pm by which time the crucial period of acid treatment is lost or ineffective thereby leading to irregular hatching.

It is always essential to maintain a temperature of 25"C ' by use of air conditioners and humidity of 70%-80% by use of humidifiers in the oviposition room. If humidifiers are not available, humidity can be maintained by providing sand beds and curtain cloths kept always wet and running a fan. It is also necessary to provide diesel generator sets to run the air conditioners without interruption, when electricity supply fails, which is a common feature in summer. Further, bivoltine female moths are picked early and stored at room temperature. Generally they do not lay eggs immediately, in case of such fear the virgin females are collected on bamboo trays or wet cloth and kept inverted so that the moths are kept hanging sticking to the support of tray or cloth. They do not lay eggs in this condition. However, such exigencies may not arise.

The appropriate time for coupling bivoltine females is 8-OOam. This also gives time to collect larger number of moths. They are decoupled at 12-00 noon and allowed to lay eggs. Since most of the eggs are laid between 6-OOpm to 8-OOpm the oviposition time is treated as 8-OOpm. The crucial period of 20 hours of acid treatment falls at 4-OOpm next day. This is an ideal situation for moth examination and acid treatment.

In case a small number ol moths are to be used for 2nd pairing, the first batch of moths are coupled at 6-OOam and depaired by 9-30am. The male moths are stored in refrigerators for 30 minutes and used for 2nd coupling with other bivoltine females. By this method, the oviposition time for first-batch is determined as 4-6pm and treatment time is about 12 noon to 4pm next day. While for the second batch, decoupling time is 1-30 to 2-OOpm. Oviposition time of the II batch is 8-OOpm, and treatment time is 4-6pm. Hence both the batches can be acid treated on the same day without difficulty.

Sometimes it so happens that some breeds lay eggs slowly and prolong egg laying. In such cases, it is not advisable to wait for all the eggs to be laid by the moth. If we wait for all eggs, those eggs laid early develop fast and reach the crucial period of acid treatment early. In such case acid treatment is not effective for these eggs. Hatching of eggs in such batches is less due to disparity of effect of acid on the eggs.

In such cases, while handling those silkworm races which are slow in egg laying, the moths which are allowed to lay eggs are transferred to a second-egg sheet to continue egg laying. The first sheet oi eggs are treated as per schedule and second sheet of eggs treated later.

The fundamental principle is that the eggs are to be treated with acid within 20 hours of egg laying or oviposition by which time the embryo has reached the proper growth of germband formation. Similarly, eggs are to be cold stored at specific period Qf their growth for cold storage in combination with acid treatrhent if hatching is required.

Schedules are prepared for various techniques of cold storage of hibernating eggs followed by acid treatment; acid treatment followed by cold storage of eggs and the inter-relation between aestivation and refrigeration of hibernating silkworm eggs. The table gjves the growth period and schedule for different period of hatching.

Requirement of etcs for hatch-inc	**Time for prewr-tation of efgs from** o<ipo^ilion	**Crowtli utafe uf** embryo	**TecliniqiM *to* be folloired**
25 days	4X hours	.Spoon shaped	25"C oviposition; 5"C 7 days. Acid treatment irKubation 10 days
.W 40 days	20 hours	Gcrmband for malion	25"C oviposition: acid treatment: 5°C-20-3O **dayt iiKubation 10 days.**
35-45 days	.10 .15 hours	After germ-band formalion	23°C ovipoeition 30-35 houn of oviposition: ISKT I day 5°C 25-35 days; acid treat mem - incubation 10 days.
50 Todays	42 50 hours	Spoon shaj^d embryo	25"C oviposition 40 50 hours of oviposition: IS'C 6 hours: 5"C 40 60 days: acid treatment incubation todays.
110 1.10 days	72 hours	Diapause stage	25"C-I0 days: 20"C-5 days: I5"C-: days; 10"C-2 days: .V'C-50 days: 10"C-I day; (5"C-I day: Acid treatment 15'C 4 days; incubation lOdavs
130 150 days	72 hours	Diapause stage	25"C 10 days: 20»C-5 days; I5°C 5 days; 2.5^-5 **days** lO-C Iday-I5°C-Iday:Acid ircatmenu !«? 2 days; incu-bation 10 days.
120 days	42 50 hours	Spoon shaped embryo	25"C 2 days; I5"C 6 hours 5»C- 40 days: 2.5"C 60 days; 25°C 3 his - Acid treatment incubation.

Chapter-XV

MANAGEMENT OF A GRAINAGE

SERICULTURE industry is measured by the quality of silkworm seed produced. Sericulturists look to the grainages for quality silkworm seed on which their economy of living depends. He believes that the eggs taken from a grainage yield successful crops. He looks to the grainage officer with respect. Quality silkworm seed production and maintaining the standards are the primary responsibility of the grainage officer and he should make all efforts to achieve this. Silkworm egg production in a grainage depends on many factors, such as the demand and supply, "procuring quality seed cocoons, their transportation, preservation, technology, management of labour and technical staff, production and sale of silkworm eggs. Hence management of a grainage is the co-ordination of these various aspects and skill of managing the technical and labour force. The officer must be vigilant and tactful. He must tackle the seed cocoon growers, on one hand and the industrial cocoon growers on the other. His success of sale depends on these two. In addition, he must handle the labour and enjoy the co-operation of the staff.

The following most important aspects in the .nanagement of grainage are discussed:

a) Programme of production
b) **Arranging** seed cocoons
c) Synchronisation of silkworm races for production of hybrids
d) Transportation of seed cocoons
e) Arranging staff for management
0 Transportation of silkworm egg and
g) Cordial relation with farmers.

a) Programme of Production

fhe demand for silkworm seed production is a vital aspect in planning the programme of a grainage. The demand for silkworm seed varies in different seasons as mulberry growth has a direct relationship with seasonal conditions. This is specially so in areas where mulberry is grown under rainfed conditions. The demand for silkworm seed naturally goes high during the monsoon & after rains, as mulberry grows very fast in response to water availability.

• The demand for silkworm seed is very low during the winter season, when the sprouting of mulberry is delayed due to cold. In tropical conditions of Karnataka even under irrigated conditions the demand for silkworm seed fluctuates considering the seasonal conditions and more particularly the availability of water in wells. In Southern states, the demand for silkworm seed is generally high commencing from March to .June and followed by September-October. 1 he demand is lowest during November-December. In Jammu& Kashmir the demand is confined to spring and autumn.

Even social customs, govern the demand for silkworm seed. During festival seasons such as Durga festival in West Bengal, farmers do not generally like to take up rearings. Similarly, the biushing of silkworm eggs will be less in Karnataka during the festivals of Shankranthi. Availability of agriculture labour is also one of the factors for determining the silkworm rearing and thereby influencing the demand for silkworm eggs. The farmers of Andhra Pradesh, who generally grow groundnut, prefer not to have anjicrop during November-December as they require labourers for groundnut harvest and cannot divert their labourers for sericulture. Hence, for management of grainage one has to study the demand of silkworm seed **for different** seasons **and workout a schedule. West Bengal has a well defined four seasons for commercial cocoon production of which the demand is always high for Agrahini and Chaithra crops. These • factors are vital for** assessing **the needs** of **the silkworm** seed **and management of grainage should be such, as to meet the demand. A good manager of the grainage generally studies such factors and arrives at an estimate of the requirement of** seed in the area **for** different months **and** seasons.

b) Pi Seed Cocoon Production and Supply

Seed cocoon production preceeds the industrial cocoon **production. Production** of **quaUty** cocoons of **two** races is a fundamental prerequisite of commercial hybrid seed production. Production of seed cocoons which can synchronise in the emergence of moths is essential for a grainage **programme. If** good seed cocoons are not available, hybrid seed production is affected very much.

Different Silkworm races behave differently because of their inbuilt genetic variability. Mysore race has 30 days of larval period and bivoltines have 26 days. Larval duration of multivoltine is longer than bivoltines. During cooler seasons, the larval duration is prolonged and moth emergence is delayed. In West Bengal Nistari race takes hardly 21 days to complete spinning in summer. The larval duration and the behaviour of the races in a different "environment differ. Considering these aspects the grainage officer plans the supply of Pi seed to the selected cocoons growers, so that the spinning dates and emergence of moths from these races coincide. For this purpose many times he preserves the eggs in cold storage and releases it to the seed growers. Sometimes even with all such care difference in emergence of moths of these races by a day or two occur. In such cases, pupae are required to be refrigerated.

Preservation of seed cocoon in cold storage is not a healthy practice and leads to many problems later. Hence grainage officer must have a good knowledge of behaviour of pure races and considering the requirements of seed cocoons for a particular season must organise the rearing of the different pure races, so that they synchronise at the time of emergence of moths.

In Karnataka, multivoltine seed cocoons are grown in seed areas. Availability of Mysore seed cocoons, is more or less ensured. This is because hardly 50-60% of the cocoons produced in the seed area are utilised for production of hybrid seed. Inspite of such an advantage, shortage of seed cocoons is noticed during summer and during October months. Similarly, in bivoltine, the Survival rate is low in summer months, thereby creating scarcity of male component. Hence a proper planning of

seed cocoons to meet the demand of the season, has to bci considered by the grainage officer. In such situations' hybrids of bivoltine female and multivoltine male can be produced without depending on additional seed cocoons. This is because the bivoltine females and multivoltine males which are otherwise thrown out are used for seed preparation. The performance of this hybrid in silkworm rearing and cocoon production is similar to multivoltine x . bivoltine hybrid. Another advantage is, these bivoltine x multivoltine hybrids can be prepared during favourable season and preserved like bivoltine hybrids by adopting cold storage techniques, acid treatment and hibernation schedules.

Emergence of moths from the cocoons of different races differ, for example, while Mysore race takes 10 days to emerge from the date of spinning, bivoltine takes 12-14 days depending upon the season and race. To avoid such complications it is advisable to procure cocoons of two races where emergence of moths synchronise.

In West Bengal Nistari multivoltine is commonly reared during summer and hybrid of Nistari and bivoltines are preferred for Agrahini (Oct-Nov) and Chaitra (Feb-season). The larval duration of Nistari race is hardly 18 to 22 days in summer and 26 days during favourable seasons. The seasons earlier to commercial cocoon production are usually unfavourable for rearing silkworms. In such situations production of seed cocoons during unfavourable seasons becomes difficult. This is one of the reasons why the hybrid seed supply is always in shortage in West Bengal for Agrahini crop. It is possible to organise production of bivoltines and multivoltine seed cocoons for chaitra because of the favourable seasons. It is extremely difficult to produce bivoltine male

component for Agrahini crop. Generally egg producers get bivoltine seed cocoons from far off places like Dehradun etc. Hence, the management of the grainage should have a complete idea about the requirement of the seed cocoons, suitable places for rearing seed cocoons and their availability to meet the demand.

In Jammu area of Jammu & Kashmir and Dehradun area of Uttar Pradesh and Assam, there are only two -seaons viz., spring and autumn favourable for rearing silkworms. Henc^ the seed cocoons are produced only during these two Seasons. The seed cocoons required for autumn are produced in spring. Similarly, the silkworm seed required for spring are produced during autumn. In Kashmir where only one season is favourable for rearing silkworms, the silkworm seed produced in the spring season is allowed to hibernate and supplied to cold storage in the month of November to December to release the silkworm seed in the beginning of spring season. Hence seed cocoon production has to be planned and managed systematically.

(c) Synchronisation of Moths

In many cases to synchronise the availability of moths for egg production, it is a general practice to refrigerate the male moths. Male moths can be refrigerated at 7°Cto *l(PC* for 6-7 days. Preservation of male moths longer than 7 days leads to loss of vigour and the coupled females lay unfertilized eggs. Sometimes it may become inevitable to refrigerate the cocoons due to prolonged difference in spinning date of races. In such cases, female cocoons can ^ bje refrigerated on the 7th or 8th day of spinning at *S'^C* for 3 days only and the male cocoons for 7 days. However, it

is advisable not to refrigerate female moths emerged from refrigerated female cocoons. This will have a bad effect on the larval growth later.

In grainages the male moths are preserved for a maximum period of 3 to 4 days at a temperature of 7°C-I0''C. In such ca,ses the moths are released from the cold storage and kept at the normal temperature for atleast half an hour before their use for coupling with females. On no occasion the moths from the pupae which are refrigerated already should be refrigerated again. Such repeated refrigeration leads to weak moths, resulting in poor hatching and bad cocoon crops. Sometimes it becomes essential to cold store the female moths. In such cases, they can be cold stored for.3 days at lO^C and not beyond. It is always advisable to cold store male moths, in preference of females as the former is resistant to refrigeration

(d) Transportation of Seed Cocoons

Parent seed cocoons, immaterial of bivoltine or multivoltine require delicate care while handling as compared to hybrid cocoons. The survival and the quality of seed cocoons received at the grainage only determine the quality of commercial seed produced. Even though best quality of cocoons are produced in seed area, if they are transported for long distance badly,' it leads to mortality of pupae. This will have an adverse effect on seed production. Transportation of seed cocoons to long distances should be avoided. As mentioned earlier the seed producers of West Bengal transport cocoons from such long distances as Dehradun. The transporting facilities available are by train or by road transport. The emergence of moths of such cocoons is very low and particularly female moths are not fit for any use.

Transportation of cocoons by public transport such as lorries, buses etc., expose them to sun, which naturally affects its quality and emergence of moths. This should be avoided. It is suggested that the grainages must have their own facilities of seed cocoon crates and vehicles for transportation. Cocoons should be packed loosely. Packing of cocoons in gunny bags or cloth bags should be avoided. Pupa is a living organisim which require at least minimum facilities for its life and activity. Packing cocoons in bags naturally generates heat dOe t'o physiological activity of the pupa which results in pupal death and melting of cocoons. It is suggested that the cocoons should be transported in plastic crates, which are well ventilated and piled up one above the other, to protect the cocoons from getting crushed. It is always necessary to transport seed cocoons during evening hours and night when the temperature is lower than the day.

(e) **Staff** of **the** Grainage

As described earlier management of a grainage is basically a human problem. The technical staff and the labourers are to be vigilant all the 24 hours. Every step in production of seeds in grainages needs human assistance. From the date of arrival of seed cocoons till the dfls are prepared and sold, the delicate live material such as the cocoon, pupa, moth and the eggs are to be handled with due care and attention. Hence arranging the labourer's for different programmes at different shifts require managerial skill. The technical staff as well as the labourers should be trained in various technologies of handling the live materials at various stages.

For day-to-day working it is suggested that the entire group of labourers and technical staff can be divided into three units as follows:

1. Day duty batch;
2. Night duty batch; and
3. Moth examination batch.

The efficiency and the production of quality seed depends on management of technical staff and the trained labourers. Considering the above, the following distribution of work is suggested.

(1) Day Duty Batch

This batch is responsible for the following:

i. Receipt of seed cocoons and arranging seed cocoons in bamboo trays.

ii. Assessment of lots, for melted cocoons, Uzi-infested cocoons etc.

iii. Reject lots with high percentage of melting.

iv. Sorting of bad cocoons.

V. Sex separation and arranging pupae in corrugated sheets, in trays or keep pupae in cocoon shell.

vi. Arrange good cocoons in single layer in bamboo tray.

vii. Attend to depairing of moths of first batch and pairing and depairing of second batch of moths.

viii. Attend to second pairing of moths. Duration of pairing is 5 hours.

ix. Arranging the female moths in oviposition for egg laying according to lots.

X. Maintain temperature and humidity in all rooms and particularly in egg laying room.

xi. While picking the moths for pairing they are advised to use specific colour plastic trays.

xii. Maintenance of general cleaning with bleaching powder, lime etc.

(2) **Night Duty Batch**

i. They must take stock of arrangements made, quantity of cocoons kept in different rooms.

ii. Programme the emergence and picking up of moths as soon as they get on to the duty.

iii. Arrange the equipments required for picking and pairing moths in pairing room.

iv. Arrange egg sheets in the pairing room.

V. Allot and arrange labourers for different room for picking, pairing and depairing moths.

For early morning emergence:- The above arrangements are to be madem the previous night.

vi. Provide light and allow for emergence in the early hours of the day and organise picking healthy moths. .

vii. Arrange pairing. In case of early emergence they have to attend to depairing.

viii. Report the work done to day duty batch.

(3) Moth Examination Batch

This batch will be responsible for sorting out the sample moths for moth examination as per the norms i.e., 20% in case of multivoltines and 100% in case of bivoltines. Wherever the crushing set is* used they can follow sampling of 4 moths from each sheet with two moths for a single crushing. If Pebrine disease is noticed even in one sample, the entire batch should be rejected. This batch should examine the smear at the rate of 30 smears/hour.

Whenever moth crushing machines are not available, double moth testing can be resorted to for multivoltine hybrids. Bivoltine batches are to be examined first to enable acid treatment. The staff must examine the moths till 4 O'clock in the evening; wash the eggs and prepare the egg card.

Even though the above work allotment has been suggested many times due to heavy load of work of production, particularly during high demand season, the technical staff cannot strictly attend only to the above work. They are to be drafted for additional work if needed. Every grainage staff must realise that his work is for the benefit of poor farmers. Such dedication to work by all the staff and labo urers with zeal can only give credit to the grainage for producfion of high quality seed. The officers must frequently' visit the grainages during the night to check up whether the technology is followed or not and to guide the staff in production of dfls. Such a responsibility not only gives credit to him but also the eggs produced in the grainage.

(0 Arrangements for Transportation of Silkworm Eggs;

The silkworm eggs produced in a grainage are transported for preservation in cold storage, to another demand area or transported by air to long distances. Care of silkworm eggs during transportation is necessary, if not, the entire effort of production is spoiled and programme of rearing affected. Even though transportation of eggs is easier than cocoons, care must be taken to maintain humidity and drastic fluctuation of temperature. It is advisable to transport eggs during-morning or evening hours. High temperature during afternoon affect the eggs. One of the main problems ^

faced in tropical conditions is dry conditions during transportation of eggs. Duo to low humidity, the eggs are killed and get dried. Hence, for transport of silkworm eggs wooden boxes lined internally with foam pads made wet are used. The foam pads can maintain a humidity of 60-70% for few hours.

It is a general habit in our country to transport eggs bound in cloth or hand bags. Silkworm eggs are alive and require proper environment for their survival. Packing the eggs tight generates heat and results in lack of air for respiration of eggs. This results in death of eggs. Sometimes it so happens that the eggs on the border of the sheets hatch and those in the centre get damaged or die due to suffocation and improper packing. Eggs are to be packed loosely.

Transportation of eggs for long distances must be taken care off. Eggs laid on sheets should be packed in wooden cartons or wooden boxes. The boxes must carry a thin layer of foam pad, which is made wet before closing the boxes. Foam pads can retain water for 8-10 hours depending on the weather conditions. This will help in maintaining humidity. The boxes must carry holes for ventilation. Eggs should never be transported tightly packed. It is advisable to wash eggs in 2% formalin at the receiving end to avoid any chances of the eggs being contaminated during transportation.

Eggs for preservation in cold storage must be transported at the right time as discussed earlier. There is a relationship between time for preservation of eggs and cold storage.

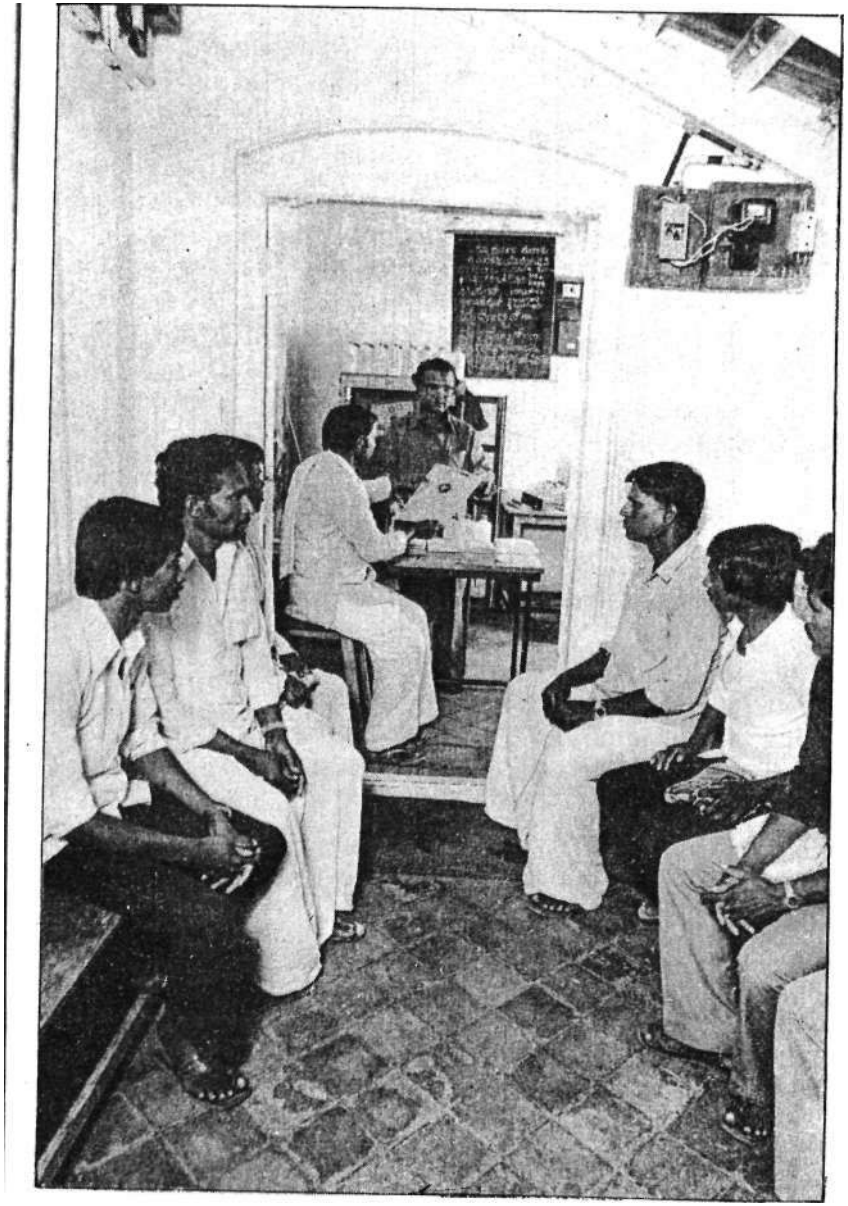
(g) Cordial Relation with Farmers

Farmers come to a particular grainage as they have confidence of good yield of cocoons from eggs. They even

wait for a day or two to take dfis from a particular jgrainage. In many cases, they indent for layings early. A good farmer generally plans his requirement of eggs considering the growth of leaf in his garden and indents for dfls in advance in the grainage. Such a system is healthy. The production manager in a grainage may have to estimate the requirement and plan production for the season and periodical demand basing on his experience. Generally in Karnataka, the farmers have a feeling that the refrigerated eggs do not hatch properly and do not yield good cocoons. This is due to improper refrigeration. Eggs preserved at improper time in cold storage show irregular hatching . Similarly, if there are frequent failures of electricity leading to fluctuations in temperature during refrigeration, the'eggs show improper hatching and death of larvae. Generally, larvae coming out of such eggs are weak. They show irregularity in growth at liater stages. Farmers in Karnataka generally enquire whether eggs are refrigerated or not before taking them. Some of the farmers do not take dfls if there is no production in the grainages on the day of his taking the dfls.

Grainage is the centre of discussions and collection of information on sericulture of the season. Farmers explain and discuss their problems with the grainage staff (Fig. 69). Information such as the general demand of eggs, performance of eggs taken from different grainages in the village can be easily collected. Farmers also complain if the yield is low and seek the advice of the grainage officer for successful crops. A grainage officer must have a good knowledge of techniques for rich harvests. He should analyse various factors responsible for poor harvest and advise the farmers properly. A cordial relationship gets established between a farmer and the grainage officer because of the proper advise of the grainage officer and rich harvest of cocoons from the eggs. Grainage officer

must visit the farmer's house and look to the progress of crops occasionally atleast. This bond between grainage officer and the farmer is essentia! for good marketing. The farmers becomes a good spokesman for the grainage and advocates to others that they take dfls from the grainage. The success of a grainage depends on the quality of dfls produced, which depend on quality of seed cocoons, proper techniques followed and the cordial relationship with the farmers and grainage officers. A grainage officer Vnust have good technical knowledge, patience to hear the farmers problems and take efforts to solve them.



I ig. *M* Sale f.l Silkuorm ci!*v.s*

COST OF PRODUCTION

'^•"^E demand for silkworm eggs in sericultural areas *JL* being high, grainages function as commercial ventures. Silkworm eggs are now produced in Karnataka by State and Central Government organisations as well as the private seed producers who are licenced. In West Bengal, a major portion of the eggs produced is by the farmers themselves or by the private seed producers. In Jamiliu & Kashmir the seed production is nationalised and is a programme of the Government for the development of the industry.

Grainages being organised both under private and public sectors naturally have to function on commercial lines as eggs are sold to the farmers. The main component of the cost of production of dfls is the parent seed cocoons. In Japan, the parent seed cocoons are sold at about l'/2 times the price of hybrid cocoons. However,

such a practice is not in vogue in our country. State Governments generally declare the rates considering the cost of production of cocoons and the demand. The rates-are fixed for standard number of cocoons/kg. In many states the rates are fixed considering the demand. In general, seed cocoons are offered about 20%-25% higher rate than hybrid cocoons.

Utilisation of cocoons has a direct relation to the cost of seed production. If the quality of seed coeoon'i-'is good, the recovery of disease free layings is high. Since, nearly 60% of the cost of production of seed goes to the cost of the cocoons, the egg producer must concentrate on procuring good quality seed cocoons. As explained earlier, cocoons with heavy pupae generally give poor yield of dfls due to melting of cocoons. He should also make sure that the cocoons purchased are free from Pebrine and are from Pi stock only. If these factors are not taken care of, the cost of production of dfls goes high.

In Karnataka, where, multivoltine x bivoltine hybrids are popularly produced, the cost of production' is generally high. This is because the bivoltine females and multivoltine males are rejected. Generally, the ratio of 2 multivoltine cocoons to one bivoltine cocoon is maintained for production of a dfi. And about 25%-30% of dfis in relation to the total quantity of good cocoons kept for seed preparation is considered as a standard. In Jammu & Kashmir and Dehradun, where loose eggs are prepared, it is expected that a kilogram of bivoltine cocoons produce 1.3-1.6 ounces (1 oz = 23 gms) of seed because of the preparation of reciprocal hybrid dfls of bivoltines. In Karnataka and West Bengal, cocoons to dfls ratio works out to 6 cocoons to I dfl. This ratio can be reduced to 4 cocoons to 1 dfl if hybrids of bivoltine female and myllivplnne males are produced. In Jammu and Kashmir, and Dehradun, it is 4 cocoons to I dfl.

Generally the following factors are considered for working out the cost of production:-

1. Cost of seed cocoons
2. Establishment charges
3. Wages to labourers
4. Depreciation cost on equipments
5. Interest cost on revolving capital for purchase of seed cocoons and sale of eggs
6. Chemicals
7. Rent
8. Electricity, water charges etc.
9. Total dfls produced.

In Karnataka 50%-60% of the cost of production of dfls goes to cocoon cost. Generally, from this cocoons cost, the sale proceeds of pierced cocoons is deducted. Of the total cost of dfls the staff salary of Government grainage works out to 18%-20%, labour wages works out to about 10%, miscellaneous expenditure including rent, water charges, electric charges etc., about 6%. Depreciation charges on equipments 6% and the interest on the revolving capital about 3%. A typical case on working out of cost of production is given below for "gjUidance. This is only a guideline and should not be qbnsidered as a standard.

Cost **of production of 25.0 lakhs** cross **breed layings in. a model grainage.**

Figures in Lakiis

No.	Pwticuivs	MuhivollliM	BlvohUw
I.	**Seed Cocoon Cost**		
1.	Seed cocoon purchased for preparation	83.00	41.50
2.	Inferior cocoons rejected (20%)	jipo	8.50
3.	Good Cocoons	66.0	33.0
4.	Percentage of dfU from toul seed cocoons	*W/i*	
5.	Toill dfb produced	25.0	
6.	Cost of multivolline seed cocoons @ Rs. 40 - per 1.000 cocoons	Rs 3.32	
7.	Cost of bivoltine seed cocoons (S) Rs 70 per 700 Cocoons	Rs. 4.14	
8.	Total cost of seed cocoons	Rs. 7.46	
9.	Recovery from pierced cocoons		
	(a) Bivohinesl.333kg@iRs. 70 kg Rs.0.93		
	• (b) Multivolline t.3^3 kg @ Rs. 70/-kg Rs. 0.96	Rs. 1.89	
	Total cost of seed cocoons	Rs. 5.57	
II.	**Expenditure at Grainage:**		
A.	Recurring txpenditures:		
	(a) Labour charges (40)	2.37	
	(b) Cost of egg sheets	0.20	
	(c) Cost of chemicals	0.20	
	(d) Rent etc.	0.36	
	(e) Transportation of seed cocoons	0.30	
	(0 Miscellaneous	0.12	
	Toul Recurring cjipendilurc	3.55	
	Non-R*currlng Expcndlturc:-		
	(a) Depreciation on cost of equipments	0.35	
	(b) 10.0% interest on Revolving Capiul	0.10	
	Total non i^xurring expenditure	i 0.4J '	
	Total Cost	•.57	
	Cost of 100 C.B. layinp*	:= R». 40.00	

; ^Establishment cost whkh includes staff salary vary in government and private sector, hence not included.

In Karnataka, if bivoltine moths are used for .preparation of bivoltine x multivoltine hybrids. T^he cost of production of dfls can be reduced by 25-30%. Generally, the cost of private grainages in Karnataka and West Bengal is always lower than that of the Government grainages. This is because the labourers employed, the wages paid and the expenditure on establishment is far less in private grainages as compared to State Government grainages.

The cost of production should not be the only criteria for production of dfls. It is quality of dfls produced that determines the stabihty of a grainage. One should look to the cost of production giving emphasis on the quality of dfls. The grainage officer should balance these to make profit.

CALCULATION TABLE FOR SILK CONTENT

Wi of shell	Weight of cocoon					
	65mg	70	75	80	85	90
6 mg	92	86	80	75	71	67
7	108	100	'∧	88	82	78
8	123	114	107	100	94	89
9	138	129	120	113	106	100
10	154	143	133	125	118	III
II	169	157	M7,	138	129	122
12	185	171	160	150	141	133
13	200	186	173	163	153	144
14	215	200	187	175	165	156
15	! 231	214	200	188	176	167
16	246	229	213	200	188	178
17	262	243	227	213	200	189
18	277	257	240	225	212	200
19	292	271	253	238	224	211
20	308	286	267	250	235	222
21	323	300	280	263	247	233
22	338	-314	293	275	259	244
23	354	329	307	288	271	256
24	369	343	320	300	282	267
25	385	357	333	313	294	278
26			347	325	306	289
27			360	338	318	300
28				350	329	311
29					341	322
30					353	331

	95	100	105	no	IIS	120
6	63					
7	74	70	67	64	61	58
K	84	80	76	73	70	67
9	95	90	86	82	78	75
10	105	100	95	91	87	83
II	116	110	105	100	96	92
12	126	120	114	109	104	100
13	137	130	124	118	113	108
14	147	140	133	127	122-	117
15	158	150	143	Mft	130	125
16	168	160	152	145 ,	139	133
17	179	170	162	155	148	14?

VVt. <>| shell	Weight of cocoon						
18	189	180-			164	157	150
19	200	190			173	165	158
20	211	200	190		182	174	167
21	221	210	200		191	183	175
22	232	220	210		200	191	183
23	242	230	219		209	200	192
24	253	240	229		218	209	200
25	263	250	238		227	217	208
26	274	260	248		236	226	217
27	284	270	257		245	235	225
28	295	2X0	267		255	243	233
29	305	29(»	276		264	252	242
30	316	3(X)	286		273	261	250
31	326	310	295		282	270	258
	337	329	305		291	278	267
y}	347	330	314		300	287	275
34	358	340	324		309	296	283
35	360	350	*in*		318	304	292
36			343		327	313	300
37 .			352		336	322	308
38					345	330	317
39					355	339	325
4«						348	333

6	125	130	135	140	145	150	
7	56	54					
X	64	62	59	57	55		
9	72	69	67	64	62	60	
If)	80	7-	74	71	69	67	
II	88	85	81	79	76	*1}.*	
12	96	92	89	86	83	80	
13	104	KM)	96	93	90	87	
14	112	108	104	100	97	93	
(5	120	115	III	107	103	100	
Ift	128	123	lly	114	110	107	
17	136	\y\	126	121	117	113	
18	144	138	133	129	1.24	120	
19	152	146	141	136	131	127	
20	160	154	148	143	138	133	
21	1,68	162	156	150	145	140	
	176	169	163	157	152	147	

Wt. of shell	Weight of cocdiOn'					
23	-184	177	170	164	159	153"
24	192	185	178	171	166	160
25	,200	192	185	171	172	167
26	208	200	193	186	179	173
27	216	208	200	193	186	180
28	224	215	207	200	193	187
29	232	223	215	207	200	193
30	240	231	222	214	207	200
31	248	238	230	221	214	207
32	256	246	237	229	221	213
33	264	254	244	236	228	220
34	272	262	252	243	234 .	227
35	280	269	259	250	241	233
36	288	277	267	257	248	240
37	296	285	274	264	255	247
-38	304	292	281	271	262	. 253
39	312	300	289	279	269	260
40	320	308	296	286	276	"267
41	125	130	135	140	145'	.150
42	328	315	304	293	283	273
43	344	331	319	307	297	287
44	352 -\	338	326	314	303	293
45		346	333	321	310	300
46		354	341'	329	317	307
47			348	336	324	313
48			356	343	331	320
49				350	338-	327
50					345	333
	155	160	165	170	175	180
It	71	69	67	65	63	61
12	77	75	73	71	69	67
13	84	81	79	76	74	72
14	90	88	85	82	80	78
15	97	94	91	88	86	83
16	103	100	97	94	91	89
17	110	106	100	100	97	94
18	116	113	109	106	103	100
19	123	119	115	112	109	106
20	129	125	121	ll«	114	111
21	135	131	127	124	120	117
22	142	138	133	129	126	122

Wi. of shell	Weight of. cocooin					
	- ___					
23	148	144	139	135	131	128
24	155	150	145	141	137	133
25	161	156	152	147	143	139
26	168	163	I5K	153	149	144
27	174	169	164	159	154	150.
28	181	175	170	165	160	156
29	l';7	181	176	171	166	161
30	194	188	\n	176	171	167
31	200	194	188	182	177	172
32	206	200	194	188	183	178
33	213	206	200	194	189	183
34	219	213	206	200	194	189
35	226	219	212	206	200	194
36	232	225	218	212	206	200
37	239	231	224	218	211	206
38	245	238	230	224	217	211
39	252	244	236	229	223	217
40	258	250	242	235	229	222
41	265	256	248	241	234	228
42	271	263	255	247	240	233
43-	72.77	269	261	253	246	239
41	m	27i-	2U	2SS	HI	2«f
45	290	281	273	265	2S1	250
46	,T97^	288	'279	271	263	256
•4T^	303	294	285	276	269	261
, 48	310	300	291	282	274	267
49	316	306	297	288	2K0	272
50	323	313 ,	303	294	286	278
51	32,9	319	309	300	291	283
52	335	325	315	306	297	289
53	342	331	321	312	303	294
54	348	338	327	318	309	300
55	355	344	333	324	314	306
56	,	350	339	329	320	311
57			345	335	326	317
58			352	341	331	322
59				347	337	328
60				353	343	333
	185	190	195	200	205	210
16	86	84	82	80	' 78	76
1?	92	89	87	85	83	81,

Wl. ol shell	Wei ight of cogoon					
IK	^7	. 95	92	90	88	86
19	103	l(X)	97	95	93	90
20	108	105	103	100	98	95
21	114	III	108	105	102	100
22	119	116	113	110	107	105
21	124	r2i	118	115	112	110
24	130	126	123	120	117	114
25	135	1.12	128	125	122	119
26	141	137	133	1-30	• 127	124
27	146	142	138	135	1.12	129
28	151	147	144	140	137	133
29	157	153	149	145	141	138
M)	162	1^	154	150	146	14,1
.11	168	163	159	155	151	148
32	173	168	164	160	156	152
31	178	174	169	165	161	157
34	184	179	174	170	166	162
35	**189**	(84	179	175	171	167
.36	**195**	**189.**	185	180	176	171
17	200	195	190	185	180	176
.18'	205	200 ;	195	190	185	18|
39	211	205	200	195	190	186
40	*i\b^*	2il_.	JOS.	2(K)	JiJl	190
	185	**190**	195	200	205	210
41	222	*m*	210	205	200	195
42	227	221	215	210	205	2(M)
43	232	226	221	215	210	205
.44	238	232	226	220	215	210
45	**243**	237	**231**	225	220	214
46	249	242	236	2.10	224	2(8
47	254	247	**241**	**2.15**	229	224
48	259	253	246	240	234	229
49	265	258	251	245	2.19	233
50	270	263	256	250	244	238
51	276	268	262	255	249	243
52	281	274	267	260	254	248
,53	286	279	272	265	259	252
54	292	284	277	270	263	257
55	297	289	282	275	268	262
56	.103	295	287	280	273	267
_57	_j^r)8	300	292	285	278	271,

Wt. shell	Weight, of cocoon						<
.58	314	305	297	>9d	283	276	
59	319	311	.103	295	288	281	
60	324	316	308	300	293	286	
61	3.10	.121	313	305	298	290	
62	.'35	326	318	310	303	295	
63	341	332	323	315	.107	300	
64	.40	337	.328	320	312	305	
65	.i5l	.1^2	.133	325	,317	310	
T6	~7.r	•~73	71"	' 70	' 681	67	
17	79	77	76	74	72	7 it	
18	84	82	80 -	78 ;	77	75	
19	88	86	84	83	81		
20	93	91	89	87.	85		
21	98	95	93	91	89	1.	
22	**102**	1(K)	98	96	94	87	
23	107	105	102	100	98	92	
24	112	109	107	104	102	96	
25			111	109	106	100	
26	121	1||8	116	113	111	104	
27	126	124	120	117	115	108	
28	1.30	127	124	122	119	113	
29	135	132	129	126	123	117	
.30	140	1.16	133	1.10	128	121	
31	144	141	138	1.15	132	125	
32	149	141	138	1.15	1.16	129	
33	153	150	147	143	140	133	
34	158	155	151	148	145	138	
35	163	159	156	152	149	142	
36	167	164	160	167	153	146	
37	172	168	164	161	157	150	
38	177	173	169	165	162	154	
39	181	177	173	170	166	158	
40	186	182	178	174	170	163	
41	191	186	182	178	174	167	
42	195	191	187	183	179	171	
43	200	195	191	186	183	175	
44	205	200	196	191	187	179	
45	209	205	196	196	191	183	
	215	220	225	2.10	235	188	
46	214	209	204	700	.196	240	
						192	

Wt. 1)1' hell	Weight of coco'pn					
47	"219	214	209	204	200	196
48	223	218	213	209	204	200
49	228	223	218	213	209	204
50	233	227	222	217	213	208
51	237	232	2h	222	217	213
52	242	236	231	226	221	217
53	247	241	236	230	226	221
54	251	245	240	235	230	225
55	256	250	244	239	234	229
56	260	255	249	243	238	233
57	265	259	253	248	243	238
58	270	264	258	252	247	242-
59	274	268	262	257	251	246
60	279	273	267	261	255	250
61	284	277	271	265	260	254
62	• 288	282	276	270	274	258
63	293	286	280	274	268	262
64	298	291	284	278	272	267
65	302	295	289	283	277	271
66	307.	300	•293	287	28l	275
67	312	305	298	291	285	279
68	^16	309	302	296	289	283
69	321	314	307	300	294	288
70	326	318	312	304	298	292
71	330	323	316	309	302	296
72	335	327	329	313	306	300
73	340	332	324	317	311	304
74	344	336	329	322	315	308
75	349	341	333	326	310-	312
	245	250	255	260	265	270
21	,86	84	82	81	79	78
22	90	88	86	85	83	81
23	94	92	90	88	87	85
24	98	96	94	92	91	89
25	102	100	98	96	94	93
26	106	104	102	100	98	96
27	no	108	106	104	102	100
28	114	112	110	108	106	104
29	118	116	114	112	109	107
30	122	120	118	115	113	111
31	127	124	122	119	117	115,

\Vl. »l .hell	Weigh i of cocoon					
32 ~	131	128	125	123	121	119
33	135	132	129	127	125	. 122
34	139	136	133	131	128	126\
35	143	140	137	135	132	130
36	147	144	141	138	136	133
37	151	148	145	142	140	137.
38	155	152	149	146	143	141
39	159	156	153	150	147	144
40	162	160	157	154	151	148
41	167	164	161	158	155	152
42	171	168	165	162	158	156
43	176	172	169	165	162	159
44	180	176	173	169	166	163
45	184	180	176	173	170	167
46	188	184	180	177	174	170
47	192	188	184	181	177	174
48	196	192	188	185	181	178
49	200	196	192	188	185	181
50	204	200	196	192	189	185
	245	250	255	260	265	270
51	208	204	200	196	192	189
52	212	208	204	200	196	193
53	216	212	208	204	200	196
54	220	216	212	208	204	200
55	224	220	216	212	208	.204
56	229	224	220	215	211	207
57.	233	228	224	219	215	211
58	237	232	227	223	219	215
59	241	236	231	227	223	219
60	245	240	235	231	226	222
61	249	244	239	235	230	226
62	253	248	243	238	234	230
63	257	252	247	242	238	233
64	261	256	251	246	242	237
65	265	260	255	,250	245	241
66	269	264	259	254	249	244
67	273	268	263	258	253	248
fi»	278	272	267	262	257	252
69	282	276	271	265	260	256
70	286	280	275	269	264	259
71	290	284	278	273	268	263

(01 hfll	We ight of cocoon					
72	294	288	282	277	272	"267
73	298	292	286	281	275	270
74	302	296	290	285	279	274
75	306	300	294	288	283	278
76	310	304	298	292	287	281
77	314	308	302	296	291	285
78	3(8	312	306	300	294	289
79	322	316	310	304	298	293
80	327	320	314	308	302	296

	275	280	28S	290	295	300
21	76	75	74	72	71	70
22	80	79	77	76	75	73
23	84	82	8(	79	78	77
24	87	86	84	83	81	80
25	91	89	88	86	85	83
26	95	93	91	90	88	87
27	98	96	95	93	92	90
28	102	100	98	97	94	93
29	105	104	102	100	98	97
30	109	107	105	103	102	100
31	113	IK	109	107	105	(03
32	ir6	114	112	110	(08	(07
33	120	118	116	114	((2	1(0
34	124	121	119	117	115	113
J5	127	125	123	121	((9	1(7
36	131	129	126	124	(22	(20
37	135	132	130	128	(25	(23
38	r38	136	133	131	(29	(27
39	142	138	137	134,	(32	(30
40	145	143	140	138	(36	(33
41	149	146	144	141	139	137
42	153	150	147	145	142	(40
43	156	154	151	148	J46	(43
44	160	157	154	152	(49	(47
45	164	161	158	155 r	153	' (50
46	167	(64	. 161 \	159 i	(^6	(53

\\1 ' shell	Weight ol cocoon					
47	171	168	(65	162	159	157
48	175	171	168	(66	163	f60
49	(78	175	172	169	166	163
50	(82	179	175	172	169	(67
	275	280	285	290	295	300
51	(85	182	179	176	173	170
52	189	(86	182	179	(76	173
53	193	189	(86	183	(80	(77
54	(96	193	(89	(86	(83	(80
55	200	(96	(93	(90	(86	(83
56	204	200	196	(93	(90	(87
57	207	204	200	297	(93	190
58	211	207	204	200	(97	193.
59	2(5	2I(	207	203	200	197
60	2(8	2(4	2(1	207	203	200
61	222	2(8	214	210	207	203
62	225	22 (	2(8	214	2(0	207
63	229	225	22 (	217	2(4	2(0
64	233	229	225	221 '	2(7	212
65	236	232	228	224	220	2(7
66	240	236	232	228	224	220
67	244	239	235	231	227	223
68	247	243	239	234	231	227
69	251	246	242	238	234	230
70	255	250	246	241	237	233
71	258	254	249	245	241	237
72	262	257	253	248	244	240
73	265	26 (	256	252	247	243
74	269	264	260	255	251	247
75	273	268	263	259	254	250
76	276	27 (	267	262	258	253
77	280	275	270	266	261	257
78	284	279	. 274	269	264	260
79	287	282	277	272	268	263
80	29(	286	281	276	271	267
	305	310	315	320	325	330
26	85	84	83	81	89	79
27	89	87	86	84	83	82
28	92	90	89	88	86	85
29	95	94	92	91	-89	88

Wi. ol shell.	WeighT 51 cocoon !					
30	98	97	95	94.	92	^
31	102	100	98	97	95	94
32	105	103	102	100	98	97
33	108	106	105	103	102	100
34	III	110	108	106	105	103
35	115	113	tit	109	108	106
36	118	116	tl4	113	III	109
37 .	121	119	117	115	114	112
38	125	123	121	119	117	115
39	128	126	124	122	120	118
40	13!	129	127	125	123	121
4t	134	132	130	128	126	124
42	138	135	133	131	129	127
43	141	139	137	134	132	130
44	144	142	140	138	135	133
43	148.	145	143	141	138	136
46	151	H2	146	144	142	139
47	154	131	149	147	145	142
48	157	155	152	150	148	145
49	161	158	156	153	151	148
SO	164	161	159	156	154	152
St	167	165	62	159	157	155
52	170	168	F65	163	160	158
53	174	171	168	166	163	161
S4	177	174	171	169	166	164
S5	180	177	175	172	169	167
	305	310	315	320	325	330
S6	184	181	178	175	172	170
S7	187	184	181	178	,175	173
S8	190	187	184	181	it 78	176
59	193	190	i".	184	)82	179
60	197	194	190	188	185	182
61	200	197	194	191	1^8	185
62	203	200	197	194	191	188
63	207	203	200	197	194	191
64	210.	206	203	200	197	194
65	213	210	206	203	200	197
66	216	. 213	210	206	203	200
67	220	216	213	209	206	203
68	223	219.	216	213	209	206

Wi ol' shell	Weight of 6ocoon					
69	226	^23	219	216	212	209
70	230	226:	. 222	219	215	212
71	233	229	225	222	218	215
72	236	232	229	225	222	218
73	239	235	232	228	225	221
74	243	239	235	231	228	224
75	240	242	238	234	231	227
76	249	245	241	238	234	230
77	252	248	244^	-241	237	233
78	256	252	248	244	240	236
79	259	255	251	247	243	239
80	262	258	254	250	246	242
81	266	261	257	253	249	245
82	269	265	260	256	252	248
83	272	268	263	259	255	252
84	275	271	267	263	258	255
85	279	274	270	266	262	258
	335	340	345	350	355	360
31	93	91	90	89	87	86'
32	96	94	93	91	90	89
3V	99	97	96	94	93	92
34	101	100	99	97	96	94
.35	104	103	101	100	99	97
36	107	106	104	103	101	too
37	nO	109	107	106	104	103
38	113	112,	11^	109	107	106
39			ij3	. Ill	no	108
40	119	iHj	•mfii	114	113	III
41	122	121	119	^ \\/ '	m\	114
42	125	124	122	120	118	117
43	128	126	125	123	121	119
44	131	129	128	126	124	122
45	134	132	130	129	127	125
46	137	135	133	131	130	128
47	140	138	136	134	132	131
48 .	143	141	139	137	135	133
49	146	144	142	140	138	136
50	149	147	145	143	141	139
51	152	150	148	146	144	142
52	155	153	151	149	146	I44i

\ \ I ol hell	W c jLIht of cocoon					
53	I5S	156	154	151	149	147
54	161	159	157	154	152	150
55	164	162	159	157	155	(53
56	167	165	162	160	158	156
57	170	168	165	163	161	158
5X	173 ,	171	168	166	163	161
59	176	.174	171	169	166	164
60	179	176	174	171	169	167
	325	340	345	350	355	360
61	182	179	177	174	172	169
62	185	182	180	177	175	172
63	ISX	185	183	180	177	175
64	191	188	186	183	180	178
65	194	191	188	186	183	181
66	197	194	191	189	• 186	183
67	2(K)	197	194	191	189,	186
6«	203	200	197	194	192	189
69	*i()6*	203	\?00	197	194	192
70	209	206	203	2(X)	197	194
7! .	212	209	*2^)6*	203	200	197
72	•>I5	212-	209	206	203	200
7.t	218	215	212	209	206 '	2(^3
74	' 221	218	214	211	208	200
75	224	221	217	214	211	208
76	227224	220	217	214	211	
77	• 230	226	223	220	217	214
78	233	229	226	223	220	217
79	236	232	229	226	223	219
80	239	235	232	229	226	222
81	242	238	235	231	228	225
82	245	241	238	2.34	231	228
8.1	248	244	241	237	2.34	231
84	251	247	243	240	237	233
85	254	250	246	243	2.39	230
86	257	253	254	246	242	2.39
87	260	256	252	249	245	242
88	263	259	255	251	248	244
89	266	262	258	254	25 r	247
90	269	'265	261	257	254	250

ni

ANNEX - I

IMPLEMENTS FOR P,BASIC SEED FARM

SI. No,-	Implements	No.
1.	Mumties	10 Nos.
2.	Crowbar	10 Nos.
3.	Bill Hooks	10 Nos.
4.	Zinc Pot	10 Nos.
5.	Koluguddali	20 Nos.
6.	Guddeli	15 Nos.
7.	Pruning Saw	20 Nos.
8.	Water Can	15 Nos.
9.	Sickles	20 Nos.
10.	Weeding Sickles	20 Nos.
II.	Iron Pans	15 Nos.
12.	Digging Fork	6 Nos.
13.	Showels	6 Nos.
147"	Secateur	6 Nos.
15.	Garden Scissors	6 Nos.
16.	Diesel Pump Set	2 Nos.
17.	Aspree Sprayer	I Nos.
18.	Measuring Tape	I No.
19.	Bullock Cart	I No.
20.	Tractor	I No.
21.	Bullocks	I pair
22.	Wooden Trays	600 Nos.
23.	Bamboo Trays	600 Nos.
24.	Bamboo Mountaees	600 Nos.
25.	Leaf Chamber	20 Nos.
26.	Hygrometer	8 No.s,
27;-	Leaf Chopping Board	4 Nos.

28.	Leaf Chopping Knives	4 Nos.
29.	Ant Wells	250 Nos.
30.	Feeding Stands	12 Nos.
31.	Foot Cleaning Trays	4 Nos.
32.	Wash Basin Stand	4 Nos.
33.	Power Sprayer for Disinfection	1 No
34.	Disinfection Masks	2 Nos.

ANNEXE 11

REQUIREMENT OF STAFF FOR P,BASIC SEED FARM

SI. No.	POSTS	No.
1.	Manager (Silkworm Breeder	**1**
2.	Assistant Manager	**1**
3.	Rearing Assistants	**2**
4.	Farm Manager	**1**
5.	Lower Division Clerk	**I**
6.	Technicians for rearing, Leaf supply, etc..	**8**
7.	Peon	**1**
8.	Chowkidars	**3**
9.	Driver	**1**

ANNEX – III

NATIONAL SILKWORM SEED PROJECT

(CENTRAL SILK BOARD)

BASIC SEED FARM

Race .....
Generation No. .....
Laid on .....
Incubation Temperature .....
Season .....
Nature of Rearing .....
Plot alloted .....
Variety of leaves .....

LOG SHEET

Bed No. .....
Date & Time of Brushing .....
No. of unfertilized eggs .....
No. of unhatched eggs .....
No. of larvae rejected .....
No. of larvae brushed .....
No. of eggs per laying .....
Percentage of hatching .....

Sl. No.	Date	FEEDING HOURS A.M. 6 – 10	2	P.M. 5	10	No. of feedings given	Quantity of leaves fed	Time of cleaning	Duration of each age	Moulting period	NO. OF WORMS REJECTED Grasserie	Flacherie	Unequal Size	TOTAL	No. of worms at the beginning of each age	No. of missing larvae	Temperature	Humidity
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		
21																		
22																		
23																		
24																		
25																		
26																		
27																		
28																		
29																		
30																		
31																		

1. Weight of 10 full worms in gms. .....
2. Date and time of Spinning .....
3. Total Rearing Period .....
   a) Eating period .....
   b) Moulting period .....

4. Quantity of cocoons harvested — No. — Wt.
   a) Good .....
   b) Flimsy .....
   c) Double .....
   d) Total .....

5. Yield per 10,000 larvae brushed .....
6. No. of Cocoons per kg. .....
7. No. of Cocoons per litre .....
8. Percentage of yield .....
9. Percentage of loss .....
10. Percentage of mortality .....
11. Percentage of missing larvae .....
12. Types of Mountage used .....
13. Cocoons Test: Sex — No. — Pupal Wt. — Shell Wt. — Cocoon Wt. — Percentage of Silk

14. Percentage of floss — i) Female, ii) Male — Weight of floss — Percentage of floss with reference to Cocoons / Shell

15. Length of Silk Filament
    a) No. of Cocoons reeled — Weight ..... No. .....
    b) Average non-breakable Filament length ..... meters
    Weight of Filament ..... gms.
    d) Average length of filament ..... meters

16. Denier .....
17. Renditta .....
18. Single Cocoon weight — Single shell weight
    Female
    Male
    Average
    Special features if any .....

ANNEX - IV

IMPLEMENTS FOR T(BASICi$EED FARM

SI. No.	Implements	No.
1.	Mumties	20Nos.
2.	Crowbar	20 Nos.
3.	Bill Hooks	20 Nos.
4.	Zinc Pot	20 Nos.
5.	Koluguddali	20 Nos.
6.'	Guddeli	20 Nos.
7.	Prunir^g Saw	20 Nos.
8.	Water Can	15 Nos.
9.	Sickles	30 Nos.
10.	Weeding Sickles	30 Nos.
II.	Iron Pans	15 Nos.
12.	Digging Fork	10 Nos.
13.	Showels	10 Nos.
14.	Secateur	10 Nos.
15.	Garden Scissors	6 Nos.
16.	Diesel Pufnfi Set	2 Nos.
17.	Aspree Sprayer	2 Nos.
18.	Measuring Tape	I No.
19.	Bullock Cart	1 No.
20.	Tractor	I No.
21.	Bullocks	I pair
22.;	Wooden Trays	600 Nos.
23.	Bamboo Trays	600 Nos.
24.	Bamboo Mountages	600 Nos.
25.	Leaf Chamber	30 Nos.
26.	Hygrometer	12 Nos.
27.	Leaf Chopping Board	6 Nos.
28/	Leaf Chopping Knives	6 Nos.
19.	Ant Wells	250 Nos.
30.	Feeding Stands	15 Nos.
31.	FoKjt Cleaning Trays	4 Nos.
32.	W^sh Basin Stand	4 Nos.
33.	Power Sprayer for Disinfection , i,	1 No
34.	Disinfection Masks	3 Nos.
35.	• Gatotj Sprayer	1 No.

,ANNEX - y

STAFF PATTERN FOR P.BASIC SEED FARM

SI. No.	POSTS	No.
1.	Manager (Silkworm Breeder)	
2.	Assistant Manager	
3.	Rearing Assistants	3
4.	Kami Manager	I
5.	Dpper I)i\ision Clerk	I
6.	lechnical StafT	14
7.	Chowkidars	3
8.	Driver	I
9.	Peon	i

ANNEX — VI

REQUIREMENT OF EQUIPMENTS FOR REARING 100 DFLs OF PURE RACES

SI. No.	Particulars	No.
I	Bamboo Rearing Trays	40
2.	WoodenlRearine' irays	5
3.	Rearing Stands	4
4.	Leaf Chopping iCnives	2
5.	Ant Wells	16
6.	Leaf Chopping Board	1
7.	Hygrometer	I
8.	Bamboo Mountages	40
9.	Sprayer	1
10.	Leaf Chambers	2

ANNEX - VII

IEOIJIPMENTS FOR GRAINAGE OF CAPACITY OF 15 LAKH DFLs/ANNUM

SI. No.	Particulars	Nqi.
1.	Microscopes	15 Nos-
2.	Air conditioners	2 Nos.
3.	Diesel generator set	1 No .
4.	Acid treatment baths	2 Nos.
5.	Refrigerators	• 5 Nos.
6.	Moth examination tables	5 Nos.
7.	Moth crushing set electrically operated	1 No .
8.	Moth examination stools	10 Nos.
9.	Egg cabinets	5 Nos.
10.	Office furniture tables & chairs	20 Nos.
II.	Cellules	3,00,000 Nos
12.	Weighing balance	1 No .
13.	Plywood bottom trays	500 Nos.
14.	Bamboo trays	500 Nos.
15.	Long benches	10 Nos.
16.	Short benches	15 Nos.
17.	Hygrometers	10 Nos.
18.	Hydrometers	6 Nos.
19.	Ant wells	300 Nos.
20.	Moth preservation trays	80 Nos.
21.	Washing trays	80 Nos.
22.	Cocoion cutting machine	1 No .
23.	Mdrtars, pestles and pins	100 Nos.
24.	Del]ossing rod & machine	1 No .
25.	Humidifiers	*A* Nos.
26.	Incubators	2 Nos.
27.	Gator sprayer	- 1 No .
2H.	Room heaters	6 Nos.
29.	Disinfection masks	2 Nos.
30.	Wooden stands	50 Nos.
31.	Timer	6 Nos.
32.	Hot air oven	1 No .
33.	Centrifuge	1 No .
34.	Cyclo mixer	I No.

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