Improved Method of Rearing Young Age (Chawki) Silkworms

Dr. S. Krishnaswami

CENTRAL SILK BOARD

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I. INTRODUCTION

In the practice of sericulture, particularly in relation to silkworm rearing, a certain amount of risk is invariably experienced by sericulturists. At fairly frequent intervals, they face cocoon crop losses which may be either partial or total. Often these losses occur at the last stages after considerable amount of expenditure has been incurred by way of leaf utilised and labour engaged in silkworm rearing. This dampens the enthusiasm of the sericulturists. Repeated total crop losses may even ruin the economic stability of sericulturists, especially those who depend mainly on silkworm rearing for their livelihood. In these circumstances, they appear to be completely at a loss to know as to what had gone wrong with the rearings and what were the factors responsible for the large scale mortality of worms that led to such serious crop failures.

The risk to cocoon crop arises mainly from diseases that afflict the rearings. These fall under the four well-known categories namely the Pebrine, the Muscardine, the Grasserie and the Flacherie. In silkworm rearing, the best method of tackling them is by taking preventive steps since these steps are easy to carry out. Curative measures, on the other hand, are only effective in the case of some diseases like Muscardine. For diseases like Pebrine, Flacherie and Grasserie, effective curative measures are yet to be devised. However, all the four categories of diseases can be prevented, if the rearing is carried out according to scientific methods as described in Bulletin No. 2 of the Central Sericultural Research and Training Institute, Mysore, on the **New Technology of Silkworm Rearing.**

The Pebrine occurrence can be avoided by rearing disease free layings and adoption of systematic disinfection of rearing houses and the rearing appliances with formalin. Similarly, Muscardine can be prevented through manipulation of moisture in the rearing bed and maintaining it at optimum levels in different seasons. In the cases of Flacherie and Grasserie, however, the diseases can be prevented only by raising vigorous and healthy stock of the worms right from the beginning, starting with the brushing operations. Worms reared under situations that lead to underfeeding or conditions of excessive moisture will become easily susceptible to Grasserie and sometimes to Flacherie as well. It is in this context, rearing of young age worms becomes very significant. If and when a healthy and vigorous stock of young age worms is raised, it will show considerable resistance to these two diseases and no problems of mortality in the late ages will be met with.

II. CHAWKI REARING

The concept of **chawki** rearing is not new. In Japan, the importance of young age silkworm rearing to raise healthy stock has been fully appreciated. There, practically the entire quantity of eggs used for raising cocoon crops is first reared in fully equipped young age rearing centres specially organised for the purpose under expert technical supervision. Although the sericulturists place their indents for eggs in terms of boxes of eggs (one box containing about 20,000 eggs or 50 layings), the indents are supplied as worms after the second or third moult. Being very healthy, the worms spin successful cocoon crops when handled by the sericulturists in the late ages. This is a very important and significant factor that is mainly responsible for ensuring successful cocoon crops. Towards this end, very heavy financial investments have been made by way of suitable buildings, necessary land for mulberry and expert personnel to guide and conduct the work of young age rearing.

In India too, particularly in Karnataka State, **Chawki Rearing Centres** (CRCs) have been organised by the State Department of Sericulture since some time in the past, but so far, they have not made any perceptible impact on the subsequent rearings by sericulturists in regard to either yields or quality of the cocoon harvests. This has been mainly because of the limited facilities and technical guidance available to these **Chawki Rearing Centres**. Since recently, however, with the introduction of the Improved Technique of Silkworm Rearing in 1971 by the Central Sericultural Research and Training Institute, there has been a greater awareness as to the needs of suitable equipments such as rearing boxes or trays, paraffin paper, foam rubber etc. While, no doubt, this is showing some improved results in the field now, full benefits from scientific methods of young age rearings are yet to be realised. It is, therefore, intended that this bulletin will provide the necessary technical guidance to all the **Chawki Rearing Centres** and also the sericulturists at large in their **chawki** rearing work. The need for this bulletin is specially significant in the context of the Intensive Sericulture Development Programme just launched by the Departments of Sericulture in Karnataka, Andhra Pradesh and Tamil Nadu under the Central sponsorship of the Central Silk Board, Government of India.

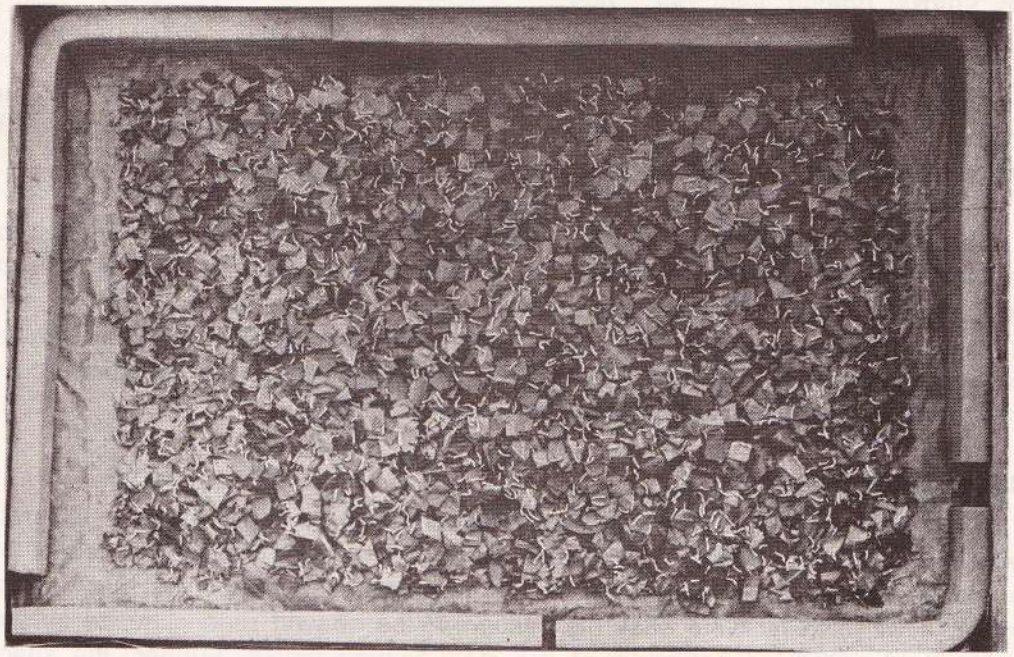
The technical details of the scientific method of young age silkworm rearing are described below:—

A. Equipments:

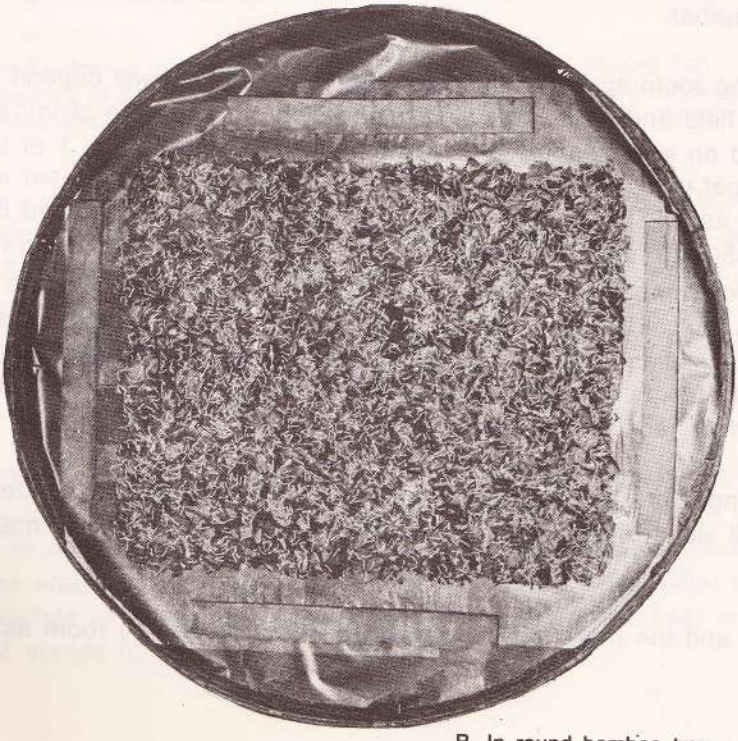
The **chawki** rearing can be carried out in ordinary rearing trays like the bamboo **'thattes'** or wooden trays, but the latter are preferred, since they are more convenient to maintain humidity and also for handling. The bamboo trays may be of 3′ diameter. The wooden trays should be of convenient size so that one person can handle it easily. It may of the measurement of 3′×2′×3″ in height, as shown in Figure 1.

For every 100 disease free layings, ten wooden trays of size 3′×2′×3″ are required, and so, for an acre of mulberry garden under irrigation, which can brush upto

Figure 1 — Rearing of chawki silkworms



A. In wooden tray



B. In round bamboo tray

250–300 layings at a time, 25 to 30 trays will be required to do the **chawki** rearing. In the case of dry garden, the requirement will be about 10 trays which will suffice to do the **chawki** rearing, upto 100 layings at a time.

In addition to trays, stands or racks are also required so that the trays containing worms which are normally kept piled up one over the other, may be spread out on the stands for short periods for necessary drying of the beds prior to each feeding. A bench is also required which is used as the base for piling up the trays.

The rearing stands meant for normal rearing of late age worms may be used for spreading the trays for drying purposes. In the case of Government owned or assisted **chawki** rearing centres or community **chawki** rearing centres, where a large quantity of eggs is brushed for young age rearing and distribution of **chawki** worms to the sericulturists later, it is important that they are properly equipped as indicated above to ensure efficient working and production of good results.

B. Rearing Room Space:

If one can afford, it is always desirable and convenient to have a separate **chawki** rearing room or house, so that chances of contamination from the debris of the main rearing house, where the diseases normally manifest themselves, are kept at minimum. It will also facilitate easy disinfection of the **chawki** rearing house as and when required, quite independently of the main rearing house. Further, the space required for young age rearing being comparatively smaller and limited, the desired temperature level for the young age worms could be easily attained and maintained even in cold weather.

The rearing room space required for young age rearing will depend on the area of the mulberry field and its leaf yielding capacity. From one acre of irrigated garden, that is cultivated on scientific lines as recommended in Bulletin No. 1 of the Institute, it is possible to get upto 10 to 12 thousand kg. of quality leaf per acre per annum. With these, as many as 1,250 to 1,400 layings can be reared, the leaf used being at the rate of 800 to 850 kg. for every 100 layings as recommended in Bulletin No. 2 of the Institute. This would mean that on an average 250 to 300 layings can be reared at a time per rearing, out of the five rearings in all that can be taken from an acre. On the basis of above reckoning, **chawki** room space required for an acre of irrigated mulberry garden is about 10′×12′ or 120 sq. ft. which is needed to accommodate about 30 trays, one stand or rack and a bench.

The rearing room should have optimum sized windows with shutters provided, preferably on all sides of the room, so that inside ventilation could be manipulated as required.

The rack and the trays may be arranged in the (10′×12′) room as indicated in Figure 2.

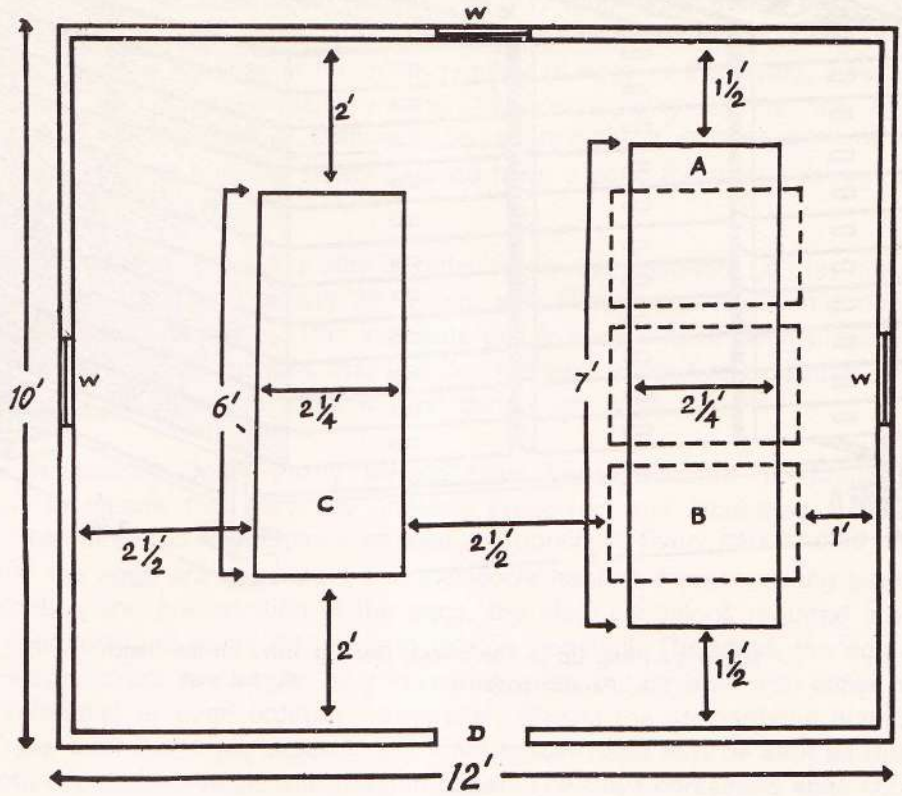


Figure 2 – Rearing Room Space and Arrangement of chawki Rearing Trays, Stand and Bench.
A. Rack: 7′ × 2¼′ × 7½′ tall (10 tiers) B. Tray: 3′×2′×3″ height
C. Bench: 6′×2¼′×1′ tall D. Door W. Window

The trays numbering about 30 can be arranged one over the other upto 10 tray height in blocks on the bench, the legs of which are mounted on ant-wells as shown in Figure 3. In fact, the bench can accommodate upto 45 trays, *i.e.,* to a height of 15 trays in each block. In that case, upto 450 layings at a time can be reared in this 10′×12′ room and therefore, this room space can manage even upto 1½ acres of irrigated mulberry. However, even for one acre, this much room will be found necessary.

Similarly, corresponding to the increased brushing capacity, there will be corresponding reduction in space required per unit of layings brushed. What is important to remember in this respect is that sufficient space should be provided for trays to be arranged in blocks upto a height of 10–15 trays, piled one over the other on the benches (with adequate spacing in between the benches) and for the required number of stands to be placed inside.

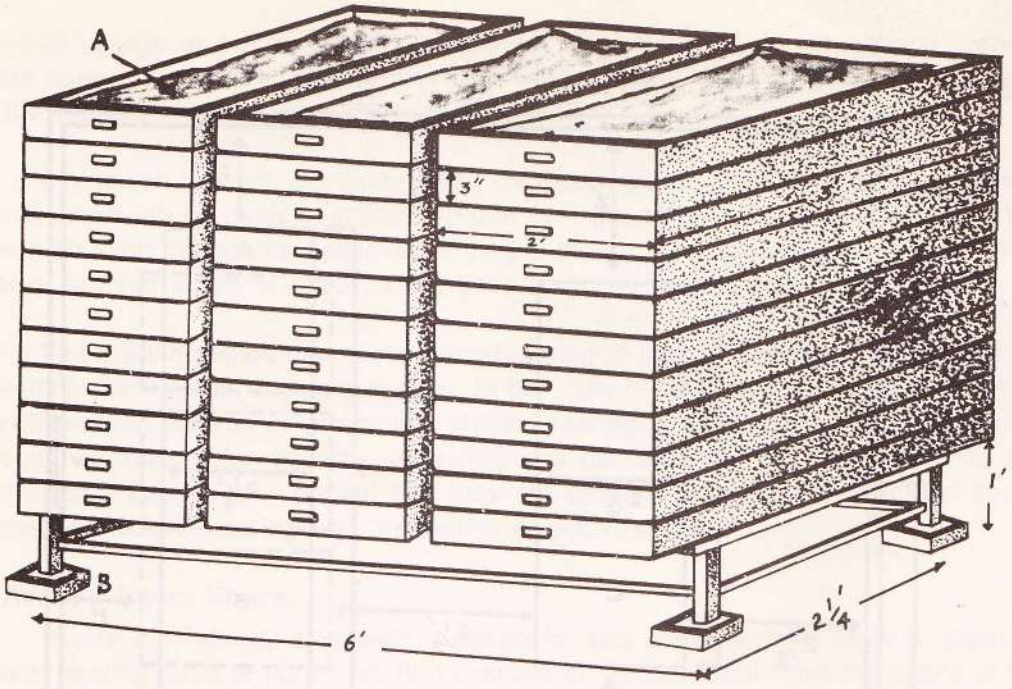


Figure 3 – Piling Up of The chawki Rearing Trays on the Bench.
A. Paraffin paper. B. Ant well.

A **chawki** rearing room of 10′×12′ dimension can command upto 4–5 acres at a time in the case of dry mulberry gardens, since the leaf yield even under the improved methods of cultivation is only about a quarter of that of the irrigated garden.

If a separate **chawki** room cannot be afforded by any sericulturist, he may still carry out his **chawki** rearing in any suitable place in his dwelling house, where the temperature fluctuation should be as low as possible and where it would be possible to raise and maintain temperature at the required level, particularly during the cold weather.

C. Preparation for Brushing:

As described in Bulletin No. 2 entitled "New Technology of Silkworm Rearing", the rearing of young age silkworms should be commenced only after due disinfection of the rearing house or the room and all the rearing appliances with 2 per cent Formalin solution.

D. The Egg:

It need hardly be emphasised that the quality of eggs to be used in rearing is a very important factor determining the success of rearing. Good quality eggs, free from diseases, ensure bumper yields of quality cocoons, that fetch good prices. They are characterised by the richness in regard to number of eggs in the laying, which should contain about 400 eggs normally. Further, in good quality layings, the eggs are generally bold, plump-looking, containing comparatively a greater amount of yolk material. This helps to give the newly hatched larva a good initial start in regard to its health, vigour and growth.

A further index of good quality is reflected by the uniformly rich layings on the egg sheets, which contain normally 20 layings, with minimum of rejection due to either poor egg number or diseases. This indicates that the eggs have been prepared from a batch of healthy seed cocoons that has been reared without any disease afflictions and therefore, can ensure for healthy next generation eggs.

(i) *Incubation:* Once quality layings have been procured, it should be the endeavour to ensure that they are properly preserved and incubated so that best results of hatching and final cocoon harvest are obtained. Every care should be taken to see that the eggs are not exposed to excessive heat or dryness during transit. For safe protection and preservation of the eggs, the ideal conditions required are about 25°C temperature and about 80 per cent relative humidity. Therefore, the egg sheets should be spread out in a single layer in rearing trays and covered with either paraffin paper (preferably) or even ordinary newspaper. Should the atmospheric humidity fall below 70 per cent R.H., wet paper or wet foam rubber band may be kept all round the egg sheets and then covered with paraffin paper. The trays containing eggs should be stored in as cool a place as possible in the dwelling house or rearing house, where the atmospheric temperature fluctuation is minimum.

When eggs are incubated as described above, the development of the embryos takes place uniformly and very uniform hatching of eggs will result. During incubation, it is very important to remember that eggs should not get affected due to desiccation resulting from low atmospheric humidity. Therefore, every care should be taken to maintain humidity around 80 per cent.

(ii) *Black boxing of eggs:* In order to ensure that hatching of eggs upto 90 to 95 per cent takes place at a time, **'black boxing of eggs'** may be resorted to as a very useful step. This may be followed as described below:

About 48 hours before hatching, the embryo reaches the 'Pin head' stage and about 24 hours prior to hatching, it attains the 'Blue egg' stage. During this period, the egg sheets should be put into convenient card board box or wooden box and wrapped up in either black piece of cloth or black sheet of paper. Then they should be left undisturbed for 48 hours or 24 hours depending on the stage of development at which 'black boxing' was resorted to. This will enable practically all the developing embryos to attain full and uniform growth without hatching.

On the expected date of hatching, (which is normally between 9 to 12 days after egg laying, depending on the seasonal temperature conditions), as indicated by the presence of a few hatched larvae on the egg cards, the 'black boxed eggs' should be exposed suddenly to bright day light between 8 a.m. and 9 a.m. The photo stimulus thus provided will ensure over 90 to 95 per cent hatching in about one to two hours time.

(iii) *Brushing:* Immediately after the young worms hatch out of the egg sheets to an extent of more than 90 per cent, which should normally be achieved within about one to two hours or so, the newly hatched worms should be fed and brushed on to the rearing beds. As the hatched worms start dispersing from the egg sheet, they should be sprinkled over with freshly chopped tender leaves cut into bits of 0·5 to 1 cm. squares. After all the hatched larvae have crawled on to the chopped leaves, the leaves alongwith the larvae should be gently brushed into the rearing tray with the help of a feather. The few larvae left over on the egg sheets may be dislodged from the sheets to the rearing bed by gently tapping the sheets. It is important to remember that the newly hatched worms should not be starved for unduly long periods, which will result in the worms getting weakened due to starvation.

Soon after brushing, the rearing bed should be made up, if necessary by giving some more chopped leaf and covered with paraffin paper. When the atmospheric humidity is low (say below 70%), wet paper or wet foam rubber band should be invariably kept around the rearing bed to provide necessary humidity required by the young worms.

E. Quality of Leaf:

It need hardly be emphasised that the main object of taking special efforts to do the **chawki** rearing is to raise robust, healthy and vigorously growing stock of young age worms so that they may not easily succumb to adverse climatic and other disease factors in the late ages, but ensure a high effective rate of rearing, resulting in bumper harvest of cocoons. This can be achieved only by feeding the young age worms with highly nutritious leaves in adequate quantities and at suitable intervals of time. Researches carried out in this regard have established that the top two to three full blown leaves immediately below the growing bud, are highly nutritious from the point of view of growth requirements of the young silkworm larvae, since they are comparatively richer in proteins, soluble sugars and carbohydrates, which are essential for vigorous growth of silkworms. Such quality leaves are tender, succulent and dark green in colour, with a pleasing shine on them. These should be plucked and fed in as fresh a state as possible after due chopping, to commence the rearing and also continue with the first age worm rearing. As the worms grow, progressively less and less tender leaves should be used for feeding them.

Quality leaves as described above can be had only from mulberry fields that are cultivated according to improved methods recommended in Bulletin No. 1 of the

Institute. The mulberry fields should receive adequate quantities of manures and fertilisers and irrigation where required. In advanced countries like Japan, special mulberry gardens are raised for **chawki** rearing purposes.

(i) *Chopping of Leaves:* Since the worms in the young ages are tiny in size, necessarily chopped leaves have to be used to feed them so that the leaves could be spread uniformly over the worms in the bed and the worms also can have ready and easy access to the leaves. It also assists in loosening and spreading the bed when the bed is required to be dried prior to feeding and also at the time of moulting. The traditional practice is to cut the leaves rather too finely into almost shreds of leaves. Such finely shreded leaves tend to dry too fast, necessitating too many feeds and at too frequent intervals. Therefore, this practice should be given up. If the leaves are chopped into too big pieces or used as entire leaves without chopping, the larvae tend to get over-crowded in localised spots which again is not desirable for free and full growth of larvae. It is, therefore, important that the leaves should be cut to optimum size at every stage of the growth of the worms.

To start with, the chopping should be fine to obtain pieces of 0·5 to 1 cm. squares which can be gradually raised to 1·5 to 2 cm. squares by the end of first instar *i.e.,* over a period of 3 to 3½ days. Similarly in the second age, the leaf size is started as 2 cm. squares and increased to 3 to 4 cm. squares by the end of the second instar. Towards the close of every instar, *i.e.* just prior to the worms entering into moult, one or two feeds are given as final cover feed for the instar and these are invariably given with slightly reduced size leaves, *i,e.,* about 1 cm. squares for the first instar and about 1½ to 2 cm. squares for the second instar.

(ii) *Preservation of Leaves:* As already emphasised in Bulletin No. 2 of the Institute of the New Technology of Silkworm Rearing, preservation of leaf, following plucking, in as fresh a state as possible till it is fed to worms and consumed by them, is a very essential requirement to ensure successful crops. This applies with greater emphasis for the **chawki** rearing stage as well. Tender leaves plucked from the garden should be brought to the rearing house in covered containers like baskets or covered in wet gunny cloth. Leaves should be plucked invariably during the cooler hours of the day, either early in the morning or late in the evening and immediately preserved in suitable containers like leaf bins, where the humidity must be maintained close to 100 per cent R.H. by repeated sprinkling or spraying of water over the gunny or cloth surface of the container. If containers are not available, they should be atleast covered with wet cotton cloth or gunny cloth. The cloth used to cover leaves should be clean as far as possible.

Although leaf preservation may be adopted systematically as recommended here, quite often sufficient care is not bestowed to maintain the freshness of leaves at the time of chopping of leaves. The leaves are left exposed due to negligence either prior to chopping or following chopping with the result the leaf loses moisture and consequently, the freshness and quality. The chopped leaves which are cut small for

feeding the **chawki** stages dry rather quickly, if left exposed. Therefore, the chopped leaves should be collected in plastic or metallic basins or buckets and should be kept covered. Proper preservation of chopped leaves is also highly essential and every care should be paid to this important aspect.

During the rainy seasons, however, the leaves are replete with excessive moisture. Similarly, the atmospheric humidity is also comparatively higher, and therefore, the drying of leaves due to exposure does not present much of a problem of preservation. Hence, the special care required to preserve the freshness of leaves during normal seasons or summer season may not be found necessary. On the other hand, if the leaves are wet with droplets of rain water physically present on the surface of leaves, they may have to be spread out in thin layers, so that the excess moisture present on the surface may evaporate away.

F. Ecological Requirements of Environment:

It has been scientifically established that early instars of silkworms show best growth under ideal conditions of temperature around 27°C and relative humidity around 90 per cent. Therefore, in order to procure best growth and consequently a robust batch of young age worms, rearings should be conducted in environmental conditions as close as possible to the above ideal. By environment, the immediate vicinity of the worms is meant, *i.e.*, the rearing bed environment. The requirements of environment can be achieved to a large extent by resorting to young age worm rearing in suitable container trays. Wooden trays measuring 3′ × 2′ and 3″ in height are suitable for the purpose.

The required humidity is secured by rearing the young age worms in between paraffin papers which are used as base for the rearing bed at the bottom of the tray and as a cover over the rearing bed. When the atmospheric humidity fall low, say below 70 per cent, wet paper or wet foam rubber bands should be placed around the rearing bed in between paraffin papers to increase the humidity of the rearing bed. As a further precaution to maintain optimum humidity and temperature, the rearing trays are piled one over the other upto a convenient height (10 to 15 trays) as shown in Figure 3. The top-most tray should be a dummy trav without the worms.

During rainy seasons, however, the atmospheric humidity will be high and so also the moisture content in the leaves. Therefore, quick withering of leaf is not experienced. On the other hand, these factors will tend to increase the bed humidity beyond 90 per cent. Under such circumstance, it will not be necessary to use paraffin paper at the bottom of the rearing bed or the wet paper or wet foam rubber bands between the paraffin papers. Should the humidity be close to 100 per cent (as during days of continuous rain), the piling of the trays one over the other may also be dispensed with. It may be found even desirable to delay the covering of the rearing bed with paraffin paper for some time (about 15 to 30 minutes) after feeding, so that some of the excessive moisture present in the leaf could evaporate.

Thus, it is important to ensure that the bed humidity is kept between 80–90 per cent and for this, necessary manipulation, as indicated above, is very essential. Otherwise, disease problems are bound to arise. If the bed humidity is high—beyond 90 per cent, the worms will automatically become susceptible to Grassarie as well as Muscardine diseases. And, if the humidity falls below 80 per cent, the leaves will tend to dry fast, leading to undernourishment and the resultant weakening of worms, as indicated by slow growth and prolonged larval instar, inspite of optimum temperature conditions.

The temperature of the room should be maintained at about 27°C by suitably manipulating the doors and windows of the room during different parts of the day and allowing better aeration of the room when the temperature and humidity go beyond the tolerance limit as indicated in Bulletin No. 2 of the Institute. When the temperature falls below 25°C, the rearing room should be artificially heated using an electric heater or a smokeless charcoal fire inside the room so as to bring up the temperature to the level of 27°C.

The maintenance of humidity and temperature as indicated above will ensure fast and vigorous growth of the worms uniformly.

G. Spacing:

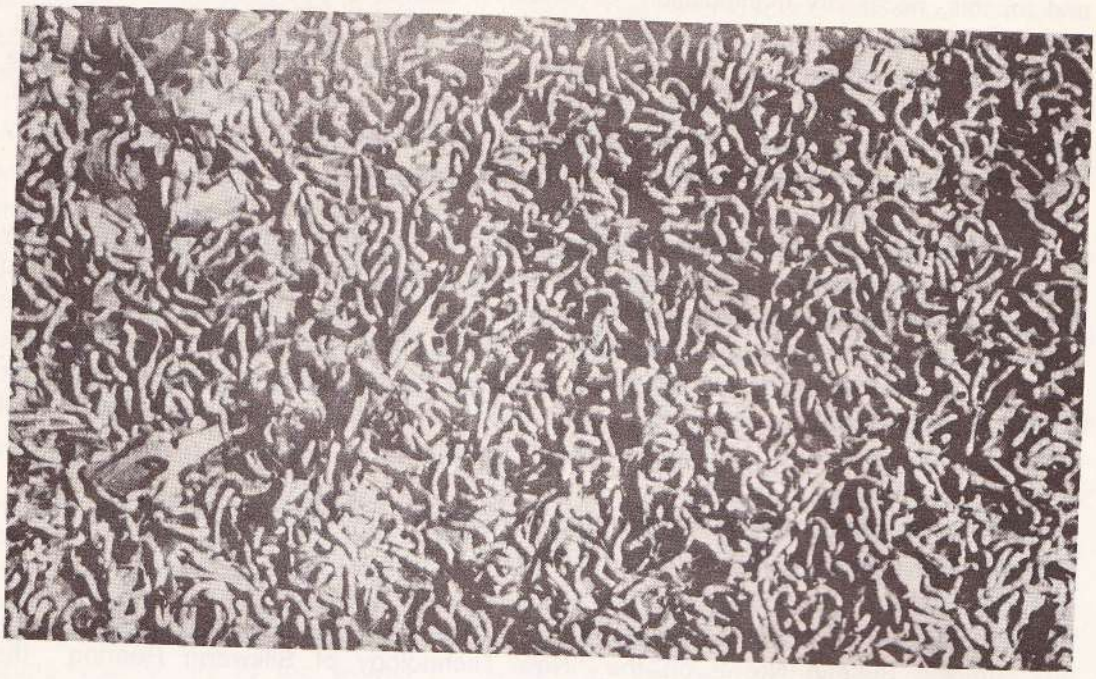
In the Bulletin No. 2 on the "New Technology of Silkworm Rearing", the importance of optimum spacing of the worms in rearing beds has been adequately stressed. This constitutes an essential technical consideration for successful harvest of bumper cocoon crops. This applies with greater emphasis to the rearing of young age silkworms. Through optimum spacing at every stage of rearing, starting from brushing of the worms, vigorous growth, robust health and uniform development of the entire batch of worms are ensured (as shown in Figure 4).

Experimental studies in this regard have established that the optimum spacing for young age worms in their first two instars is as follows for 100 layings which contain an average of 400 eggs per laying:

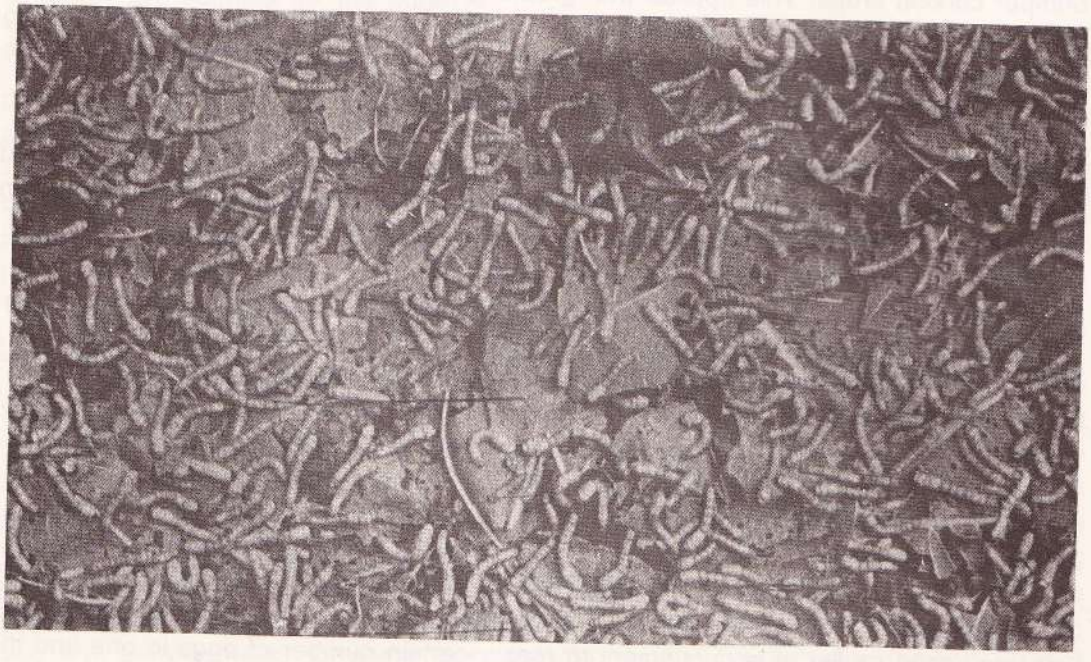
Age of the worm	Area of the rearing bed		Increase in spacing during the instar
	At the beginning	At the end	
I	4 sq. ft	14 sq. ft	3½ times
II	15 sq. ft	45 sq. ft	3 times

In actual practice where 3′×2′×3″ trays are used for **chawki** rearing, as recommended earlier, it is convenient to rear a certain number of eggs in one and the same tray till the second moult is passed. Therefore, 100 layings should be brushed in 10 trays at the rate of 10 layings per tray (measuring 3′×2′×3″). In that case, the spacing to be adopted in each tray will be as described further.

Figure 4 – Spacing of Chawki Silkworms in the Rearing Bed



A. Overcrowded



B. Optimum

1st Instar	Area of the bed
At the time of brushing	6″× 9″
At the end of 24 hrs. (1 day)	9″×12″
At the end of 48 hrs. (2 days)	12″×12″
At the end of 72 hrs. (3 days)	12″×18″

(In the next 12 hrs., the worms will settle for first moult—Figures 5 & 6)

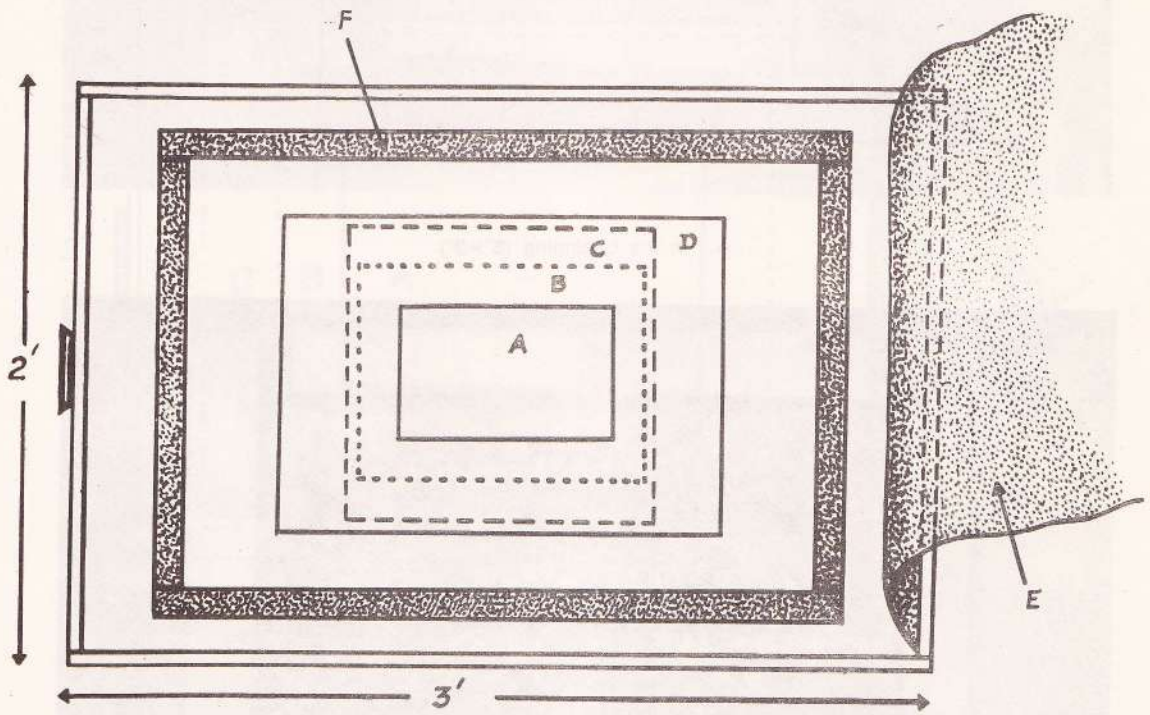
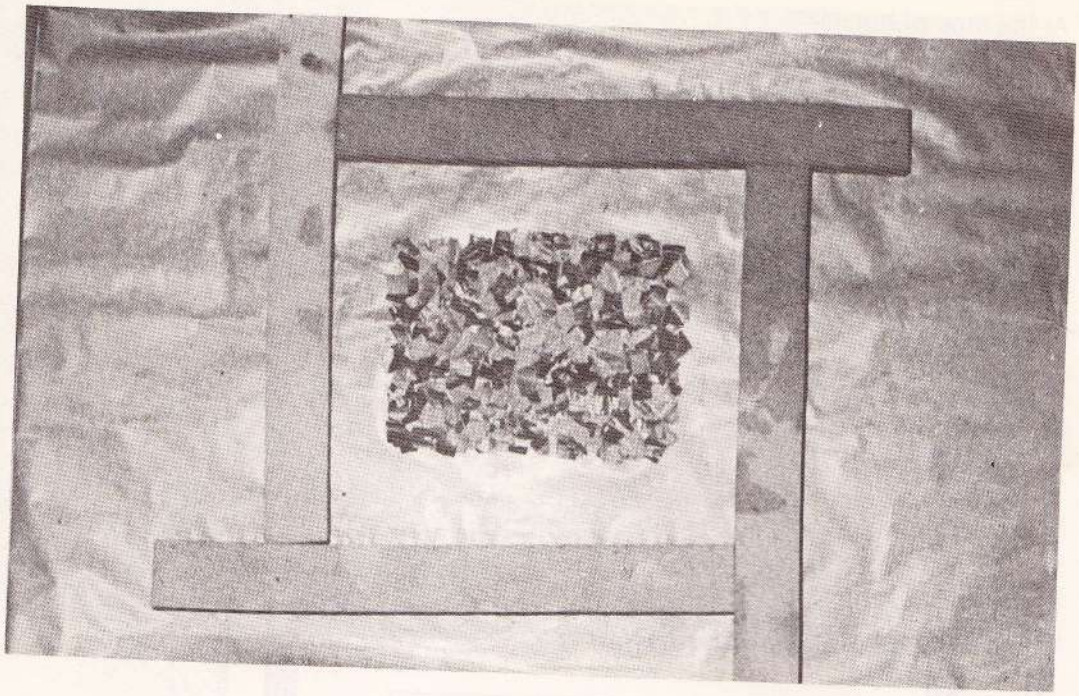


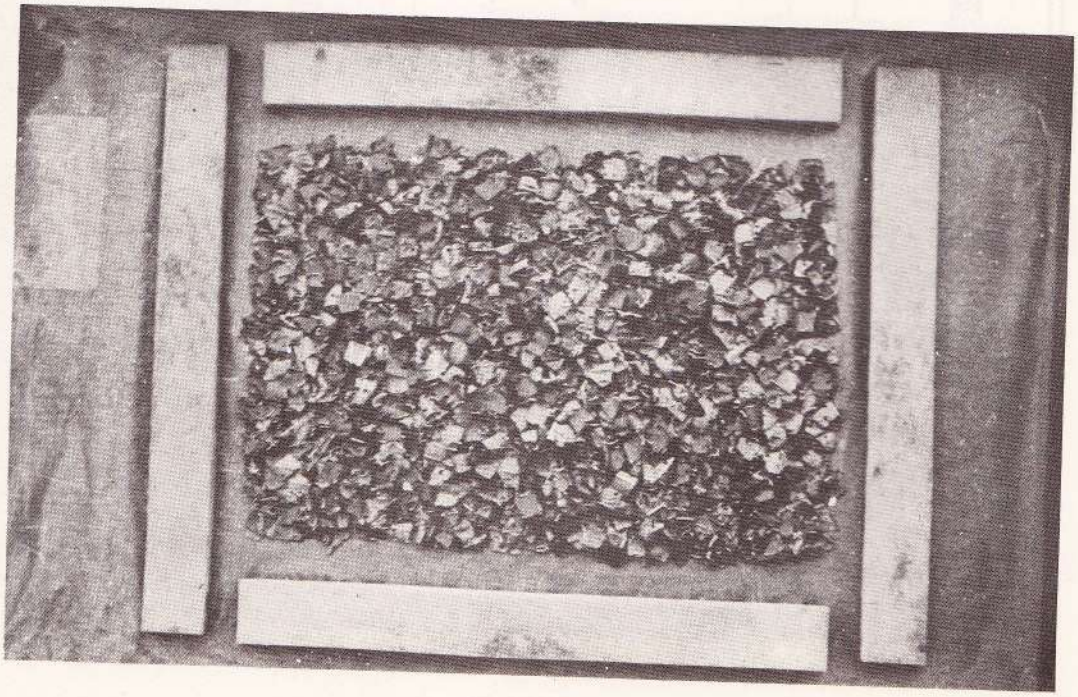
Figure 5 – Spacing for First Age Worms

A. At the time of brushing (6″×9″)
B. At the end of 24 hours (9″×12″)
C. At the end of 48 hours (12″×12″)
D. At the end of 72 hours (12″×18″)
E. Paraffin paper
F. Foam rubber band

Figure 6 – Optimum Spacing for First Age Worms in (3′×2′×3″) Wooden Tray (10 Layings per Tray)

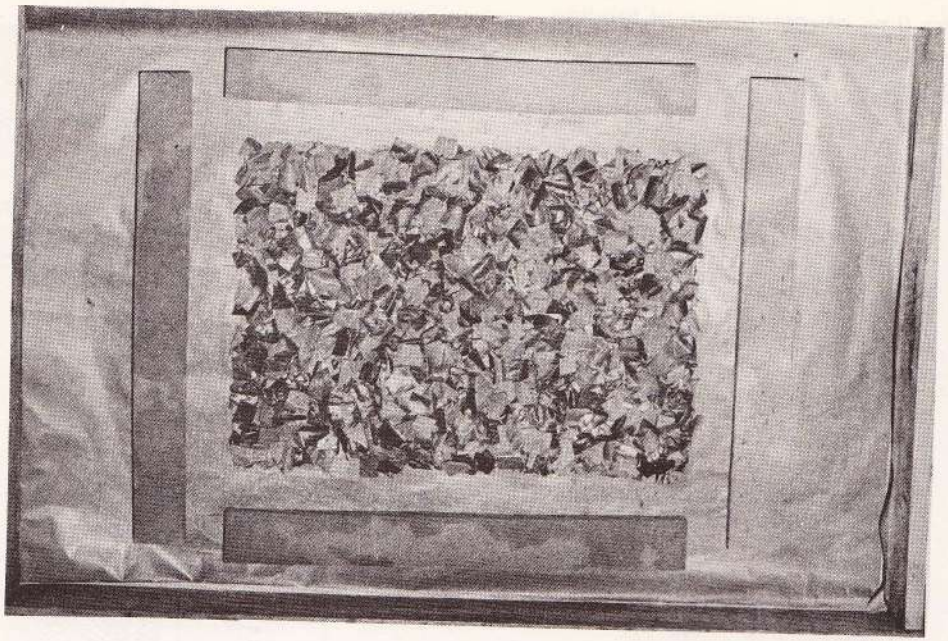


A. In the beginning (6″×9″)



B. At the end (12″×18″)

Figure 8 — Optimum Spacing for Second Age Worms in Wooden Trays.



A. In the beginning (1′ × 1½′).

B. At the end (1¾′ × 2½′)

Some people are already using wooden trays of size 4′×3′×4″. In such large size trays, only 25 layings should be brushed per tray, for rearing the worms upto second moult. In other words, 100 disease free layings containing about 40,000 eggs should be brushed in four trays and not in one or two trays as hitherto being practised. In such cases, using 25 layings per tray, the spacing to be adopted will be as follows:

1st Instar	**Area of the bed**
At the time of brushing	12″×12″ or 1′×1′
At the end of 24 hrs. (1 day)	15″×18″ or 1¼′×1½′
At the end of 48 hrs. (2 days)	18″×21″ or 1½′×1¾′
At the end of 72 hrs. (3 days)	18″×30″ or 1½′×2½′

(In the next 12 hrs., the worms will settle for first moult)

2nd Instar	**Area of the bed**
At the time of resumption of feeding	18″×30″ or 1½′×2½′
At the end of 24 hrs. (1 day)	30″×36″ or 2½′×3′
At the end of 48 hrs. (2 days)	36″×45″ or 3′×3¾′

(In the next 12 hrs., the worms will settle for second moult—Figures 7 & 8)

Those who cannot afford wooden trays and who would like to use bamboo round **thattes** of 3′ diameter may brush upto 15 layings per tray and adopt spacing as indicated below:

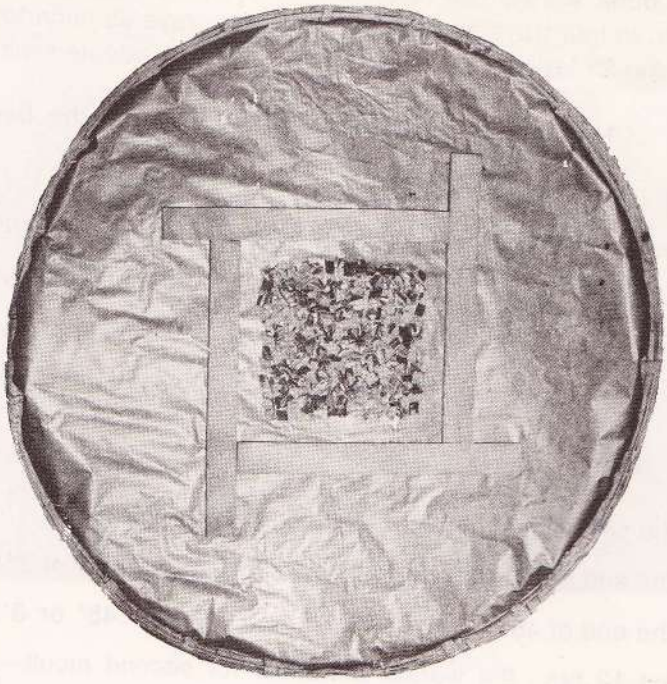
1st Instar	**Area of the bed**
At the time of brushing	9″×9″ or ¾′×¾′
At the end of 24 hrs. (1 day)	12″×12″ or 1′×1′
At the end of 48 hrs. (2 days)	15″×15″ or 1¼′×1¼′
At the end of 72 hrs. (3 days)	18″×18″ or 1½′×1½′

(In the next 12 hrs., the worms will settle for first moult—Figure 9)

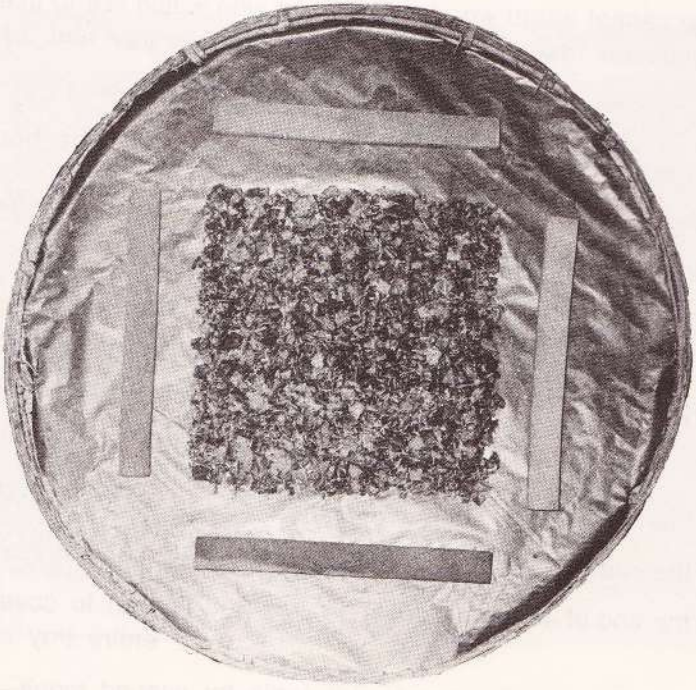
2nd Instar	**Area of the bed**
At the time of resumption of feeding	18″×18″ or 1½′×1½′
At the end of 24 hrs. (1 day)	24″×27″ or 2′×2¼′
At the end of 48 hrs. (2 days)	Spread to cover the entire tray area

(In the next 12 hrs., the worms will settle for second moult—Figure 10)

Figure 9 — Optimum Spacing for First Age Worms in Round Bamboo Trays. (3' Diameter) (15 Layings Per Tray)

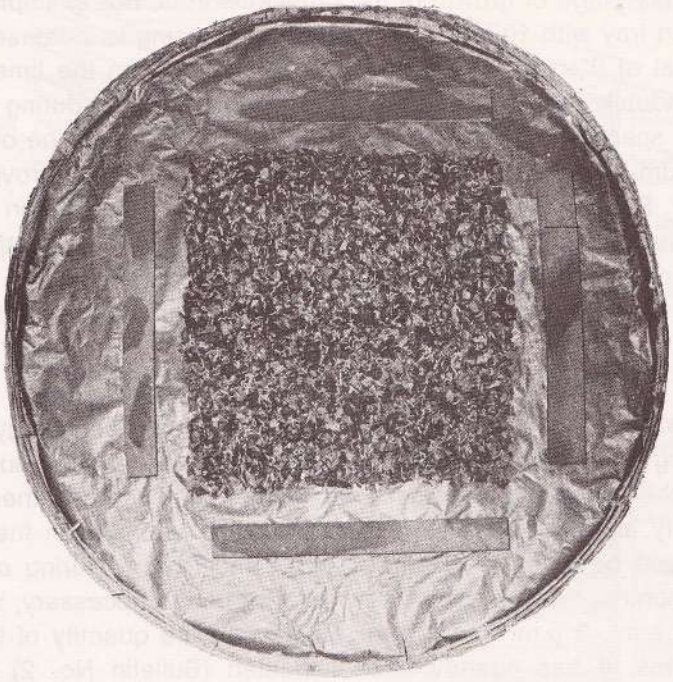


A. In the beginning (9" ×9").

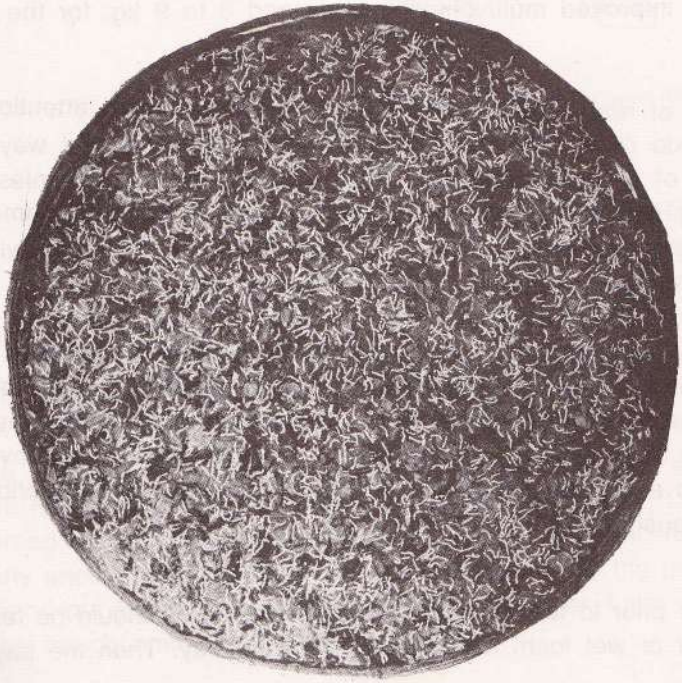


B. At the end (18" ×18")

Figure 10 — Optimum Spacing for Second Age Worms in Round Bamboo Trays.



A. In the beginning (18″ × 18″).



B. At the end (Full Tray).

It may be seen from the above that spacing' is required to be increased systematically at every stage of growth of the **chawki** worms. For example, in the case of 3′×2′×3″ wooden tray with 10 layings brushed, the spacing is increased from a bed size of 6″×9″ to that of 9″×12″ over a period of 24 hours from the time of brushing. This is achieved gradually by increasing the spacing at every feed during the 24 hours. period. In this way, spacing is increased every day of the rearing. The object in doing so is to ensure maximum development of all the larvae uniformly by providing required space as they grow. Further, it helps to keep the bed thin (*i.e.,* less than ½″ in height) and this assists in the drying of beds prior to every feeding. It is well to remember here that thick beds, which cannot be dried easily and which tend to build up bed humidity beyond 90 per cent will lead to the outbreak of Muscardine and Grasserie diseases.

H. Feeding:

As already pointed out in Bulletin No. 2 on the 'New Technology of Silkworm Rearing', the young age silkworms are fed thrice or four times during the day depending upon the seasonal weather conditions. In wet weather, when the atmospheric humidity as well as moisture content in the leaf are on the higher side, only three feeds need be given at 6 a.m. 1 p.m. and 8 p.m. During other seasons including summer months, however, four feeds may be found necessary, which may be given at 6 a.m., 11 a.m., 3 p.m. and 8 p.m. As regards the quantity of leaf to be fed to the **chawki** worms, it has already been indicated (Bulletin No. 2) that the leaf requirement for 100 layings (with average of 400 eggs per laying) during the first age will be about 2 to 2·5 kg. for the improved multivoltine hybrids and about 2·5 to 3 kg. for the new bivoltine hybrids. For the second age worms, the leaf requirement will be 6 to 7 kg. for the improved multivoltine hybrids and 8 to 9 kg. for the new bivoltine hybrids.

In the case of rearing of **chawki** worms, great care and attention have to be given to the method of feeding as well, in addition to the correct way of chopping, optimum quantity of feed, number of feedings to be given etc. Unless the correct method of feeding is adopted, the objectives of **chawki** rearing, namely raising of vigorously growing larvae of robust health and uniform development will not be fully realised. The correct method of feeding is described below:

Immediately after brushing, the rearing bed is made up, with due spacing prescribed (as already described) and covered with paraffin paper. If required, the wet paper or wet foam rubber band is placed around the rearing bed in between the paraffin paper sheets. The trays are later piled up one over the other to a convenient height. Thereafter, prior to every feeding that is to follow, the procedure described hereunder should be meticulously adopted.

Half an hour prior to feeding, the paraffin paper cover should be removed and so also the wet paper or wet foam rubber band from the tray. Then the tray is placed on

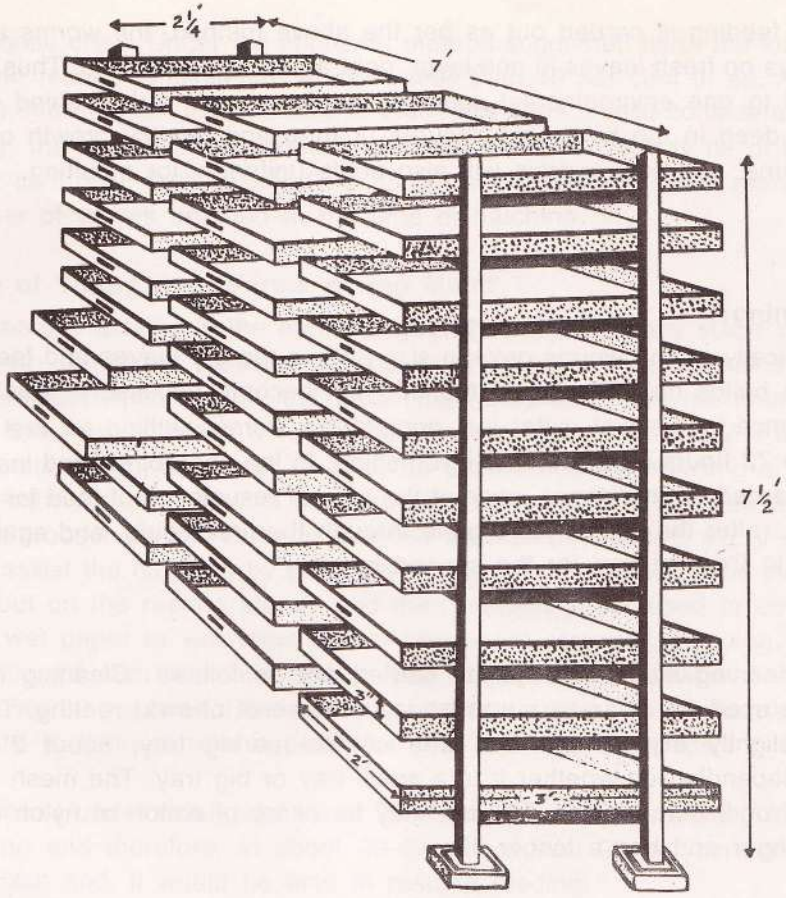


Figure 11 – Arrangement of Chawki Rearing Trays on the Stand (Rack)

the rearing racks or stands (as shown in Figure 11) so that the bed along with the unconsumed leaves may dry sufficiently. If need be, the bed may even be slightly opened up by spreading the chopped leaves in the bed further with the help of feathers to facilitate quick drying of the bed. In about half an hour's time, the entire bed would have almost dried. The young worms are also enabled to drive out excessive moisture from their body. After the bed is dried alongwith the unconsumed bits of leaves present, feeding with fresh chopped leaves is resumed. At that time, it should be ensured that the worms are uniformly distributed over the bed area. If worms are overcrowded in spots, they are removed with the leaf and redistributed uniformly. Later fresh chopped leaves are spread thinly (not more than one or two layers in thickness) over the dried bed without any uncovered gap. Then the bed is made up to the prescribed area, wet foam rubber band put around and closed with paraffin paper. Later the trays are finally piled up on the bench one over the other.

When feeding is carried out as per the above method, the worms are enabled to feed always on fresh leaves in one layer, right at the top of the bed. Thus, the worms are exposed to one environmental condition, and no worm lurks behind or feeds at lower levels deep in the bed. This ensures uniform and healthy growth of the entire batch of worms, and such worms will also settle uniformly for moulting.

I. Bed Cleaning:

Periodically as the worms grow in size and as the dry leaves and faecal matter accumulation builds up, cleaning of the bed will become necessary. This is usually carried out once in the first instar just prior to the worms settling for first moult, say around 60 to 72 hours from the time of brushing. In the case of second instar the bed cleaning is carried out two times, once at the time of resumption of feed for the second instar larvae, (after the worms have gone through the first moult), and again about 12 hours prior to their settling for the second moult.

Bed cleaning should always be carried out as follows: Cleaning nets should invariably be used for cleaning purposes in the case of **chawki** rearing. The net size should be slightly bigger than the area of the rearing tray, about $2\frac{1}{2}' \times 3\frac{1}{2}'$ or $3\frac{1}{2}' \times 4\frac{1}{2}'$, depending on whether it is a small tray or big tray. The mesh size should be about $\frac{1}{3}''$ or 8 mm. square. The net may be either of cotton or nylon thread. The latter is stronger and has a longer life.

When it is intended to carry out bed cleaning, the net is uniformly spread on the rearing bed just prior to feeding. Over the net, the chopped leaves are fed and again covered as usual. About 2 hours after giving the subsequent feed over the net, which is done normally in 5 to 6 hours time, the net alongwith the feed and the worms are removed carefully with the net fully stretched and placed on to a new tray. When next cleaning becomes due, another net is used once again over the one already in use. Thus, through the use of net for cleaning, handling of worms by hand is completely avoided and chances of contamination from diseases greatly reduced. Again by this method of cleaning, almost the entire batch of larvae can be successfully transferred from the old bed to the new bed without any serious loss of the worms during the cleaning process.

It must be remembered in this connection that heavy loss of worms occurs during the moulting process and the cleaning operations under the traditional system of **chawki** rearing, amounting to over 25–30 per cent of the hatched worms. Further, loss due to mortality in later ages will also be higher, the total loss amounting to over

50 per cent quite often. Under the improved method suggested here, the loss of worms during **chawki** rearing is minimum, which is less than 10 per cent or so. Again, these worms being more robust, the mortality at their later ages is also considerably less and consequently, the total loss of worms is also minimum, which may be of the order of 15 to 20 per cent only, thus ensuring 80–85 per cent effective rate of rearing from the actual number of worms brushed at the time of hatching.

J. Handling of Young Age Worms during Moult:

As already indicated in the earlier Bulletin (No. 2), the early stage worms show vigorous growth, if they are provided with optimum temperature and humidity conditions and also necessary spacing and leaf feed. Then they will attain maximum growth in minimum of time and will take 3 to 3½ days in the first instar and 2½ to 3 days in the second instar to go into moult. In order to ensure uniform moulting of the worms, settling of worms for moult should be anticipated and carefully watched for. As signs of moulting are observed and as soon as a few worms have settled, every effort should be made to assist the moulting by gradually drying the rearing bed. The piled up trays are spread out on the rearing stands and then paraffin paper used to cover the bed as also the wet paper or wet foam rubber bands are removed. Feeding, however, is continued with reduced quantities and in later stages with somewhat finely chopped leaves until over 90 per cent of the worms settle for moulting. This is normally achieved within about 6 to 8 hours over a period of next two or three feeds.

The worms under moult take about 20 hours to complete moulting from the time of last feeding and therefore, in about 20–24 hours over 90 per cent of the worms would come out and, it would be time to resume feeding.

It need be hardly emphasised here that worms in moult should not be disturbed at all and that there should be adequate ventilation during moulting.

The first feed, after the worms come out of the moult, is given only when over 90 per cent have come out of the moult. It is always carried out over the net and the cleaning of the bed is followed within 2 hours of the second feed. By this time, practically all the worms would have crawled on to the new feed over the net and hardly any worm will be left behind. If their number is small, these larvae may be rejected, if they are more than 5 per cent they may be separately collected by repeating the net feeding after some time. The first one or two feeds are invariably given with comparatively more tender leaves than the one normally meant for the age.

K. Issue of Young Age Worms:

Young age worms reared in special **chawki** rearing centres are normally issued in the third instar stage, *i.e.*, after the second moult. It is always desirable to issue the **chawki** reared worms when it is about one day old by which time, the young worms would have received at least four feeds and gained sufficient growth and strength to

stand transport over distances. It is also advisable that the worms are transported during the cooler hours of the day either early in the morning or late in the evening so that no damage due to heat may be caused to them.

L. Rearing of Third Age Worms:

Third age worms coming out of the second moult are also considered sometime as young age worms. This age is in fact an intermediate stage between the young age and late age worms and differs in its rearing from the other two. During the third age, the humidity in the bed should be slightly lower, say about 80 per cent, and for this the silkworms are reared only under the paraffin paper cover, but without any paraffin paper at the base. The use of any wet paper or wet foam rubber bands is also dispensed with. If, inspite of this, the humidity is high, even the top paraffin paper may be removed for short periods to bring down the bed humidity.

From the third age onwards, the worms can be reared in wooden trays or round bamboo trays mounted on rearing stands.

III. ADVANTAGES OF CHAWKI REARING

The object of organising special rearing units to raise young age silkworms is to ensure healthy batch of vigorous growing robust silkworms that will spin successful cocoon crops in later stages with minimum of loss due to diseases and other adverse conditions of weather. It has been established through experimental studies that it is possible to avoid crop failures to a large extent, if sufficient care and attention is given to rearing of young age worms according to scientific methods described in this Bulletin. Thus, the special steps taken to do the **chawki** rearing to go a long way in stabilising cocoon crops, which are traditionally known to suffer on an average at the rate of one out of every three or four crops. Besides saving the cocoon crops, **chawki** rearing also helps to reap bumper harvest of cocoons in the region of 45 to 55 kg. per 100 layings resulting from very much improved effective rate of rearing between 70–80 per cent and also much higher cocoon weight ranging between 1·7 to 2·0 gm. The cocoons of such bumper harvests are also superior in quality and,therefore, fetch much higher prices in markets. Bumper harvests of cocoons resulting from scientific methods of **chawki** rearing will also mean most efficient use of leaf harvests. In other words, by using about 800 kg. of leaf for rearing 100 layings, a cocoon yield of 45 to 50 kg. can be obtained, which works out to a leaf/cocoon ratio of 18 to 16:1.

Thus, it may be seen that scientific method of young age silkworms rearing is a major step in the New Technology of Silkworm Rearing.