The Scientific Temper
VOL-VIII, NO.1&2; JANUARY-JULY, 2017
ISSN 0976 8653, E ISSN 2231 6396
UGC SR NO 2535; JR NO. 47226
e-mail:letmepublish@rediffmail.com
Web: www.scientifictemper.com

EVALUATION OF SILKWORM RACES/HYBRIDS FOR CULTRE AT FARMERS' LEVEL IN UTTAR PRADESH: APPROPRIATE TECHNIQUES

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ABSTRACT

The ensuing discussion explains the methodology and techniques for evaluation of mulberry silkworm pure races and some hybrid varieties for cultivation by farmers in the terai region of Uttar Pradesh. After rearing at various places and in different seasons the most suitable variety of silkworm race is found and therefore, suggested for sericulture at farmers' level for the better production and minimum damage of crops.

Keywords: *Bimbyx mori, Moras alva*, SR%, rearing,

INTRODUCTION

Historical evidence shows that silk was discovered in China and that the industry spread from there two other parts of the world. According to some Indian scholars silkworms *(Bombyx mori*) were first domesticated in the foothills of the Himalayas. There is also evidence in ancient Sanskrit literature that certain kind of wild silkworm were cultivated in India from time immemorial. The British East India Company exploited the industry and developed silk centres in many parts of the country. The company exported large quantities of the raw silk produced in west Bengal to England. The company's monopoly was abolished in 1836 and the entire trade turned over to private enterprise which at that time was not properly organised and as a result the silk industry in Bengal declined. In the meantime other major silk producing states namely Mysore, Jammu and Kashmir took steps to develop the industry.Silk has played an important role in the economic life of man ever since its discovery more than 4000 years ago. Fabulous silks from China and India were carried to Europe along the famous 6000 – mile Silk Road, which passed through Tashkent, Baghdad, Damascus and Istanbul, and silk has been traditionally associated with the socio economic life of many Asian and central Asian countries. Even today, despite the onslaught of man

made fibres, silk continues to reign supreme as the "queen of textiles". Although produced in small quantities compared to other textile fibres both natural and man made less than 0.2 percent – it still holds a position of importance among the textile fibres, and is universally sought after for its elegance and colours by the world's top fashion designers. The demand for silk is steadily increasing and between 1960 and 1970 silk production and demand registered a growth rate of 2.5 percent per annum. Sericulture today is practised in industrially advanced countries such as Japan, China, India, South Korea etc. which are now becoming industrialised. In the developing countries, it is essentially village – based welfare – oriented industry capable of providing employment to large sections of the population. Although sericulture had been considered for a long time as a subsidiary occupation in rural areas, recent technological developments have made it possible to practice sericulture on an intensive scale, producing greater profits than most of the agricultural crops. Sericulture is being practiced both as a subsidiary crop under unfavorable agro climatic conditions and a highly paying crop, if necessary agricultural inputs can be ensured. Furthermore, since mulberry trees grow fast and in great abundance, two to three crops in temperate zones and four to six cocoon crops in tropical areas can be raised in a year and this will provide the ready cash required by the Sericulturists throughout the year. Although till now, sericulture has been practiced mostly uyjhmnon small or medium – sized land holdings in most sericultural countries the remunerative return from sericulture have opened up possibilities of establishing the industry on a plantation scale. Silk also plays an important role as a foreign exchange earner for many of the silk producing countries of the world. For a period of about 70 years preceding the Second World War, silk used to head the list of Japan's exportable items, accounting for 30 to 50 percent of her aggregate foreign exchange earnings. Silk figures prominently also in the exports of South Korea, China, Thailand and India and earns valuable foreign exchange for those countries are looking to silk as a potential foreign exchange earner and have taken up programmes for sericulture development seriously.

Uttar Pradesh is one of the most populous states in the Indian Union, containing roughly one sixth of the country's total population. Only six countries in the world are more populous than U.P., they are China, U.S.A., Japan, Indonesia and Brazil. It has a common border with Nepal and Tibet in the North Himanchal Pradesh, Haryana, Delhi and Rajasthan; also have common boundaries with it in the West and South – West, Madhya Pradesh in the South and Bihar in the East. It is situated between latitudes 23 52′ and 31 28′ N and longitudes 77 3 and 84 39 E, It has an area of 2, 97, 547 Sq. Km. have three distinct physiographical regions:

Himalayan region in the north.

Gangitic plain in the centre.

Vindhya Hills and plateau in the South.

The climate of the state is tropical monsoonic but variations exist because of differences in altitude. The Himalayan region is very cold with perpetuating snow above 3950 metres and have snow fall between Dec. – March, but climate is milder in the valleys. In the plains the average temperature varies from 3 – 4 C in January to 43 – 45 C in May and June. State possess three distinct seasons – the cold seasons from Oct. to Feb., summer from March to mid June to Sept. The Himalayan region has rainfall of about 100 – 200 cm., The rain fall in the plains is heaviest in the East being more than 127 cm. and decreases towards the North – West, where it is only about 69.8 cm. Nearly 85 to 95 % of the rains fall during the four months from June to Sept., the remaining falls in the winter months. Uttar Pradesh where population pressure on land is high more than 90 % of holdings are marginal / small with an operated area of over 65 %, working force is huge with severe under / unemployment, literacy / venture which possess great potential as guaranteed source of gainful and remunerative employment, utilizes available resources of the state i.e. man power and agriculture / land, requires little or no investment, is adoptable by common people under prevailing climate without advance training or know how and does not significantly alters / modifies hither to adopted their

way of livelihood / life should be most suitable for the economic development of the state. It is here, where "sericulture industry" because of its tremendous potential, good scope and suitability for the economic development of the poorest of the poor, the down trodden and rural peasants is automatically mentioned. Further it may also be noted that Uttar Pradesh is one of the highest silk consuming state, weavers of Varanasi region itself consume 2000 – 3000 mt. of raw silk annually against the states record production of 23000 kg. raw silk during 1985 – 86. Sericulture being an agrobased, labour intensive and cottage industry par – excellence should, therefore, be a most suitable industry for the aforesaid socio – economic conditions of the state, hence should find due emphasis in the development schemes of the state. Uttar Pradesh unlike that of Karnataka, West Bengal and Jammu and Kashmir is a non – traditional state far as sericulture is concerned. The first attempt to introduce sericulture industry in the state was made as far back as in 1847 at Lucknow by Capt. Huttar of Masoorie was allowed to undertake plantation of mulberry trees near Masoori. Later, in the year 1981, this work was transferred to M/S Lister and Co., a reputed Textile Manufacturing firm of England. The modest beginning of the systematic approach for the development of sericulture industry by state Govt. was started after independence in the year 1948 – 49 at presently functioning in 37 districts of the state which are grouped into for different regions (Uttaranchal included) as given below-

Plain areas: Covering 17 districts under mulberry silkworm schemes (both for multivoltine and bivoltine) viz, Meerut, Saharanpur, Etawah, Agara, Fatehpur, Moradabad, Mathura, Unnao, Allahabad, Kanpur, Muzaffar nagar, Bareilly, Mainpuri, Rampur, Sitapur, Biznaur, and Shahjahanpur.

Tarai areas: covering 7 districts (adjoining Nepal border) where intensive sericulture development project has been launched viz, Gorakhpur, Bahraich and Lakhimpurkheeri. State Govt. has been able to develop a sound organization with 222 mulberry farms / nurseries/ chawkie rearing centres, two P 1 farms, six industrial grainages, two Research Development Centres, one training centre and three reeling units / filatures Similarly under non – mulberry sector a sound infrastructure has also been established with 22 Tasar Farms, 9 grainage, 5 reeling centres, one cocoon godown and one cold storage. The projects / schemes are currently managed by the staff strength of 973 personnels. The mulberry cocoon production in the state has touched all time record of 2.38 lakh kgs. During 1985 – 86 from that of only 60 kg. production of 1949 – 50. At present, under various state govt. schemes approx. 12,000 families are being benefited bythis industry.

Uttar Pradesh is located between 77 and 84 east longitude and 25 and 31 north latitude. The state is surrounded by Himanchal Pradesh on the northern side, Madhya Pradesh on the south, Bihar in the east and union territory Delhi and the states at Rajasthan and Haryana on the West. The state is physiographically divisible into three distinct regions viz., the Himalayan terrain in the north, Gangetic plains in the centre and Vindhya hills, and plateau in the south. As such the state enjoys both tropical and sub – tropical climatological variations. Agriculture is a predominant avocation of the state. The state is faced with unemployment problem for which sericulture can be a solution. Uttar Pradesh is a major consumer of silk in the country with its silk industry consuming about 2500 – 3000 MT per annum against annual raw silk production of 40 – 45 MT. Uttar Pradesh practices mulberry and tropical / oak tasar sericulture. The agroclimatic conditions are suitable for development of the industry in the state in different pockets. Mulberry and tropical / oak tasar Sericulture. The agroclimatic conditions are suitable for development of development of the industry in the state in different pockets. Mulberry Sericulture is practised both on nature grown mulberry trees and plantation raised. Though, mulberry sericulture is introduced in 1948 – 49, systematic approach was initiated only from the first plan period. Mulberry sericulture is practised in the plain, tarai and hilly region of Uttar Pradesh.

The main verieties and their hybrids being reared in Uttar Pradesh are –

Multi x Biv *P2D1 X NB18* (Summer / Early Autumn),

RD1 X NB18 (Summer / Early Autumn)

Biv x Biv. *YS3 X SF19* (Spring),

SH6 X KA (Spring),

SH6 X NB4D2 (Spring)

CA2 X NB4D2 (Spring / Autumn / Early Winter

PAM101 X NB4D2 (Autumn / Early Winter),

CC1 X NB4D2 (Autumn / Early Winter),

PAM111 X SF19 (Autumn / Early Winter)

Silkworm is not only a commercially important insect, it is also found to be an important laboratory tool. It is estimated that more than 3000 silkworm strains are available all over the world due to various ongoing breeding programmes (Nagaraju, 2002; Thangavelu et al., 2003). These silkworm verities include univoltines, bivoltines and polyvoltines. Univoltines , bivoltines are qualitatively and quantitavely superior races whereas polyvoltines are relatively inferior in both the traits but superior in their survival and hardiness. But in tropical countries like India, polyvoltine silkworm strains play important role in the production of silk, since they are well accustomed to the tropical climatic conditions. Hence, maintenance of polyvoltine silkworm genetic resources has become very important for meeting the desired objectives of the breeder for immediate or long – term utilization in silkworm breeding programmes. But, it is necessary to maintain them in their original form for their rational use in different breeding and other research purposes (Mukarjee *et al* Basavaraja *et al.*, 2003; Thangavelu *et al.*, 2003; Yamaguchi, 2003). In additional maintenance, systematic study of resource material is also very important, not only for classification and characterization of verities but also for the selection of promising parents to initiate various breeding programmes. Evaluation of genetic material also helps in identification of lines with special characters like longer filament length, fine denier, fluoride resistance, disease resistance, etc, (Li *et al.*, 2001). Availability of diverse genetic stock, give sample choice for the breeder in selection of initial parents of his desire. Even half of a good silkworm egg laying from a good genetic stock can potentially transform the sericulture scenario to a greater extent (Chandrashekharaiah and Ramesh Babu, 2003) Polyvoltine silkworm gene bank of APSSRDI, Hindupur consists of geographically isolated verities and breeds, obtained from indigenous and exotic origin. In the present study, an attempt was made to evaluate and characterize polyvoltine germplasm and inbred lines based on evaluation index and sub – ordinate function statistical methods, frequently used for evaluating breeds / hybrids. Germplasm evaluation was conducted to ascertain the genetic potential of various silkworm lines / strains for commercial exploitation. Since sericulture is practiced in diverse agro climatic zones, systematic evaluation is needed for the proper utilization of the available lines. The information generated will be useful for future breeding programmes. Constant efforts are being made to develop productive polyvoltine silkworm hybrids suitable for sericulture in tropical agro climatic conditions of peninsular India because, more than ninety percent of the raw silk is still coming from polyvoltine silkworm hybrids (polyvoltine x bivoltine cross breeds) only. Therefore, maintenance of polyvoltine resource material and their effective utilization has become very important. Most of the quantitative traits of commercial importance in silkworm are under complicated polygenic control under the influence of the environment. For synthesizing the potential polyvoltine cross breeds, usually, the high yielding traits of bivoltine varities and fitness traits of polyvoltine strains are hybridized as proper selection of potential and homozygous parents is very important. Effective utilization of selected germplasm also plays an important role in saving the time of the breeder in the synthesis of new hybrids. Keeping the need in view, the germplasm strains have been reared consecutively for several generations and their quantitative traits were evaluated using two reliable statistical methods, i.e. evaluation index method and subordinate function method to assess the performance of the inbred lines. Earlier many breeders (Mano et al., 1993;

Gower, 1971; Ramesh Babu et al., 2001, Rao et al., 2004) analyzed their breeds by adopting the above methods either individually or together. The breeds which have been selected through these methods could be effectively used in further breeding programmes as potential parents for synthesizing superior polyvoltine silkworm hybrids that are suitable for culture under tropical climatic conditions. Proper choice of suitable parents plays a pivotal role in achieving the targets in scheduled time.

For the present study, selected races were reared according to the standard methods under hygeinique rearing conditions (Krishnaswami, 1975; 1983) for some generations in various seasons of the year. Various qualitative and quantitative parameters were observed and analyzed such as rearing period, fecundity, cocoon yield, pupation rate, cocoon weight, shell weight, shell ratio, filament length raw silk (%), reelability (%),neatness and some other biological and commercial features.

The rearing was carried out at some selected places in tarai region of Uttar Pradesh and few among the following verities were evaluated.

Multi x Biv Nistari x NB4D2
Nistari x SH6
Biv x Biv NB4D2 x SH6 or
SH6 x NB4D2
Major component - CSR4 x CSR2

(A) Methodology and Techniques of Rearing:

The nutritive value of mulberry leaf is one of the important factors which contributes maximum for a good cocoon crop. Hence, it is necessary to keep the mulberry leaves fresh and nutritious for the development of silkworms. Mulberry leaf, once plucked, looses its nutrients to a considerable extent by the time it is actually fed to the silkworms. There will be considerable lapse of time between leaf harvest and feeding of leaves to the silkworms, which varies from 12-24 hours. During preservation, the leaf looses its moisture content, proteins will be decomposed into amino acids, glycogen converted into glucose and vitamins decrease gradually. All these, ultimately affect, the quality of feed. Therefore, preservation of mulberry leaves in proper condition is of immense, importance for better feeding and successful cocoon crop.

Various methods of leaf preservation *viz*. earthen pot, wooden leaf preservation chamber, polythene bag and gunny bag etc. are available. But, majority of the farmers preserve the leves heaped in a corner of rearing house covered with wet gunny/ old cloth. In this method, leaves wither rapidly due to evaporation. Besides, temperature inside the heap rises, favouring the fermentation of the leaves. There is always the danger of leaves getting infected with disease from the dust of rearing house, especially during bed and room cleaning.

Bamboo device:

Keeping this in view, a simple device for mulberry leaf preservation has been designed. This device is made up of bamboo split strips. It consists of three parts *viz*. a rectangular bamboo tray, bomboo mat and central funnel. The rectangular tray is 107 × 67 × 6 cm in size. In place of rectangular bamboo tray round bamboo tray can also be used. The bamboo mat is of 86cm in width and 340cm in length. The central funnel is 90cm in height and the mouth at funnel is 35cm diameter which narrows to 16cm at the top.

At the time of preservation, this device should be assembled in a cooler part of the rearing room. The funnel is kept in the middle of the tray. The bamboo mat is kept encircling the tray and bamboo mat is tied with thread at bottom, center and top to keep the mat straight. Leaf is loosely placed in between these two and covered with wet gunny cloth.

Sericulture crops here suffer from the problem of poor cocoon productivity. This is mainly attributed to certain lapses which can be easily addressed to.

A brief account of lapses leading to low cocoon yield at farmers level is given below:

***Programme planning* :**

It is observed that there is no fixed time schedule or interval between the disinfection of rearing places and the data of silkworm distribution. Therefore, many a times, disinfection is done much earlier which increases the changes of recontamination of rearing places and often leads to outbreak of diseases.

***Use of household equipments without disinfection*:**

Many of the farmers were found to be using cots of their daily use as silkworm seat for making the rearing beds, keeping domestic appliances within the rearing premises and using them in rearings without disinfecting.

Such practices render the silkworms to succumb to contagious diseases, ultimately resulting in poor cocoon crop.

***Rearing hygiene* :**

It was observed that the rearers in villages do not practice disinfection of their hands prior to handling/feeding the silkworms. Unsterilized handing is always detrimental to the silkworms as various disease causing pathogens could be transmitted.

***Rearing bed cleaning* :**

Generally, the rearers carry out silkworm bed cleaning operations directly with their hands. This practice exposes the silkworms to injuries due to rough handling and increases the changes of various contagious diseases.

***Use of bed disinfectants* :**

It was observed that the rearers in the field don't practice the dusting of slaked lime powder over the bed of moulting worms to keep it dry. Due to non-adoption of such practice, the early moulted larvae start feeding on old leaves and grow faster resulting in larvae of different sizes in a batch. Management of such worms in a batch becomes difficult due to difference in their rearing/feeding requirements.

***Ventilation* :**

Lack of cross ventilation at the rearing places during the late age rearing, moulting and spinning stages causes not only stagnation of flow of air-current, but also favours accumulation of harmful gases expelled by the silkworms and the rearers through respiration. Such stagnation of the air increases humidity inside the rearing rooms particularly when the silkworms are at the spinning stage. It may also lead to mortality of the silkworms either on mountages or half way spinning, resulting in more flimsy cocoons.

***Disposal of diseased worms* :**

Usually the farmers remove the diseased and dead silkworms by picking them up directly by their hands instead of using bits of paper or old leaf when they clean the silkworm beds or feed the worms. There is also lack of proper disposal of diseased/ dead/discarded worms and silkworm litter/rearing waste amongst many a farmers. The common practier of throwing the diseased or dead silkworms, rearing waste etc., along with the domestic garbage in the vicinity of rearing place allows multiplication of pathogens.

***Mulberry leaf transportation and storage* :**

Farmers many a times, fetch the mulberry leaves/shoots from distant places either exposed or covered with a piece of dry cloth. It leads to fast drying of leaves, making them less palatable and unfit for consumption by the silkworms. Improper leaf preservation also affects the quality and quantity of cocoons.

***Verification during cocooning* :**

It was also observed that farmers do not pay much attention towards the ventilation during spinning stage of silkworms. Besides, they moult the worms over semi-dried area, which increases the humidity in moulting place, thereby facilitating infection by pathogens, which ultimately causes mortality of the worms.

Keeping in view the above lapses, there is an urgent need to be more vigilant and to educate/ convince the farmers to adopt the recommended practices. The following tips would help them in ensuring better silkworm crop:

- Timely disinfection of the rearing places and equipments/appliances must be ensured.
- The rearing capacity of the farmer be judged before hand and only suitable quantum of silkworms should be distributed.
- Farmers should be helped in selecting a good place/corner with good ventilation in their houses for practicing sericulture.
- More emphasis should be given on maintenance of hygienic conditions in the rearing rooms/ places, disposal of the diseased/dead silkworms, silkworm litter, rearing waste etc.
- Timely application of bed disinfectants and slaked lime to prevent the diseases.

- Leaf should be transported with due care and also preserved properly to retain the leaf quality to the maximum extent possible.
- Proper and suitable mounting materials should be used. Care more for aeration during spinning.
- Timely guidance during the course of rearing particularly before and after the moults and to avoid starvation, will help the farmers to have better rearing and crop.

It is a well-known fact that chawki rearing plays an important role in the success of cocoon crop production as it determines, to a large extent, the degree of success in silkworm rearing. The significance of chawki rearing is being realized more and more in recent times, with the result that there is a study improvement in the productivity of cocoon crop harvests. The scientific method of rearing involved in chawki is to secure maximum healthy growth of worms so that they will not easily succumb to diseases. The growth aspect is governed by optimum temperature, relative humidity and leaf moisture. Besides, the care in the form of providing spacing, applying feed of particular nutritional level, while preparing for moult, at moult and after moult form the crucial aspect of successful rearing.

The major constraints encountered during chawki rearing are more relative humidity and high leaf moisture, thus leading to creation of humid rearing beds and in turn provided room for fungal. To overcome these problems, a progressive sericulturist, Sri Annegowda adopted a model method for chawki rearing.

New Method :

The new method involves using of a wooden frame of 2 × 2´, to which a cotton net of 10 mm² hole size is firmly fixed. Immediately after brushing, newly hatched worms are fed with tender mulberry leaves of 0.5 cm² size. After 30 minutes of first feeding the framed net is placed over the bed and second feed is given by sprinkling tender mulberry leaf bits over the net. The worms crawl on to the leaf bits on the cotton net and rearing is continued by giving recommended number of feeds. The bed is daily spread using the fingers from the lower side of the cotton net, which enables dropping of faecal matter from the bed and to increase aeration alld reduce the heat developing in the bed. This method of rearing worms on wooden framed cotton net can be followed upto second instar. The later instar worms are reared in the usual manner.

According to Shri Annegowde, the new method of chawki rearing has the following advantages:

- Handling of tiny and delicate worms is easy.
- The rearing bed is kept dry by spreading the beds from lower side by using fingers,
- The rearing bed size can also be increased by spreading from the lower side by fingers without using chopsticks. So mechanical injury to delicate worms can be avoided.
- Dead and diseased worms remain at the bottom of the bed, so uniform growth of larvae can be achieved,
- Good aeration is assured so that the fungal infection to infant worms can be avoided,
- Transfer of chawki worms from place to place is easy by holding the wooden frame, instead of transferring the whole chawki, and,
- Wooden framed cotton net is simple, cheap and home made.

Shri Annegowda gives more importance to chawki rearing because he believes as he says, in the "success of cocoon crop production depends on chawki rearing". During April 1989 and March 1990, Shri Annegowda has taken five rearings. He harvested 378 kg of bivoltine cocoons from 654 dfls and sold at an average rate of Rs. 138/per kg at the bivoltine cocoon market, Bangalore, for seed purpose. His gross income from one acre of mulberry garden was over Rs. 52,100/ while expenses amounted to nearly Rs. 15,000/ including mulberry production and silkworm rearing. Leaving him with a net earnings of Rs. 37,100/ this, he says is because of the quality cocoons harvested by adopting new method of chawki rearing than what used to practice earlier.

All the same, during popularization of technologies, it is learnt that farmers can give the support even better than that achieved in the laboratory, if the extension staff are trained and geared up to apprise the farmers correctly about the

technologies and do a continuous follow-up of the programme. This also warrants the creation of facilities like supply of quality incubated seeds to the well equipped young silkworm rearing centers, utilization of independent rearing houses, irrigated mulberry garden, chawki rearing centers with the facility of maintaining required humidity and temperature.

In this appropriate technology, proper disinfection of the rearing house, its surroundings, appliances and practice of hygienic measures are essential for raising successful bivoltine crop. Under this project, disinfectant formalin is replaced by the newly identified chemical called chlled chlorine di-oxide mixed with slaked lime solution. This chemical is least corrosive as compared to formalin or the bleaching powder solution. The technology also identifies the total quantity of disinfectant required to be used in a rearing house of 100-200 dfls capacity. The bed disinfectant like VIJETHA, developed at CSR & TI, Mysore kills all the pathogens of Grasserie, Flacherie, Mus-cardine and Pebrine diseases in the rearing bed. This powder has to be dusted on the silkworms after each moult, half-an-hour to one hour prior to resumption of feeding as well as during the 3rd day of 5th age.

Chawki or young age rearing has been identified as the most crucial period for bivoltine silkworm rearing since it ensures the crop stability and higher cocoon yield. Through research, it is found that chawki rearing should be done in a separate rearing house having all facilities like maintenance of constant temperature and humidity as well as full disinfection and use of bed disinfectant. The young age chawki rearing center is recommended for catering to the needs of cluster of farmers (10-20), since all the farmers cannot maintain such a proper hygienic condition and provide optimum environmental conditions for young age worms.

SIGNIFICANCE OF THE WORK

Silk obtained from mulberry silkworms has its impact not only on the heritage and culture but also on the commerce of our country. Innumerable possibilities are there to explore the innovative methods and procedures which should be compatible with the existing ones. Living beings are integral part of their environment. Therefore, scientific study of mulberry silkworm verities in its habitat will be beneficial for silkworms as well as for human beings not only by improving the economy of the state but also by providing the much needed employment to the rural women and landless laborers. The present work is an humble effort to fill the lacuna in the present knowledge and to enrich it along with the practical possibilities.

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