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Innovations for reviving sericulture in Jammu and Kashmir

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Abstract

Innovations refers to the practice of developing or introducing new technologies in different areas. Innovation, being cost effective and easy to maintain comes up with new ideas to revive sericulture industry through technological solution to the sericulture problems. The development of seasonal and regional genotypes of mulberry in the UT of Jammu and Kashmir proves to be a great insight for the successful introduction of sericulture in different agroclimatic conditions. The sericulture output can be increased through introduction of region/season specific breeds of silkworm, integrated farming system, establishment of public private partnership, cocoon banks etc. Fortification of mulberry leaves with food additives, development of herbal bed disinfectants proves to be cost effective and recent approaches in sericulture. Seribusiness and Reshamandi are one of the emerging start-ups in sericulture which aims to engage and motivate huge masses of unemployed youth in entrepreneurial activities in sericulture. The present review have emphasised on the importance of innovations associated with mulberry and silkworm for the revival of sericulture in the UT of Jammu and Kashmir.

Keywords: Innovations, silkworm, cocoon banks, mulberry

Introduction

Sericulture is an art rather than a science which deals with the cultivation of mulberry as well as rearing of silkworms for high quantity cocoon production to obtain quality silk. Sericulture is one of the most prominent agro-based industry which involves a series of on-farm and off-farm activities that provides employment to about 8.7 million people in India (Hatibaruah *et al.*, 2021) ^[18]. One of the major concern of the silk industry is the need to make the most efficient use of natural fibres, but also focuses on utilization of by products of mulberry and silkworm. Mulberry leaf quality is one of the most potential factor influencing the growth and development of silkworm, as the leaf contributes about 38.20 per cent towards successful rearing/quality cocoon production (Gangwar, 2010) ^[12]. In Jammu and Kashmir there are only two crops viz., spring and autumn. Out of the two crops, spring crop contributes about 80% of the total annual cocoon production (Singh and Murali, 2019) ^[31]. For successful qualitative as well as quantitative cocoon production there should be chance of summer crop in between spring and autumn. Successful silkworm rearing mostly depends on three promising factors such as environment, mulberry leaf, and silkworm hybrid. For better quality and quantity cocoons, selection of the potential cultivars based on disease resistance, biochemical properties and their effect on growth and economic parameters of *Bombyx mori* races in different agro-climatic conditions is an emerging needs for better sericulture practices (Sajgotra *et al.*, 2018) ^[29]. In recent years, several attempts have been made to fortify the leaves with different beneficial nutrients and combination of nutrients to enhance the quality of cocoon crop (Rajegowda, 2002).

Sericulture can be integrated with other agricultural crops, agroforestry, dairy or livestock, poultry, aquaculture and horticulture for sustainable development and prosperity of farmers involved in their respective sectors. This will raise the income of the farmers of sericulture during the whole year. Besides this, integrated farming in sericulture can provide employment to many unemployed youth and this will also explore sericulture. Mulberry, the host plant of silkworm *Bombyx mori* can be planted as tall trees under mixed cropping system or on side bunds of the vegetable crop fields.

Owing to the potential of sericulture industry in India, recent developments and technologies have been made for the utilization of innovations in various fields of sericulture in order to improve the productivity level.

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Innovations in Mulberry

Identification of region-specific mulberry genotypes suitable for different agro-climatic zones of Jammu and Kashmir

Jammu and Kashmir is comprised of three different varied climatic zones viz., temperate, intermediate (lies between temperate and sub-tropical) and sub-tropical zone. Due to these predominant agro-climatic conditions, the mulberry varieties and cultivation practice evolved elsewhere cannot be accepted as it is in these regions. Thus, there is urgent need to develop mulberry varieties suitable to these regions to meet the emerging challenges for the bivoltine silk production. At present, there are no identified genotypes having specific characters based on the varied climatic regions along with soil status (Shabnam *et al.*, 2018) [30]. Early sprouting nature of mulberry is one of the most potential factor in silkworm rearing, as mulberry cultivars which sprout early can make the leaf available before time and aids in proceeding the rearing at commercial level thereby helping in utilizing the favorable atmosphere for an extra crop under temperate conditions. However, early sprouting and late leaf fall varieties under subtropical conditions shall be helpful in adjusting additional crops. Also, the extent of damage due to frost or snow in temperate regions is up to 30% in existing varieties which reduces leaf yield during spring season. Therefore, mulberry variety resistant to frost damage is a pre-requisite to save time at sapling stage and to increase the availability of mulberry foliage during the spring season under temperate climatic conditions.

Cultivation of mulberry

Mulberry can be planted in ridges of terrace land. It has the ability to grow even under barren lands and can be cultivated along the road sides, along the banks of rivers, gardens, edges of field crops (Rohela *et al.*, 2020) [27]. Mulberry riches is primarily found in the form of local variation, which is spread around the habitation units or farmers bunds, i.e. along the periphery of agricultural fields.

Fortification of mulberry leaves

About 70% of silk protein produced by mulberry silkworm is derived from protein of mulberry leaves in optimum amount for successful cocoon production (Bhaskar *et al.*, 2008; Narayanan *et al.*, 1967) [5, 24]. The supplementation or fortification of mulberry leaves is the recent technique in sericulture research and is one of the most effective alternative way of improving larval growth and cocoon production by feeding mulberry leaves enriched with supplementary nutrients to the silkworm (Murugan *et al.*, 1998) [23]. It has been revealed that botanicals are cheaper and better supplement which can improve the quality and yield of cocoons (Maribashetty *et al.*, 2010) [22]. The medicinal botanical plant extracts increase the feeding efficiency of silkworms as they have phago stimulant characteristics and contain sterols of different kinds which are required for normal growth of insects. These techniques can improve growth and development of silkworm and also reduce the contamination of silkworm rearing environment by diseases and their further spread.

Sericulture based agroforestry system

Sericulture based agroforestry system has developed a great potential to generate income as it is a job-oriented industry specifically for the below poverty line farmers. In addition to

sericulture, mulberry has a wide and diverse potential to protect the environment in unfavourable agroclimatic conditions. It also provides protein rich biomass and foliage. Mulberry can be grown as a tree as well as in combination with other agricultural crops (as an intercrop) to increase the per unit area yield as it is well known that sericulture is a subsidiary crop. Mulberry is capable to fulfill the growing challenges such as scarcity of fuel wood, fodder, timber, environmental protection, improvement of wastelands, phytoremediation etc (Kant *et al.*, 2004).

Silk milk-An ecofriendly approach of farming

Combination of animal husbandry with various agricultural farming systems has proved to be profitable and economically viable enterprise. Mulberry is a deep-rooted perennial plant, cultivated as seasonal plant for harvesting leaves for feeding silkworms during rearing. About 60-70 metric tonnes (MT) of mulberry leaf is harvested annually for silkworm rearing. It is estimated that more than 100 MT of biomass is harvested from one hectare of mulberry garden annually for silkworm rearing. Out of which 50% of biomass is left over along with 25-30% thin branches that will remain as waste in the garden. Mulberry left-over waste is utilized for cattle feeding. Farmers have revealed that there is increase in the milk yield of cattle fed with mulberry leaves as compared to the grazing cattles (Sudhakar *et al.*, 2020) [34].

Various innovations in silkworm

Silkworm seed

Silkworm seed of superior quality is one of the most important aspect of Sericulture (Chouhan *et al.* 2016) [2]. The silkworm eggs are produced in the grainages are called as DFLs (Disease Free Layings). As government grainages produce only 10% of the total requirement of the seed and 90% of the seed is produced by farmers themselves to meet their own needs. In J&K, only 70% of our seed demand is fulfilled and rest 30% we have to import from other states especially from Karnataka. The silkworm seed production requires adoption of scientific method right from seed crop rearing to egg incubation sector (Khan *et al.*, 2016) [19].

Evaluation of thermotolerant silkworm breeds

Multivoltine silkworm strains are more tolerant to high temperature but produce inferior quality silk whereas bivoltine silkworms produce high quality silk, are less tolerant to high temperature (Keerthana *et al.*, 2020). During summer, 10-15% farmers take up Sericulture in temperate regions of Kashmir (Neelaboina *et al.*, 2019). So, there is need to evaluate certain breeds that are tolerant to high temperature and are season or region specific. It has been found that the quantitative characteristics of cocoons decline at high temperature and is one of the main factor for bivoltine crop failure.

Introduction of region and season specific silkworm breeds

Region specific silkworm breeds

Voltinism in silkworms is influenced by environmental conditions where univoltines are suited for cold regions, bivoltines for warm and polyvoltines for tropical regions (Chauhan and Tayal, 2007) [8]. Among these, the silkworm produces a higher quality of silk belonging to temperate origin, whereas the silkworms are hardy and disease tolerant from the tropical origin. Thus, it becomes necessary for

silkworm breeders to develop region-specific breeds/hybrids as one of the main factor to minimize the risk of decrease in yield.

Season specific silkworm breeds

Cocoon yield, an important phenotypic character, is influenced by both environment and genotype. The quantitative and qualitative cocoon crop can be obtained in season with ideal environmental conditions for its genotype. For better cocoon crop, it is necessary to develop breeds specific to particular season. So, there is need to introduce season or region-specific races due to the variations in climate and geography of an area along with the leaf quality. Thus, the breeds having high silk content are preferred for spring and breeds having better survival rate are preferred for summer and autumn (Rudramani *et al.*, 2019) ^[28]. Hence, it is utmost important to evaluate silkworm breeds suitable to particular season and agro-climatic conditions for raising the income of farmers.

Introduction of summer crop (Silkworm Rearing) in Jammu and Kashmir

There is a great hinderance in cocoon production which ultimately leads to degradation of sericulture industry as there is only one successful cocoon crop during spring season which alone do not fulfill the requirements of reeling industry. So, due to limited cocoon crops, there is obstacle in the growth and development of sericulture industry in Jammu and Kashmir. Silkworm rearing is practised twice a year, i.e. during spring season by brushing of silkworm in the first week of March and during autumn season by brushing of silkworms from last week of August to first week of September. Due to severe changes in the climate after October next rearing season comes only when mulberry sprouts in the month of February after winter dormancy. Silkworm get fresh mulberry leaves of 50-60 days old, hence brushing of silkworm is ideal in June to explore the chance of third crop side by side of the two crops (Singh and Murali, 2021) ^[32].

Integrated farming system

It is an interdependent, interrelated often interlocking production system based on few crops, animals and related subsidiary enterprises in such a way that maximize the utilization of nutrients of each system and to minimize the adverse effect of these enterprises on the environment. Within the wide concept of sustainable agriculture "Integrated Farming System" possess special place as in this system nothing is wasted, the by-product of one system becomes the input for other.

Sericulture and Horticulture

In India, Horticulture is a blooming industry and holds unique importance among various fields of agriculture as the fruits and vegetables cultivated under horticulture are consumed as basic commodity by all being rich in nutritive value (Kumar *et al.*, 2012) ^[20]. Mulberry the host plant of silkworm *Bombyx mori* can be planted as tall trees under mixed cropping system or on side bunds of the vegetable crop fields. Among various horticulture crops, mango, coconut and sapota can be easy integrated with mulberry cultivation (Kerutagi *et al.*, 2019). Thus, the farmers need not to engage their entire land for mulberry cultivation and can generate additional income by practising sericulture on part time basis.

Integrated fish-cum sericulture farming system

It aims to utilize the organic waste of live stock, poultry and agriculture by-product. In fish-cum sericulture system, pupae are used as fish feed, while worm faeces and wastewater from silk extraction processing plants are used as pond fertilizers (Kumar *et al.*, 2012) ^[20].

Development of herbal bed disinfectants for silkworm rearing

Mulberry silkworm, *Bombyx mori* L is highly susceptible to various diseases caused by different infecting pathogens like viruses, fungi, bacteria and microsporodians (Ahmad and Ahmad, 2020). Various bed disinfectants such as Vijetha, lime, Captan, RKO (Resham Keet Oushad), Ankush, Vijetha green, Resham jyothi, Labex are used in silkworm rearing. Besides being costly, the chemical disinfectants have various limitations to be effective in open and rearing cum dwelling type of rearing house which results in incomplete disinfection and hygiene at farmer's level. Regular use of these chemicals have been found to be carcinogenic to human beings. So, under such circumstances formulation of new disinfectants having both the botanicals and effective chemicals in combination for the disease management becomes more essential (Rasool *et al.*, 2017). Biomolecules present in botanicals have antibacterial as well as antiviral properties which can be used in silkworm rearing and also in management of diseases (Maria Joncy and Priyadarshini, 2018) ^[21].

Artificial diet for silkworm

There are various factors that contribute to good cocoon yield, leaf quality is one of them contributing to 38.2% of the total production. It is well known that the leaf quality varies from chawki worms to the late age worm as they feed on leaves with higher moisture and on coarse leaf respectively. During rainy season, there is problem to feed worms with wet leaves which will result in numerous diseases, so it is necessary to have some backup such as artificial diet which is available in all seasons. The first ever attempt to rear silkworm on artificial diet was made in 1960. There are two different kinds of low-cost artificial diet viz., pellet diet and yuneri diet along with a semisynthetic diet 'Serinutrid'. Thus, it becomes possible to rear silkworms successfully by feeding it on artificial diet (Alam *et al.*, 2021) ^[1]. The most important advantage of artificial diet is that it is available in all seasons and labour saving.

Biosensor

The biosensor technology is one of the useful advanced technique developed by assembling complex analytical platforms into a single miniature device for on-site detection of pathogens by monitoring a biological reaction at the surface of transducers. Biosensors are easy to use, portable and do not require skilled personnel, laboratory reagents or equipments and capable of on-site diagnostics, laborsome procedures which significantly reduces the cost. The bioreceptor is coated on the surface of a sensor and is integrated directly or indirectly with the transducer. The specific physiological interaction between the bioreceptor and analyte is translated by the transducer into a measurable electric signal for interpretation (Gani *et al.*, 2021) ^[13].

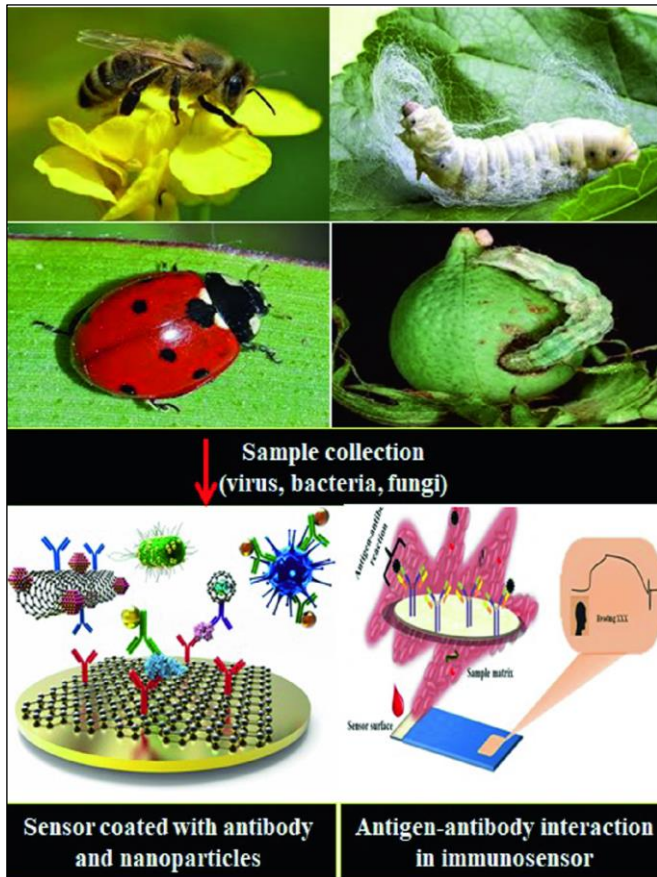


Fig 1: Biosensors-for the detection of insect pathogens (Source Modified from Ayyar and Arora 2013; Farka *et al.* 2017)

Silk reeling

Silk reeling is the process of unwinding the silk filaments from the cocoon and combining them together to make a thread of raw silk. In J&K there are 37 reeling units out of which only 14 are functional (Farooq, 2016) ^[11]. Silk reeling is processed by reeling devices viz., Charkha, Cottage basin, reeling machines, filature. Charkha is manually operated system, where inferior quality cocoons are reeled. Cooking and reeling is done in the same basin. Charkha reeling machine is traditionally homemade using locally available material like bamboo sticks. It is used mostly by farmers for small scale silk production. In reeling process, the whole cocoon is not used for reeling, some wastes are left from the good cocoons which includes deflossing waste, cooking waste, thread waste, charkha waste, basin waste, re-reeling waste (Gogoi *et al.*, 2020) ^[15].

Marketing of cocoons

A Cocoon market is a place where the buyers and sellers can transact cocoons through open auction under the regulations of law. Marketing is the most potential aspect which directly effects the growth of sericulture (Khan *et al.*, 2016) ^[19]. Around 70% cocoon crop produced in Jammu and Kashmir is sold to people from outside every year (Dar *et al.*, 2021) ^[10]. Maximum cocoons are purchased by reelers from West Bengal therefore, fair prices of cocoons are not offered to rearers and only a small portion is consumed by local reelers (Babulal *et al.* 2016) ^[2]. So, there is need to organise marketing of cocoons within the state so that the farmers will be able to sell their cocoons without facing any difficulty in the prices of cocoon or transport system as some of them live in far flung areas away from the cities.

Establishment of public-private partnership

Public-Private Partnership (PPP) is a general term that is usually applied to several different types of contractual agreements between the private and the government sector. It facilitates greater efficiency and innovation in the production and promotes rapid economic development (Bhat *et al.*, 2014) ^[6]. It is one of the alternative solutions to promote the sericulture industry by automating the process of silk production and bringing down the cost of raw silk. Besides it will also facilitates the economic conditions of reeling activity by effective utilization of by-products which leads to proper and timely marketing facilities, thus reducing the economic imbalance between rural and urban areas. Thus, the combined effort of private and government sector will boost this industry with the timely supply of disease-free eggs, modernization in mulberry cultivation, rationalization of marketing of raw silk, value addition of by-products of raw silk, awareness of low-cost innovative sericulture technologies among farmers and so on.

Establishment of cocoon banks

In non-traditional and most of the northern states, sericulture is not fully developed in terms of silk production due to number of crops per year. The states having two commercial crops per year compels the reelers to procure raw material and store them at least for 6 months to be used during the off season. Cocoon banks should be established in order to help the reelers and make the raw material available throughout the year (Directorate of Sericulture, Government of Assam, 2021) ^[6]. In Jammu and Kashmir there are only two crops per year; one in spring and another in the autumn season. There is a huge gap in between the two crops (rearing) so there is an urgent need of cocoon banks so that the farmers will continue reeling and other art and craft activities during the off season. This will also help the farmers to earn an additional income which otherwise is not possible.

Start-ups in sericulture

Seri-business

Seribusiness, an entrepreneurship venture motivates young people to transform their ideas into business. There are a lot of people today having business ideas, but only a few have the ability and opportunity to transform such ideas into profitable venture. The capacity of youth to transform their ideas into businesses is a bit critical to the future of small business start-ups. It is totally the choice of youth to know the profit of the enterprise and then put it to use, depends upon his willingness to start such entrepreneurial activity. Sericulture is an enterprise that engages people into a profitable business which includes plantation of high leaf-yielding mulberry varieties, silk reeling, seri-by product recycling, utilization of seri-waste into valuable products, cocoon art and craft etc. The phases of starting a profitable business begin with identifying the inspiration for starting a company followed by a viable concept. This concept must be appealing and tested to see how it will satisfy the needs of consumer followed by appropriate services such as supplies, financing, and reputable suppliers. The final step is to put the strategy into action by starting an enterprise and then building a professional network to keep the venture going (Hamid and Bhat, 2021) ^[17].

Resha Mandi

Reshamandi is India's first digital sericulture start-up that serves as a market place for farmers, stakeholders, retailers all

over the country. It was started by Mayank Tiwari at Bangalore in 2020. It is based on IoT (Internet of Things) digital system and links farmers directly to the consumers. It offers services like quality monitoring, technical advice, high quality inputs, market linkages.

Conclusion

Sericulture, being the most labour- intensive sector, provides opportunities for employment, need to be explore more. Innovations play a prominent role in achieving this target. Further, this can be made possible by exploring new ideas, focussing on sericulture linked with farmers and much more developments in sericulture technology. It can be achieved by accepting the challenges and daring innovations leads to the development of the sericulture sector. Thus, the innovations should reach to the farmers so that they can upgrade themselves with the traditional methods with reduced income and make them to overcome the losses by adopting the recent innovative approaches in sericulture.

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