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Grass Root innovations for Better Performance of Sericulture Industry

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ABSTRACT: Sericulture is the art and science of rearing silkworms for the production of silk. It comprises a lot of on-farm and off-farm activities generating employment and income to rural population of India. Innovations are technical solutions to the problems faced in each sector of sericulture. The development of novel techniques in mulberry cultivation can help farmers to plant mulberry on large area. The need of convenient, strategic and cost-effective approaches may ensure mass scale rearing of silkworms. Conduct of programs/trainings/workshop by acquainted resource staff can persuade the farmers to adopt the novel techniques which can help in transfer of technologies and adoption of innovations. The large scale mass rearing of silkworms can generate bulk of silk output offers chance for upliftment of socio-economic status of Indian rural population.

Keywords: Mechanization, silkworm, CSRTI-Mysore, technology.

INTRODUCTION

Innovation may be defined as the process of addressing a new idea, technique or solution to a problem to enhance efficacy and durability of system. In agriculture, innovations are the new products, techniques, or strategies developed by research scholars, farmers or organizations to maintain sustainability of agriculture for its contribution to food security, economic development and natural resource management (Blakeney, 2022). Sericulture is an agro-based industry that deals with rearing of silkworms for the production of silk. Sericulture is the greatest labour-intensive sector of Indian economy, offers source of livelihood to major part of population by providing profitable self-employment to farmers and their families. It requires low investment, short gestation period with greater income returns and self-employment to small and marginal farmers (Sarkar *et al*., 2017). Sericulture is regarded as both, an art and science which involves three major components *viz.*, mulberry cultivation, silkworm rearing and post-cocoon processing. It comprises of a series of on-farm and off-farm activities and generates a lot of by-products from each activity directly or indirectly (Sharma and Kapoor 2020).

China is the leading producer of high quality silk. The development of different techniques, machines and equipments for different sectors of silk industry had strengthened the production of high grade silk in bulk (Chanotra and Bali 2019). Different machines have been evolved and implemented from last few decades to maximize the silk yield. Many developments have been advocated in silk reeling sector, different traditional and conventional techniques were evaluated (Hariraj *et al.*, 2019). Sericulture byproducts are developed as alternative options to food industry, drug system biomedical engineering and textiles. Silkworm pupa being proteinaceous has a wide range of applications in dietetics, animal food, cosmetics and fertilizers (Jaiswal *et al.*, 2021). Sericulture is inter-connected and inter-related with agricultural crops *viz.*, biogas production, livestock production, aquaculture, horticulture etc. Wastes in sericulture are generated in bulk in each activity and can be exploited for biofuel, biogas, livestock production and mushroom cultivation. Seri-bio waste *viz.*, surplus leaf, bed-refuse from silkworm rearing activity can be used for cattle and sheep fodder (Wani *et al.*, 2020).

The integrated system of sericulture farming with agriculture and other allied fields stimulates maximum exploitation of bio-resources of each system with reduction in its adverse effects on the environment (Bhattarcharjya *et al.*, 2019). Nothing is waste in sericulture and can be potentially exploited in other sectors which promote sustainable development and prosperity of small enterprises of other sectors. Sericulture fulfills the employment to 7.6 million people in India (Syamaladevi, 2022) and identified by researchers and policy makers as a potential hub for socio-economic development. In this review an attempt has been made to elucidate many innovations at grassroot level for the upliftment of sericulture industry.

INNOVATIONS IN DIFFERENT SECTORS OF SERICULTURE

1. Mulberry cultivation: Mechanization is the use of machines or technology in providing the services more effectively and efficiently to increase the productivity. In mulberry cultivation, timely harvest of leaf with quality and quantity is of prime importance (Mwai *et al.,* 2021). Mulberry is propagated mainly through stem cuttings (Hawramee *et al.,* 2019). The manual preparation for cuttings requires many skilled labors. The cutting preparation machine which makes 1200 cuttings in one hour has been developed by CSRTI Mysore (Chanotra and Bali 2019). Mulberry leaf harvest and disposal at the place where silkworm rearing is being conducted is time consuming and laborious process. Mulberry plant cutter which uses a holder to hold the plant and a cutter to cut the plant has been developed. It is movable, simple, convenient and farmer friendly machinery. CSRTI Mysore have developed paired row and 3M plantation system to accommodate large number of mulberry bushes and mechanized practices evolved (Patnaik, 2008). It reduces cost of leaf production and working efficiency faster. Different equipments have been developed for ease in intercultural operations viz., Power Rotavator, Cultivator and Weeder. These are cost-effective and convenient for use in different mulberry plantation systems *viz.*, pit system, row system and tree or bush plantation system (Chauhan and Tayal 2017). Disease and pest control is important for healthy mulberry production. Different sprayers have been developed by different institutes viz., self-propelled sprayer, power tiller mounted sprayer by CSRTI and TNAU respectively. Many technological innovations have been developed for the control of mulberry diseases viz., Navinya, Nemahari (Plant based formulation), Raksha (Talc-based biofungicide) and root-fix for control of root-rot and root knot diseases of mulberry. Azotobacter biofertilizer (*Azotobacter chrococum* bioformulation) is being effectively used as a nitrogenous fertilizer in mulberry.

2. Innovations in silkworm rearing: Silkworm rearing is the mass scale rearing of silkworms for production of silk (Vijayakumar *et al.,* 2007). Both on-farm and off-farm activities imparts greater employment potential feasible for women fork of the rural society as well. However, need of technological developments asserts higher silk production with better income to farming people. The contemporary sericulture has been advanced by the implementation of novel technological innovations at farm and industry level to enhance the silk productivity (Andadari *et al.,* 2022). The growth and development of silkworm is influenced by environmental factors. Therefore, the maintenance of environmental parameters as per requisites of silkworm health is a bit challenging process (Rahmathulla, 2012). However, the potential performance of novel innovations *viz*., Arduino aided Internet of Things (IoT), image processing technique and smart sensors of technological innovation is appraised as a master stroke key to the problem. It is simple, convenient and cost-effective solution to achieve successful cocoon crop production (Rokhade *et al.,* 2021). One more innovation, is the development of Internet of Things (IoT) empowered Wireless Personal Area Network (WPAN) system using sensors for monitoring of environmental factors according to recognized different life cycle stages and capturing photos simultaneously to achieve the improvement in series of life cycle stages in silkworm (Nivashini *et al.,* 2018; Singh *et al.,* 2021). Many models have been proposed time to time based on Internet of things (IoT) for the development of smart sericulture technology to promote sericulture (Srinivas *et al.,* 2019; Sreedhar *et al.,* 2020; Eethamakula *et al.,* 2020; Jeegadeesan *et al.,* 2021). In the UT of Jammu and Kashmir, there are three different agro-climatic zones viz., temperate, intermediate (lies between temperate and sub-tropical) and sub-tropical zone. Therefore, there is need of different mulberry cultivars, cultivation practices and silkworm breeds which are specific to different agro-climatic regions. The development of region specific silkworm is of prior importance to revive sericulture industry in Jammu and Kashmir. Fortification of mulberry leaves with proteins and other supplements is a latest technique to enhance the cocoon production. It employs use of different plant or animal based products rich in proteins more particularly to feed the silkworm larvae (Islam *et al.,* 2023). A chawki leaf chopper for chopping the mulberry leaf in thin slices for consumption of young age larvae have been developed. An artificial silkworm diet known as "Nutrid" have been developed for healthy and vigorous growth of silkworms (Gahukar, 2014). CSRTI Mysore, have developed a device which acts as both heater and humidifier as per requirement of rearing room (Chanotra and Bali 2019). A device which picks and separates matured silkworms from mulberry twigs in shoot system of rearing and from trays in tray system of rearing have been developed with almost negligible injury risk to silkworms (Chanotra and Bali 2019). Disinfection is the foremost operation to be carried before commencement of silkworm rearing to maintain the pathogen-free environment for silkworm. An ecofriendly and cost-effective tool which employs the use of fire-flames and LPG as fuel known as flame-gun, have been developed to disinfect the incubation, rearing, leaf, cocoon storage room and rearing equipments (Verma and Dandin 2006). Many bed-disinfectants have been developed such as, labex, Ladhoi, Jeevan- Sudha, Resham Jyoti, RKO, Sericillin, Ankush, Vijetha, Amruth to defend the disease causing pathogens in silkworm rearing (Surapwar *et al.,* 2019). Manual dusting of bed-disinfectants is unsafe for applier. CSRTI Mysore have developed power/battery operated duster which evenly spreads the disinfectants over the silkworm body on trays in less time (Dandin and Verma 2002). Pest control can be achieved by application of uzitrap, uzicide etc. to control the major pest, *Exorista bombycis* in silkworm rearing (Singh and Saratchandra 2003). Plastic tray washing machine possesses efficiency of washing 120 trays/hr with complete disinfection are developed to save the labour

charges and time in silkworm rearing (Chanotra and Bali 2019).

3. Innovations in Post cocoon sector: The collection and separation of cocoons from cocoon frames is laborious and time consuming process. CSRTI Mysore have developed handle/ pedal operated cocoon harvesting machine used for harvesting from 25-50 frames/hr and 50-60 frames/hr from hand operated and pedal operated harvester respectively (Chanotra and Bali 2019). Deflossing is the process of removing floss layer of the cocoon. Manual deflossing is time consuming process and requires labour (Angel *et al.*, 2018). Cocoon deflossing machines *viz*., hand operated, hand operated cum motorized and fully motorized which can defloss 25-30 kg/hr, 50-60 kg/hr and 75-80 kg/hr respectively have been developed (Chanotra and Bali 2019). In grainages, an ample quantity of cocoon needs to be cut for sex determination of pupae and estimation of quantity parameters such cocoon weight, shell weight and shell ratio (Subramanian *et al.*, 2012). Cocoon cutting machine have been developed with efficiency of cutting 5000 cocoons/hr have been developed (Bindroo and Verma 2014). Cocoon boiling or cooking is the process of boiling the cocoons to soften the sericin layer for smooth unwinding of silk fiber from cocoon. It is mostly carried by simple cooking either in single pan system or in three pan system at different temperatures. These methods render the cocoons either over-boiled or under-boiled which are unsuitable for reeling process (Naik and Somashekar 2007). A new technique "Vacuum boiling machine" has been developed in which the uniform softening of all the layers is attained with better reelability. Metallic buttons are non-circular stainless steel device used as thread guide with required specification as that of yarn size, have been developed to avoid slubs in yarn and can be used for comparatively longer time (Lee, 2011).

CONCLUSIONS

Sericulture being the labour- intensive sector provides a source of profitable self-employment to large number of Indian population. Labour wages costs are considerably higher of the total cocoon produced from different sectors of sericulture in India. Hence reduction in labour dependency will ultimately reduce the production costs. The farming technicality in each sector of sericulture is the need of hour. Innovations play a prominent role to accomplish the goal. The novel ideas related to different approaches, appliances, techniques connected with farming people can be explored in developing sericulture. Investment in technology, promotion of technologies and conduction of training programs can contribute in improving the competence in sericulture. The acceptance of challenges and adoption of innovations can lead to the developments in sericulture.

FUTURE SCOPE

The grassroots innovations are technical or general solutions to basic problems faced by silkworm rearers, reelers, mulberry growers, which are associated with the sericulture industry. Innovations at grassroots level may be helpful in studying the genetics of silkworm which plays significant role in improving the characteristics of silkworm by biotechnological approaches. It provides an edge for more advanced innovations with significant balance between innovation and tradition by utilising the accuracy and efficiency of advanced machinery. It may serve as bedrock in preserving the cultural legacy linked with traditional methods employed in different sectors of sericulture. The present need of sustainable silk production approaches can be achieved by ecofriendly methods evolved as grassroots innovation (Seyfang and Smith 2007). Utilization of biodegradable and recyclable materials in machinery, reduction in energy consumption and waste generation during silk reeling can contribute to more sustainable silk industry (Moriwaki, 2018). The advancement of rearing techniques and modernising of silk manufacturing procedures and mechanisation can increase silk output at minimum labour work and charges (Mwasiagi *et al.*, 2012). Therefore, may contribute to increased silk production and improvement in quality of silk.

Conflict of Interest. None.

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