Research Paper
Impact Factor: 3.072

IJBARR
E- ISSN -2347-856X
ISSN -2348-0653

IMPROVEMENT IN THE PRODUCTIVITY, QUALITY OF SILK

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Abstract
This paper deals with international and national scenario of commercial production and market share of silk fabrics with particular reference to process along with machine control parameters followed by adoption of good practices in the preparatory stages during production of the silk fabric in a commercial Silk Mill. An observatory report has been presented here for starting from yarn to the fabric stage, which indicates the major technical reasons for deterioration in the quality of the silk products affecting the cost factor and environment to some extent. This paper delineates an effective monitoring and controlling process variables along with machine parameters at every step of production of silk fabric from its filament yarn stage, particularly during the modern high speed silk twisting process, enhancing the quality of the finished product on one hand and minimizing wastage along with the cost of production and adverse environmental impact on the other.

Keywords: Mulberry silk, Spooling, Doubling Twisting, Reeling.

INTRODUCTION

Silk is a naturally occurring protein fibre produced by the worms. Silkworm races differ in the number of generations that they produce in one year. Monovoltine silkworms have one generation, or harvest. Biovoltine silkworms have two harvests in a year, and Multivoltine types an unlimited number. The quality of Monovoltine and Biovoltine silk filament is normally better than that of multivoltine types [1]. India, the second largest producer of silk in the world, enjoys the unique distinction of producing all the four varieties of natural silk, namely, tasar, eri, muga and mulberry this delicate filamentous fibre is well known for its sheen texture, water absorbency, dyeing affinity, thermal tolerances, and insulation properties [Several silk filaments can be collected to produce textile yarn. The yarn is formed by twisting reeled silk filaments and it is carried out in a particular manner to achieve certain texture as per the endues requirement. In many countries silk is used for clothing, including light weight suits, coats and slacks, jackets, shirts and neckties, robes, loungewear, underwear, furnishing, etc. Silk fabric is also used in lace, napery, draperies, linings, narrow fabrics, and handbags Silk fiber also can be used in parachutes, tire lining materials, artificial blood vessels, and surgical sutures.Over the last few years, China and India emerged to be the, major production centres for various commercial varieties of silk .Globally, silk is produced in more than 20 countries across the world. China, India, Brazil, Thailand and Uzbekistan are the leading producers of raw silk in the world. As may be seen from the above world raw silk production was 1,52,868 MT in 2012. China leads the world with raw silk production of 1,26,000 MT or 82.41% of the global raw silk production India is the second largest producer of silk in the world and has 15.49 % share in global raw silk production. All the countries except China and India mainlyhave been witnessing declining trend in raw silk production in the last two decades. There may be several technical reasons behind this decline or marginal sluggish growth of raw silk. Some of researchers are of the view that the advent of synthetic fibres in the market, such as nylon and polyester, which are comparatively low in price, are to some extent substituting silk compromising thereby with the quality. While others opine that the reeling sector remains highly unorganized and fragmented and mostly uses traditional reeling techniques. Low yield of silk due to improper quality of cocoons, price fluctuation due to exports and dumping, and shift in preference among the weaving community from the traditional Indian reelers to imported silk are major concerns of the reelers. Also, many a times, because of inconsistent quality of the raw silk, which does not meet requirements of international customers, quality of the final product is not up to the mark. This, in turn, hampers the prospects of the exporters in establishing a name of repute for them in the international market.. Indian silk production has shown 7.22 % growth (18,370metric ton in financial year 2008to 23,679metric ton in financial year 2012).The quantity and value of raw silk imported during 2007-08 to 2011- 12 are provided in the Table below. The Table below.

Quantity and the value of the raw silk imported from 2007-08-2011-12

Year	Quantity in metric tonns	Value in crores
2007-08	7922	734.44
2008-09	8392	903.06
2009-10	7338	933.70
2010-11	5820	927.59
2011-12	5683	1111.53

The Indian silk goods are being exported to the traditional major markets like the USA and European countries and small markets of Asia Region. There was a slump in silk goods exports from the country from 2008-09 onwards due to melt down in the global economy and sharp depreciation in the value of Indian Rupee against US$. The silk goods export earnings

increased by 16.5% during 2008-09 (Rs.3,178 crores) over the previous year's performance of Rs.2,728 crores. However, the export earnings reduced in the subsequent years to reach Rs.2353.33 in 2011-12.

The value of exports silk and silk goods from 2007-20011-12 is given below in the table.

2007-2008	2008-09	2009-10	2010-11	2011-12
45.38	35.08	29.42	39.39	19.65
1851.68	2092.64	1942.57	2083.82	1498.00
746.55	986.57	854.94	683.31	765.83
72.11	58.67	40.59	21.10	20.08
12.15	5.23	24.92	36.14	49.77
2727.87	3178.19	2892.44	2863.76	2353.33

The commercial silk manufacturing process begins with reeling which involves the sorting and grading of cocoons as per color and texture. The graded cocoons are then steamed or placed in warm water to soften the natural gum. This is followed by the unwinding of the cocoons. About 2,000 to 3,000 ft. (610–915 m) of filament can be obtained from each cocoon, four to eighteen strands of which are reeled or twisted together to make an even thread strong enough to withstand the weaving tension. This is called raw silk. The next step, called twisting/throwing, involves preparation of the raw silk for the loom by twisting and doubling it to the required strength and thickness. The series of preliminary steps involved in the preparatory process are winding, doubling, twisting, rewinding, warping and pirn winding [Silk, after throwing, assumes three Forms singles, tram and organized. For sewing and embroidery thread, more doubles and smoother twists are made

The silk yarn specimens have been subjected to the process of soaking. The main objective of this process is to improve the pliability of silk filament in subsequent twisting process followed by facilitating smooth unwinding of the hank. The soaked hanks are then dried in air in a confined chamber. This is followed by spooling where filament yarn is converted from hank to bobbin eliminating the imperfections such as slubs, weak places; gums spot entangled extra yarn etc. The yarns are then doubled as per the requirement of fabric specification followed by the twisting process where the primary objective is to impart required twist on parallel doubled yarns. The level and direction of twist give the required texture to the fabric. Eventually, the twisted yarns are subjected to heat setting by saturated steam to avoid snarling followed by reeling to make hank from plied yarn package which will be used for subsequent wet processing treatments.

After the silk yarns have been subjected to the different processes like soaking, spooling, doubling, twisting and reeling it has been observed that if effective monitoring and controlling process variables along with machine parameters at every step of production of silk fabric from its filament yarn stage, particularly during the modern high speed silk twisting process, can be carried out then it enhances the quality of the finished product on one hand and minimizing wastage, costs and adverse environmental impact on the other. The different good practices that need to be adopted at the different process stages have been discussed here. In the process of Soaking, an anionic surfactant solution, needs to be circulated through silk books/bundles of standard mass of 5 kilograms each, for 20-25 min. approximately at 40 C. But if this temperature gets elevated due to negligence then there is a possibility of degradation in quality of the temperature sensitive silk yarns. Liquor should contain soft water to avoid the presence of any type of iron stain appearance on the finished product. During the process, silk books should be wrapped by a fine nylon filter cloth before putting it in silk press machine to avoid the occurrence of any staining. Required dosage of anionic surfactant is to be applied depending upon the twist of the yarn for the high twisted material such as warp yarn. The anionic surfactant should be 6% to 7% on the weight of the yarn intended for high twist and 4% to 5%on the weight of the yarn intended for low twist It is always a good practice to remove the central three threads out of five packing threads of the silk book /bundle before placing it in the silk press machine for healthy penetration of liquor in the silk books. Approximate time required to complete one soaking cycle is approximately 22-24 min of 20 kg capacity in a modern soaking machine.

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The year 2011-12 being the terminal year of XI Plan has been an excellent year so far as silk production is concerned. All the sectors of silk covering mulberry (both multivoltine and bivoltine) and Vanya silks have shown positive growth over the previous year. While the mulberry bivoltine silk and tasar silk have respectively shown an increase attributed to improvement in productivity leading to vertical growth of the industry due to R&D interventions and implementation of centrally sponsored Catalytic Development Programme resulting in technology absorption. The industry has now taken a momentum

of growth which is likely to be continued in the coming years of XIIPlan. of 20.4% and 36.4% production, the overall registered an increase over previous year silk production has of 13% reaching a touchdown performance over the previous year as The remarkable performance of silk industry during IX, X and XI Plan periods indicated below, has shown a steady growth over the years Inspite of drastic reduction in the area due to various constraints like drought, labour scarcity, urbanization, drastic fall in cocoon prices etc. The increase in the silk production in the country is attributed to improvement in productivity leading to vertical growth of the industry due to R&D interventions and implementation of centrally sponsored Catalytic Development Programme resulting in technology absorption. The industry has now taken a momentum of growth which is likely to be continued in the coming years of XIIPlan.

MULBERRY SERICULTURE

The productivity of mulberry plantation in terms of silk has reached 93.38 kg/ha/year when compared to yesteryear's 40 kg/ha/yr and enhanced the country's capability in producing silks of international grades. The research interventions in the improvement of host plants through introduction of high yielding mulberry varieties such as V1, S1635, S1, S799, S13, S34, S146, BC259, Tr10 and improved silkworm breeds like CSR2 x CSR4, CSR2 x CSR5, SH6 x KA, SH6 x NB4D2, NB18 x P5, YS3 x SF19, Dun6 x Dun22, etc., coupled with the improved processing machinery and management practices have made it possible to reach such acclaimed performance.

MULBERRY DEVELOPMENT

During the year, use of advanced generation breeding technique has resulted in evolution of five new high yielding mulberry genotypes. The technology for identifying the nutrient deficiencies and increasing mulberry productivity, through “Poshan” – a nutrient mixture of macro and micronutrients and a bio-formulation 'Navinya' for control of root-rot disease of mulberry were commercialized, while, the Root-rot and Root-knot diseases were controlled with leaves of Brassica juncea, Raphanus sativus and mustard oil cake. Seven new mulberry progenies and hybrids with higher gain in leaf yield were identified for eastern and North-eastern regions. The selection of water logging tolerant variety C-2028 yielded 6.96 MT/ha/crop under flooded conditions. Technologies like foliar application of 1% KCl in rainfed conditions and pruning of the plants during June with application of Morizyme-B for increased leaf yield and reduction of pest and disease incidence were evolved. Further, application of 1% Pongamia oil and 1% Neem oil respectively were found effective in reducing the pest population in mulberry plants. In temperate zone, mulberry germ plasm was Categorized M.bombyciswas found comparatively frost tolerant. Three new mulberry hybrids S-106, S-140 and S-145 were found superior under multi-location trial, across the Jammu & Kashmir and Uttarakhand regions. The mulberry varieties S-146 and S-1635 were recommended for tree plantation in Himachal Pradesh on the basis of higher leaf yield. New nitrogen fixing bacteria, viz., Stenotrophomonas maltophilia was evolved under Integrated Nutrient Management Programme for mulberry inDehradun soils. Lavendula officinalis, was found to be ideal intercrop with mulberry under temperate conditions. An Integrated Pest and Disease Management (IPDM) module for mulberry pests and diseases was also developed.

SILKWORM IMPROVEMENT

Three new three-way-cross hybrids, namely; FC1 x CSR2, FC3 x CSR2 and FC3 x CSR17 were identified for high productive traits of pupation rate, shell percentage, filament length, raw silk and neatness. A newly developed double hybrid [DH2 (CSR50 x CSR52) x (CSR53 x CSR51)] was tested in large scale with a record cocoon yield of 67.5 kg. Two new double hybrids, one [(D1 x D2) x (D11 x D13)] with shorter larval duration and average cocoon yield of 89 kg/100 dfls and another [(CSR2 x CSR50) x (CSR51 x CSR26)] with an average yield of 90 kg /100 dfls were identified. One SSR marker for IFV resistance was identified. A bivoltine male parent 'CSR50' has been identified for multi x bi hybrid production. CSR16 x CSR17, CSR46 x CSR47 and Gen3 x Gen2 were tested at farmers' level and obtained cocoon yields of 67.5 kg, 65.3 kg and 68.1 kg/100 dfls respectively. Three new bivoltine silkworm hybrids, viz, Pam115 x CSR2 ; Pam117 x Pam114 and CSR2 x Pam117 were developed for Jammu & Kashmir region. 73 multivoltine and 350 bivoltine silkworm accessions were characterized, evaluated and conserved in Germplasm bank. 15 MV and 21 BV silkworm accessions were identified as hardy races based on esterase and alkaline protease enzyme inhibitor kinetics. For eastern and northern states, 80-day egg preservation technique has been developed for multivoltine silkworm-pure and hybrids, viz, Nistari, Nistari x NB4D2 and Nistari x CSR2 respectively. Similarly, P2 layings of CSR2, CSR4, CSR6, CSR26 & CSR27 in West Bengal were preserved for a two year schedule along with regular schedules of 4, 6 and 9 months. Biological control method was developed to control papaya mealy bug, Paracoccus marginatus in mulberry garden by releasing exotic parasitoid, Acerophagus papaya.

VANYA CULTURE

The Vanya silk production has reached a greater height of 4748 MT giving a scope for further increase. Tasar and eri silk production has increased to 36.6% and 9.8% respectively.

SILKWORM IMPROVEMENT

The evolved BC-IV line of Andhra Local performed better than their parents yielding 35 cocoons/dfl. Tasar Amrit tested at farmers' level y ield e d 9 3-9 5 c oc oo ns /dfls . Remarkable performance of Jeevan Sudha (botanicalformulation against Virosis) in increasing cocoon production by 10-12 cocoons/dfl has led to patent filing. Two productive lines of oak tasar silkworm with an yield potential of 65 and 74 cocoons/dfl were developed. A polythene device developed for practising indoor rearing has achieved 65.8% success in survival of II instar worms. 8 wild muga silkworm stocks were collected and conserved under ex-situ conditions of Assam. Out of these, Aa00-1 collected from South Garo Hills showed 96% polymorphism. Application of 20-hydroxy ecdysone on fifth instar larvae was found improving vitellogenin synthesis (40-70%), egg formation (40-60%), ovarian development and protein synthesis in the haemolymph of larvae, retention of less eggs in abdomen (12-15), fecundity (50-59%) reduction of egg laying period by 3 days and overall rearing performance. With the development of muga seed cocoon preservation technique, the seed cocoons could be preserved upto 62 days during Jarua crop and 42 days during Aherua crop without affecting fecundity and hatching. A new eri hybrid (C2) was developed and subjected to multi-locational trials in different parts of North-eastern region.

TECHNOLOGIES COMMERCIALIZED

1. High sprayer pump – for rearing house disinfections,
2. Bio-fertilizer - for mulberry plants
3. Navinya - a bio-formulation for control of root-rot disease
4. Poshan – a multi-nutrient formulation for mulberry.

POST-COCOON TECHNOLOGY

A compact vertical reeling-cum-spinning machine was developed jointly with DOS, Jharkhand. The machine yields 200 g of raw silk per day. Reeling permeation chamber technique was standardized for production of superior quality wet reeled tasar yarn and sizing. The chemical formulation Muga Silkplus developed for cooking and reeling of muga cocoons is yielding raw silk recovery ranging from 40-45% to 50-55%. Application of solar heating systems in multiend reeling unit with installation of an Ushma Shoshak (heat recovery) unit and 1000 LPD insulated water tank, significantly reduced fuel consumption (up to 40%) resulting in reduction of production cost. Comparison of properties of Indian multivoltine, Indian bivoltine and Chinese bivoltine woven silk fabric revealed that Indian multivoltine is more lustrous with better drape and is a desirable quality for sarees / dress materials. Lac dye in screen printing on mulberry silks was found to be more lustrous than non-mulberry (tasar) silks but the fastness properties were in acceptable range except wash and perspiration fastness. Different types of new fabrics were developed with a focus on Vanya silks (tasar and eri). Shawls with 2/40s peduncle yarn for Gents /ladies were developed. Similarly, furnishing fabrics from mill-spun peduncle yarn were also developed. Sarees were produced on power loom using wet reeled tasar yarn. Five different combinations of Solapur chadars using eri (spun and noil), mulberry and cotton were developed. Himroo shawls of Aurangabad using eri and cotton were developed.

SEED ORGANIZATION

National Silkworm Seed Organization produced a total of 125.06 lakh bivoltine hybrid and 196.482 lakh cross-breed dfls during the year. Under basic seed production programme, 7.69 lakh bivoltine and 2.79 lakh multivoltine layings were produced. Average egg recovery in CSR hybrids was 64.05 g/kg and 71.07g/kg seed cocoons in double hybrids in southern region, while it was 55.06 g/kg in the northern region. The average egg recovery in cross-breed dfls produced in the southern region was 30.36 % Ø Sericulture is included as agriculture allied activity under RKVY. This enables the Seri culturists to avail the benefits of the scheme for the entire sericulture activities up to reeling. During the year 2011-12, sericulture projects costing Rs 42.114 crore have been posed for funding under RKVY. The CSB (Amendment) Act, Rules and Regulations have been notified by the Govt. of India to bring quality standards in s silkworm m seed production. Seed production units are being registered as per the provisions made under the Act Anti-dumping Duty: Anti-dumping Duty has been imposed on import of low quality raw silk and fabric from China to protect the interest of domestic silk industry. The Govt. had imposed anti-dumping duty with effect from Jan-2003 on the cheap imports of raw silk of Grade 2A and below till January, 2008 and continued till January, 2014 after a review. Regarding the fabric, the anti-dumping duty imposed by Directorate General of Ø Ø NSSO produced 562.09 lakh bivoltine and 355.54 lakh multivoltine seed cocoons. A total of 60.49 lakh bivoltine hybrid and 201.11 lakh crossbreed layings were distributed through SSCs, SSUs and Franchisee CRCs. 78.24 lakh seed cocoons were supplied to the SSPCs, LSPs & DOS of West Bengal and DOS, UP. In tasar sector, the performance in all activities has surpassed the laid targets. 11.73 ha of tasar host plants were raised at different places. Out of 35.08 lakh tasar dfls produced, 34.23 lakh dfls were supplied. 70.79 lakh cocoons were produced through rearing of 1.32 lakh dfls by the units, with a yield of 53.6 cocoons/dfl. In muga, 2,14,532 g of P2 basic seed and 38,613 g of commercial seed were produced and in eri, 2.77 lakh dfls were produced at SSPCs.

POLICY INTERVENTION

Some important policy initiatives taken recently for the development of silk industry are:

1. Sericulture is included as agriculture allied activity under RKVY. This enables the Seri culturists to avail the benefits of the scheme for the entire sericulture activities up to reeling. During the year 2011-12, sericulture projects costing Rs 42.114 crore have been posed for funding under RKVY.
2. The CSB (Amendment) Act, Rules and Regulations have been notified by the Govt. of India to bring quality standards in silkworm seed production. Seed production units are being registered as per the provisions made under the Act.
3. Anti-dumping Duty: Anti-dumping Duty has been imposed on import of low quality raw silk and fabric from China to protect the interest of domestic silk industry. The Govt. had imposed anti-dumping duty with effect from Jan-2003 on the cheap imports of raw silk of Grade 2A and below till January, 2008 and continued till January, 2014 after a review.
4. Reducing import Duty: Govt. of India has reduced the custom duty on import of raw silk from 30% to 5% during the last Budget, in order to safeguard the interest of the silk weavers of the country and to bring in stability to the abnormal increase in the raw silk prices of both domestic & imported silk.
5. Regarding the fabric, the anti-dumping duty imposed by Directorate General of Ø Ø NSSO produced 562.09 lakh bivoltine and 355.54 lakh multivoltine seed cocoons. A total of 60.49 lakh bivoltine hybrid and 201.11 lakh crossbreed layings were distributed through SSCs, SSUs and Franchisee CRCs. 78.24 lakh seed cocoons were supplied to the SSPCs, LSPs & DOS of West Bengal and DOS, UP. In tasar sector, the performance in all activities has surpassed the laid targets. 11.73 ha of tasar host plants were raised at different places. Out of 35.08 lakh tasar dfls produced, 34.23 lakh dfls were supplied. 70.79 lakh cocoons were produced through rearing of 1.32 lakh dfls by the units, with an yield of 53.6 cocoons/dfl. In muga, 2, 14,532 g of P2 basic seed and 38,613 g of commercial seed were produced and in eri, 2.77 lakh dfls were produced at SSPCs. Policy intervention Some important policy initiatives taken recently for the development of silk industry are: Anti-dumping & Allied Duties (DGAD) which was in force till May, 2011 from Nov. 2006 has been extended for another term of 5 years from the date of final Notification, i.e. from 5th December 2011.

CONCLUSION

Specific efforts are required to promote development of basic designs, structures and materials that can be used in production of commercial silk products. Initiatives are required in creating awareness among all the levels of the organization hierarchy to produce high and consistent quality of finished products. In order to achieve this it becomes highly essential to have stringent process control and adoption of good practices for obtaining clean surface of yarn, good cleanness character, less no of knots, tail end size of knots, unwinding condition of cones, sufficient tenacity, high elongation, which give us good quality fabric mitigating thereby the wastage percentage and cost factor on one hand and increasing the acceptance percentage of the finished product on the other creating thereby a brand image for —Indian Silk‖ as an international brand.

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