A STUDY ON TECHNOLOGICAL UP GRADATION IN SILK AND HANDLOOM INDUSTRY

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ABSTRACT

The silk and hand loom Industry is one of the productive cottage sectors in India is developing rapidly and lucratively over the past years. Pre-cocoon and Post-cocoon are the two major areas in this industry. The pre-cocoon sector, called farm or sericulture sector, is connected with larval stage to cocoon production stage. The post-cocoon process involves reeling, twisting, dyeing, designing, weaving and trading, which help in the production of silk apparel. However, as far as individual sector is concerned, several constraints are involved. For instance, it is found that the silk reeling and dyeing entrepreneurs face several problems starting from purchase of cocoons to dyeing of yarn. Handloom sector manufactured cotton terry towels and bed sheets. The towels and bed sheets are renowned in the country and have good market in India. The main raw material for the units is cotton yarn, which is procured from local spinning mills and agents. Majority of the cluster units are of integrated type, where the raw material yarn is processed in-house to the final product. The electricity is used for power looms, doubling machines, winding machines, hydro extractors, warping machines and lighting. In general wood is used as fuel for boilers, thermic fluid heaters, and chulhas for hot water generation. Using of Auto Loom or Rapier Loom in Handloom Sector, the weavers can increase their productivity and decrease operational cost. The main objective of the study is to find solutions for effluent treatment and for drying the chrysalises through solar energy. Further, it is to verify the relevance, effectiveness, and efficiency of the solar system for the silk reeling and dyeing sectors, besides identifying constraints / bottlenecks and inherent problems during implementation. This study also assesses the actual benefits to be accrued to the beneficiaries in the silk and handloom industry and to provide an idea whether the intended Non-Conventional approach would be beneficial.

Key Words: *silk and hand loom Industry, solar system, conventional and non conventional methods, Multi-end Reeling Machine unit, Automatic Reeling Machine, Auto Loom / Rapier Loom*

I. INTRODUCTION:

The silk Industry is one of the productive cottage sectors in India is developing rapidly and lucratively over the past years. Pre-cocoon and Post-cocoon are the two major areas in this industry. The pre-cocoon sector, called farm or sericulture sector, is connected with larval stage to cocoon production stage. The post-cocoon process involves reeling, twisting, dyeing, designing, weaving and trading, which help in the production of silk apparel. These processes occur gradually for the production of silk fabrics. Finally, the finished product is made available to the traders for sale. Considering this cottage industry as a whole, the entire process of silk manufacturing is profitable. However, as far as individual sector is concerned,

several constraints are involved. For instance, it is found that the silk reeling and dyeing entrepreneurs face several problems starting from purchase of cocoons to dyeing of yarn. The main objective of the study is to find solutions for effluent treatment and for drying the chrysalises (silkworm pupae) through solar energy. Further, it is to verify the relevance, effectiveness, and efficiency of the solar system for the silk reeling and dyeing sectors, besides identifying constraints / bottlenecks and inherent problems during implementation. This study also assesses the actual benefits to be accrued to the beneficiaries in the silk industry and to provide an idea whether the intended Non-Conventional approach would be beneficial. The present investigations would be carried out to find certain solutions for the environmental and financial related obstacles in the silk reeling and dyeing sectors of silk industry through renewable solar thermal energy.

II. OBJECTIVES:

1. To analyze how to ETHP based Solar Water Heating System (ETHP-SWHS) to minimize the usage of firewood in both reeling & dyeing (wet processing) sectors.
2. To analyze how to ETHP based Solar Hot Air Generating System (ETHP-SHAGS) to produce hot air for drying of silk yarn, so that the consumption of electricity can be reduced.
3. To study about Effluent Treatment Plant (ETP) / Waste Water Treatment Plant for treating the effluents released from both reeling and dyeing units.
4. To study uses of Developing of Silkworm Pupae Solar Dehydrator (SPSD) for drying the chrysalises to supply the dried pupae for poultry, fishery, pharmaceutical and cosmetic industries, so that the revenue of the reelers will be increased. It further supports to make the silk industry eco friendly.
5. Comparative study between Conventional Power-Loom and Rapier Loom In Handloom Sector
6. To make the silk and handloom industry more environmental friendly and to improve the quality of life of the silk entrepreneurs.

III. OPERATIONAL PLAN FOR INNOVATIVE PRODUCTS IN SILK INDUSTRY:

1. ETHP based Solar Water Heating System (ETHP-SWHS) that generates hot water can minimize the usage of firewood to the maximum extent in both reeling & dyeing (wet Processing) Sectors. In reeling sector, the maximum heat is required for cocoon cooking, which is 98^{o} C. And the quantity of hot water required for cocoon cooking is approximately 330 liters to 350 liters per day for a 10-basin MRM (Multi-end Reeling Machine) Unit. After this, cocoons will be shifted to the reeling basins. A 10-basin MRM contains 10 reeling basins. Each basin holds 40 liters of hot water with temperatures between 35^{o} C and 45^{o} C. For all these purposes, the reelers rely upon the boilers.In other words, this process is unprofitable for the silk entrepreneurs, and considerably contributing to elevate pollution levels through increased emission of Carbon dioxide ($C0_2$), Carbon Monoxide (CO), Methane (CH_4) – a strong greenhouse gas and Nitrous Oxide (N_2O). The concepts and results presented here are the outcome of preliminary work and studies carried out within recent times. Therefore, if Evacuated Tube Heat Pipe Collectors (ETHP) is introduced for reeling sector, a boiler needs to raise the temperature only between 10^{o}C and 15^{o}C to generate team from 90^{o}C to 95^{o}C of hot water, produced through ETHP-SWHS. A 10-basin MRM unit needs about 115 liters of hot water with different temperatures. Further, a 10 kg capacity boiler needs around 500 liters of cold water per day. If ETHP-SWHS with 90^{o}C or 95^{o}C output

temperature is adopted for the silk reeling and dying sectors, the savings will be significantly high.

Firewood consumption and the expenditure incurred by MRM Units

For 45 boilers *(Assuming 250 kg firewood consumption per boiler / day)*	**Per Day**	**Per 30 Days**	**Per 350 Days**
Average firewood consumption (in Tons)	11.25	337.5	3937.5
Expenditure @ Rs. 2000 per ton	22,500	6,75,000	78,75,000

2. ETHP based Solar Hot Air Generating System (ETHP-SHAGS) to produce hot air for drying of silk yarn. Apart from hot water requirement, it is also very much essential to generate hot air for various applications like silk cocoon stifling, silk yarn drying on reeling/re-reeling machines etc. The conventional hot air drying methods burden the entrepreneurs. This recurring financial burden can be significantly minimized through free solar energy. It can be achieved the hot air of 85^{o}C temperature, through Evacuated Tube Heat Pipe based Solar Hot Air Generating System (ETHP-SHAGS). This is 74% of the maximum temperature i.e. 115^{o}C that is required in conventional method of electrical hot air stifling. Therefore, the silk industry can make use of the common solar energy systems with electronic temperature controllers to minimize the recurring expenditures on electricity and firewood. As SHAGS can generate 85^{o}C hot air, it is easy to raise another 30^{o}C through electrical heaters. Drying is the removal of moisture from a product until its moisture content is low for safe storage. The method of renewable energy based drying is not a new concept, but the place of application may be new.
3. Effluent Treatment Plant (ETP) / Waste Water Treatment Plant for treating the effluents released from both reeling and dyeing units. Both reeling & dyeing sectors release lot of effluents to the ground without treating them which in turn causes both surface and ground waters pollute. Therefore, appropriate Waste Water Management System / ETPs are necessarily to be introduced to control this pollution.
4. Silkworm Pupae Solar Dehydrator (SPSD) for drying the chrysalises to use the dried pupae for poultry, fishery, pharmaceutical and cosmetic industries. In silk industry nothing goes waste, as every waste brings additional revenue as well as additional employment. Surprisingly, this value addition may even go up to 10% to 25% in various sectors of post cocoon with effective management and utilization of the waste. As far as silk reeling sector is concerned, silk and pupae wastes are the main by-products. Silkworm pupae are rich in vitamins such as B12 and D. Large quantity of pupae that accumulate in reeling process could be utilized better to produce value aided by-product, by adopting improved technology / process. The oil that is extracted from dried pupae is very much used for soaps, animal biscuits, cosmetics, while cakes feed for fish and poultry. Dead pupae are highly perishable. Value addition to silkworm pupae can be enhanced, finding suitable preservation methods and by conversion of silkworm pupae into convenient processed products for wider market acceptability in different regions. In India, approximately 40,000 MT of silk worm pupae is produced through sericulture, per annum. Conventional method of drying and disposal of silkworm pupae cause environmental pollution besides loss of nutrients in them.Fats and oils are collectively termed as lipids are in great demand for food and non-food. About 90% of this is used in production of soap and other

surface-active compounds and the balance is used for other industrial purposes. The resent, open sun-drying practice invites insects / microorganisms, dogs, rodents, pigs, monkeys, crows, eagles and vultures for a pupae feast, which in turn causes reduction in production Considering the disadvantages associated with conventional pupae drying, a new technology named as Silkworm Pupae Solar Dehydrator (SPSD) is to be designed. The main idea is to dry the pupae in a closed solar cabinet with necessary gadgets that support the pupae dry faster and also to rescue the pupae from insects, birds, animals and unfavorable climatic conditions. Therefore there will be no decline in the production. In addition, the solar dried pupae are protected against decaying and fungal attacks for a longer period.

5. Scaling Innovations through Entrepreneurship Development and new Enterprise creation (Give Business Model to establish commercial viability – how the business built around innovation would make money). Killing of pupae without damaging the cocoons is said to be stifling. For this purpose, the reeling sector uses 3-phase, 5 kW to 10 kW ho air driers. Therefore, to reduce the usage of electricity and in turn curtail the electricity bills, it is proposed to design a solar based hot air generating system named as ETHP-SHAGS. If the silk reeling sector adopts ETHP-SHAGS, the expenditure can come down to 40%. Saving the money is nothing but generating the money. Similarly, silkworm pupae are the by-product of the silk reeling industry, which can generate additional revenue for the reeling entrepreneurs with effective management and utilization. The dried silkworm pupae (Chrysalises) can be used for poultry, fishery, pharmaceutical and cosmetic industries. The silkworm pupae have high nutritive and medical values and it is essential to store them for longer periods. It is difficult to restore these values through convention open-air sun drying system. Therefore, it is essential to be designed and to introduce a solar based dehydrator, named SPSD, to reduce the moisture content in the pupae. If the pupae are dried through Silkworm Pupae Solar Dehydrator (SPSD), they can be packed, stored and can be exported for various purposes, as mentioned above. Further, SPSD minimizes the fungus attack, as 70% moisture will be removed from the pupae.It is difficult to restore these values through conventional open-air sun drying system. Due to the advantages listed above, if the silk reeling sector adopts the ETHP-SHAGS and SPSD, it will not only be beneficial to the entrepreneurs but also be eco-friendly.

IV. ECONOMICS FOR MULTI-END REELING MACHINE (MRM) UNIT:

Generally, a 10-basin Multi-end Reeling Machine (MRM) Unit with 100 kg cocoons consumption per day produces about 12.5 kg of raw silk and 50 kg to 68 kg of wet pupae. Every day huge quantity of silk worm pupae is generated through 10-basin, 20-basin or 30-basin reeling units. By selling these pupae, the reeling entrepreneurs are obtaining merely Rs. 10,000 to Rs. 15,000 per annum as a token amount. But, if the reeling entrepreneurs adopt the SPSD, they can obtain approximately Rs. 45 through every Kg of dried pupae from the pupae oil extractors. Hence, reelers can obtain better revenue from the oil extractor than from the local pupae collectors. Similarly, the dried pupae can be sold for poultry, fisheries, pharmaceutical and cosmetic industries, as pupae are rich in proteins.It was below suggests that the SPSD is another earning source for 10basin MRM reeling entrepreneurs, as solar dried pupae can generate revenue of Rs.2,36,250 per annum. Similarly for 30 basis, the revenue will be Rs. 7,08,750 per annum. Therefore if reeling entrepreneurs adopt SPSD for their reeling units,

they can obtain better revenues from the pupae oil extractors, poultry and fisheries which will be 16 to 23 times then their present earnings.

Economics of SPSD for a 10-basin MRM Unit

- Quantity of wet pupae that generate / day 50 Kgs
- Wt. of the 70% dried pupae 15 Kgs
- Dried pupae price / kg. Rs. 45
- Revenue through dried pupae per day Rs. 675/-
- Revenue for 30 days Rs. 20,250/
- Revenue for 350 days Rs. 2,36,250/-

The manufacturing cost of the SPSD depends on the capacity of the wet pupae to be dried. The manufacturing cost of the SPSD for drying one kg of wet pupae, would be Rs. 3000/- Hence, to develop a 50 kg capacity SPSD, it required to spend Rs. 1,50,000/- as one time investment. When compared to the manufacturing cost of SPSD and the revenues through it as above, the payback period would be 3 months. Further, a 50 kg capacity SPSD needs 9.2903 m^2 (100 sq. ft) areas.

V. ECONOMICS FOR AUTOMATIC REELING MACHINE (ARM) UNITS:

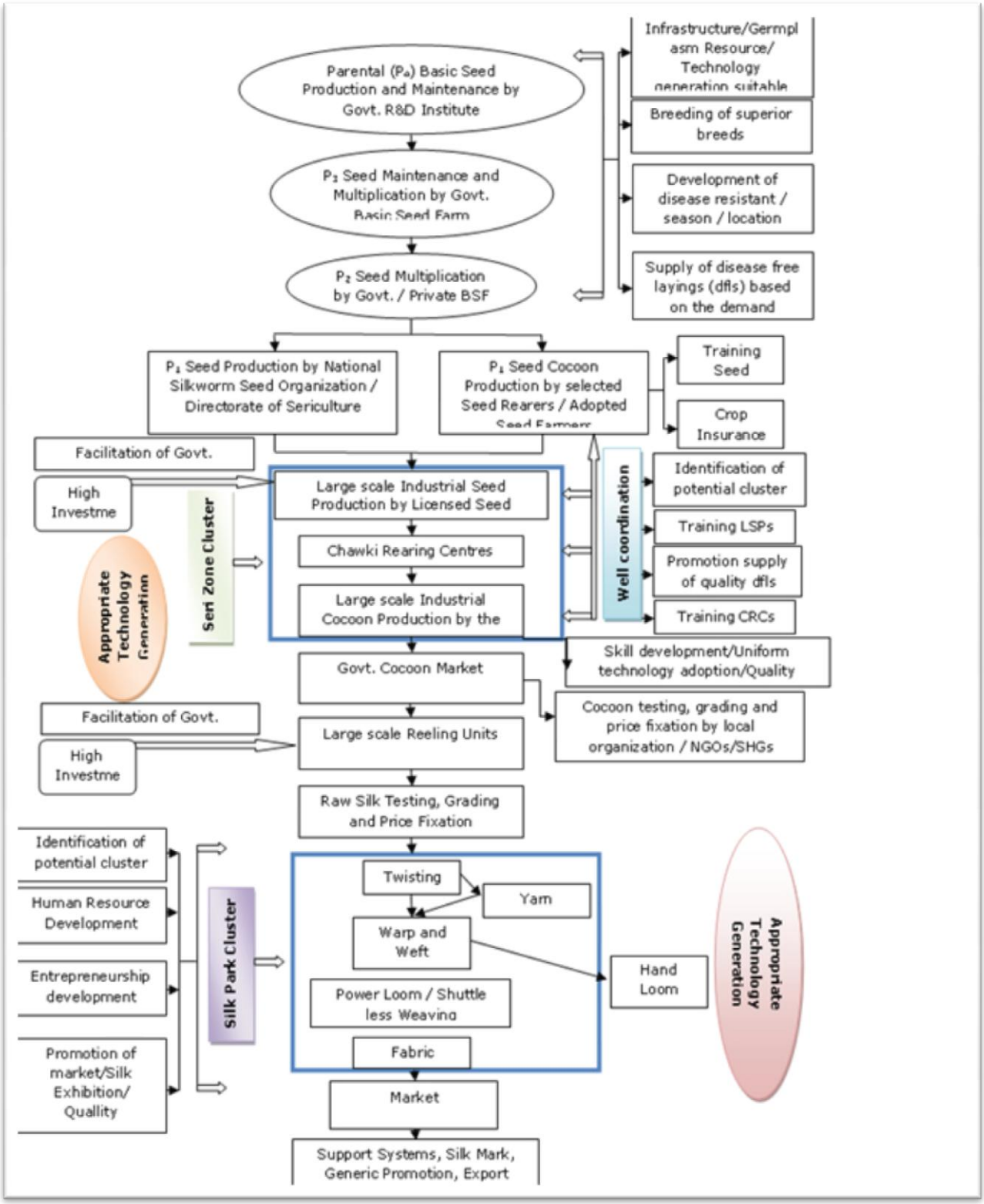
In general, each Automatic Reeling Machine (ARM) Unit consumes 500 kg cocoon per day in 1 ½ sift (each shift = 8 hours) and produces 63 Kg of raw silk. From these 500 kg of cocoons 375 kg green pupae (pupae before stifling) and 225 kg dried pupae will be generated. The pupae that are dried in hot air chamber will again absorb the moisture during cooking and reeling processes. And, these pupae are called as waste wet pupae. Hence, at the rate of 225 kg wet pupae per day the ARM unit generates 78750 kg of wet pupae per annum (350 days). It was illustrates the reveue generation through SPSD dried pupae, for ARM unit.

Economics of SPSD for ARM unit

- Quantity of wet pupae that generate / annum 78,750 Kgs
- Wt. of the 70% dried pupae 23,625 Kgs
- Dried pupae price / kg Rs. 45/-
- Revenue for 350 days Rs. 10,63,125

Based on above the capacity of SPSD and payback period for an ARM unit will be 3 months. Further, the shade free open area required for installation of 225 kg capacity SPSD will be 46.45 m^2 (500 sq. ft.), at the rate of 9.29 m^2 (100 sq. ft.) for each 50 kg capacity SPSD. Due to its simplicity, faster drying rate and many other advantages, the proposed system is relatively inexpensive. Therefore, commercial application seems to be viable.

A strategic model to strengthen and promote Silk, Sericulture& Handloom industry in India


Infrastructure/Germpl asm Resource/ Technology
Breeding of superior breeds
Development of disease resistant / season / location
Supply of disease free layings (dfls) based on the demand
Parental (P₀) Basic Seed Production and Maintenance by Govt. R&D Institute
P₁ Seed Maintenance and Multiplication by Govt. Basic Seed Farm
P₂ Seed Multiplication by Govt. / Private BSF
P₃ Seed Production by National Silkworm Seed Organization / Directorate of Sericulture
P₄ Seed Cocoon Production by selected Seed Rearers / Adopted
Training Seed
Crop Insurance
Facilitation of Govt.
High Investme
Large scale Industrial Seed Production by Licensed Seed
Chawki Rearing Centres
Large scale Industrial Cocoon Production by the
Seri Zone Cluster
Well coordination
Identification of potential cluster
Training LSPs
Promotion supply of quality dfls
Training CRCs
Appropriate Technology Generatinn
Skill development/Uniform technology adoption/Quality
Govt. Cocoon Market
Cocoon testing, grading and price fixation by local organization / NGOs/SHGs
Facilitation of Govt.
High Investme
Large scale Reeling Units
Raw Silk Testing, Grading and Price Fixation
Identification of potential cluster
Human Resource Development
Entrepreneurship development
Promotion of market/Silk Exhibition/ Quallity
Silk Park Cluster
Twisting
Yarn
Warp and Weft
Power Loom / Shuttle less Weaving
Fabric
Hand Loom
Appropriate Technology Generation
Market
Support Systems, Silk Mark, Generic Promotion, Export

VI. SILK INDUSTRY IN ANDHRA PRADESH AND TELANGANA AT A GLANCE:

Reeling Sector:

- Total No. of MRM Basins: 1110 (137 MRM Units)
- Total Cocoons Production: 3000 M.T.
- Total Silk Production: 920 M.T.
- Job opportunities to: 1500 Families
- Pupae Generation: 3000 x 65% i.e. 1800 M.T.

Weaving:

- No. of Looms: 2,00,000 handlooms (Approximately)*

**All allied activities means warp preparation, weft preparation, Harness tying, warp joining etc*

- Job Opportunities to : 15,00,000 members (Incl. all allied activities)
- Consumption of Raw Silk: 13320 M.T.

Twisting:

- Total No. of Units: 250 No.s
- Capacity: 75,000 spindles

Computer Aided Textile Designing: 75 Units

Dyeing: 25 units (Major) + Countless street dyers

VII. AUTO LOOM / RAPIER LOOM IN HANDLOOM SECTOR

The products manufactured in Textile Cluster are cotton terry towels and bed sheets. The towels and bed sheets are renowned in the country and have good market in India. The main raw material for the units is cotton yarn, which is procured from local spinning mills and agents. The cost of energy (electrical and thermal energy) as percentage of manufacturing cost varies between 8% and 10%. Majority of the cluster units are of integrated type, where the raw material yarn is processed in-house to the final product. The energy cost is second to the raw materials cost. Majority of the units in the cluster are dependent on local/ run of the mill technologies of low end and with little investment initiatives and technology up-gradation. The main energy forms used in the cluster units are grid electricity, wood, and small quantity of coal. The electricity is used for power looms, doubling machines, winding machines, hydro extractors, warping machines and lighting. Wood is used as fuel for boilers, thermic fluid heaters, and chulhas for hot water generation. The details of annual energy consumption of a typical unit having a production capacity of 1, 20,000 kg of final product of the cluster are Electricity consumption - 1,97,784 kWh per annum and Wood consumption 144 tons per annum

VIII. PRODUCTION PROCESS

The main operational process for production of towels and bed sheets in cluster units are:

- **Doubling:** In the Doubling process, thin single yarn is converted to double yarn for strengthening the yarn by using doubling machine.
- **Yarn dyeing:** Initially, the yarn is soaked in soap water for 24 hours to remove the dirt and other foreign materials and after soaking, the yarn is taken for bleaching. Bleaching is carried out by soaking the yarn in tanks mixed with bleaching agents and after completion of the process; the yarn is washed with normal water. The hang dyeing machine tanks are filled with required quantity of

normal water and required chemicals and dyeing agents are added. The temperature of the water is raised by oil circulation or direct steam injection. Firewood is used as fuel. The required colors are added to the yarn and the dyeing process takes about 90 to 120 minutes per batch. After dyeing, the yarn is washed with normal water, and the yarn is taken for soaping for colour fixation in hot water for about 20 minutes in hang dyeing machines. The water is drained to the waste drainage lines. The wet yarn is taken to hydro extractors for removing the water in the yarn and taken for drying in the natural sunlight.

- **Winding:** The yarn after drying is taken for winding in which the yarn is wounded to bobbins and cones. The winded yarn is taken for further process
- **Warping:** In warping, the winded yarn is wound to beams according to designed pattern (customized designs). Then the beams are taken for Weaving.
- **Weaving:** The beams, which are wound with yarn are taken and placed in power looms where the designed pattern is already set. In power looms, the yarn is converted to final product (Towel or bed sheets) by weaving. The product obtained from weaving is taken for stitching and packing. The general process flow diagram of a typical unit for production of towels and bed sheets. The production process as depicted above is similar for all textile units in all textile clusters. However, depending on type of product and product quality, the above stated process flow varies as per the requirement of the industry.
- **Energy Performance in Cluster:** Majority of the industries located in Sholapur are engaged in manufacturing of towels and bed sheets. The main energy sources for Sholapur cluster units are electricity and fuels such as Wood & briquettes. The wood and GN husk briquettes are used as fuel for boilers, thermic fluid heaters and chulhas for hot water generation and electricity is used for operation of prime movers of doubling machine motors, ID & FD fans, pumps, hank dyeing machine drives, power loom drives, winding machine motors, etc. Majority of the units in the Sirisilla textile cluster are using wood for thermal energy generation due to easy availability and economical point of view. Energy cost is around 8 to 10 percent of manufacturing cost in typical manufacturing unit, out of which the cost of electrical energy works out to 58 percent of the total energy cost and remaining accounts for thermal energy. In a typical textile manufacturing unit annual consumption of electrical energy and wood is 1,97,784 kWh and 144 tons respectively for average production capacity of 1,20,000 kg of final product.
- **Specific Energy Consumption of Final Product:** Specific electrical and thermal energy consumption in textile unit depends upon the final product manufactured in that unit. The electrical and thermal energy consumption of typical textile unit is 1.65 kWh per kg of final product and 1.20 kg of wood per kg of final product respectively (includes all colours dyeing in cold water, medium temperature water and high temperature water)

IX. EXISTING EQUIPMENT:

Description: During energy audit studies in various textile industries in Sholapur textile cluster, it wasobserved that about 1200 power loom in Sholapur Textile cluster. All power looms are of shuttle type and are too old. These power looms are used for weaving terry towels and bed sheets. In the present conventional shuttle looms, it is necessary to pass a shuttle weighing around half a kilogram through the warp shed to insert a length of weft yarn, which weighs only few grams. The shuttle has to be accelerated rapidly at the starting of picking cycle and also to be decelerated, stopped abruptly at the opposite end.

This process creates heavy noise and shock and consumes considerable energy. Beat-up is done by slay motion which again weighs a few hundred kilograms. The wear life of the picker and checking mechanism is also limited due to heavy shock. Due to the above reasons smooth sequence of weaving is disturbed which affects the maximum running speed and hence machine production. In multi colour weft insertion, Drop box motion is attached which is also further limits the speed of the machine. The small weft package in the shuttle requires frequent replenishments and for each loom stoppage there is a possibility of one defect. The probability of weft way fabric defects are high to the tune of 70% in shuttle looms. Even in automatic shuttle looms there is a chance of transfer failures and weft lashing in defects.

Role in Process: The power looms are one of the most important equipment in producing of cotton terry towels and bed sheets. The power looms are used for weaving the dyed yarn to towels and bed sheets.

Baseline for Existing Equipment: Energy consumption for Power loom would depend on Load on Power loomandOperational & maintenance practices

Design and Operating Parameter: Present conventional loom is operated for 12 hours in a day and average electricity consumption is 34 kWh per day (8.5 kWh per loom for four conventional looms) connected with 1 HP motor. The average production is 48 kg per day per machine.

Barriers for Adoption of Proposed Equipment: The technology and innovations in SMEs are generally different from that of large firms. Technology in the SME sector has an increasingly complex or combinative character, most of the SMEs units in Sirisilla cluster are labour intensive and utilize local resources. The SME entrepreneurs are generally not willing to invest in state-or-art technology. Major barriers in the up-gradation of technology in the cluster are non availability of technology; distrust on technology supplier, lack of awareness about energy efficiency among small and medium enterprises, prevents them from adoption of energy efficient technologies.

1. **Technological Barriers:** The major technical barriers that prevented the implementation of Rapier loom areLack of awareness and information about the rapier loom and its benefit, Absence of local Rapier loom supplier and Dependence on local equipment suppliers, whom doesn't have technical knowledge about rapier loom and its proper installation
2. **Financial Barrier:** Implementation of the proposed project activity requires investment of Rs. 49.81 lakhs per unit. Such investment is not commonly seen in the cluster units for energy efficiency Improvement. Further, from the business perspective of SMEs, it is more viable, assured, and convenient to invest on project expansion for improving the production capacity or quality, rather than make piecemeal investment in retrofit and replace options for energy savings. In view of this and given the limited financial strength of the textile mills, it is evident that the owners would not like to take the risk and invest in energy efficiency measures. However, the financial attractiveness of the project activity may motivate the owners to move forward in taking up initiatives in energy conservation and efficiency.
3. **Skilled manpower:** The non-availability of skilled manpower having awareness about energy efficiency and related issues in the cluster is one of the major barriers. Lack of skilled manpower for operation and maintenance of the rapier looms is also one of the major barriers that prevented the implementation.
4. **Other barrier:** The recent recession in European and other Asian countries and reduction in market trend for the products in national and international markets was also one of the major barriers for the proposed technology.

X. NEW ENERGY EFFICIENT EQUIPMENT

Description: The rapier looms offer unparalleled versatility when it comes to yarns. From the finest counts of cotton to the thickest Industrial yarns and can handle anything thrown at its negative rapier head. The soft-pick gear system enables smooth transition of even highly fancy yarns like embroidery and slub. The rapier loom is upgrade from shuttle-looms to the world of modern weaving system and shuttleless weaving. Rapier looms has been designed to replace the old shuttle looms without any major changes to the existing infrastructure. The Immediate benefits of selecting rapier looms are; No need for new buildings or any new infrastructure, could fit in place of current shuttle-looms, configured specially keeping in mind the skills of power-loom operators, no special training required for loom operators, Immediate reduction of man-power and laborers.

Speed: The normal speed of the conventional power looms is around 120 RPM, where as in rapier looms, the speeds upto 220 RPM (actual) can be attained and coupled with high efficiencies of upto 95%, this machine gives upto 3 times more productivity than the conventional power looms.

Color Weft Insertion: Rapier looms offers up to 8 Color Pick-at-Will weft insertions, so that weave the fanciest of fabrics can be attained. The pick-at-will system is computerized and microprocessor controlled, hence letting the programme sequences of more than 1, 00,000 picks. Such technological edge will definitely give an edge in the market.

Start-Mark Prevention System: Rapier looms realizes the most delicate need of rapier users to prevent start-marks in weaving. The custom designed 'HT-Drive' motor of the machine supplies more than 150% torque for the first-pick to successfully prevent the start marks.

Lower per meter Costs: Considering 3 times more productivity with same space and even lesser amount of man power along with lower power consumption, it is quite obvious that rapier looms can offer lower production costs compared to conventional power-looms or even rapier-shuttle change machines. Moreover continuous weft-insertion eliminates the need for investing in pirnwinding machines or even extra operators.

Lower Maintenance: Due to lower vibrations, there's less wear-n-tear of rotating components and bearings resulting in lower maintenance costs. Also, centralized lubrication offered on the looms gives single-point lubrication for the complete machine, thus further reducing the headaches of maintenance.

Shedding: The rapier loom has the flexibility and can easily add and attach any of the shedding motions available in the market including:Dobby**,** Jacquard,Cam Shedding**,** Positive Cam for Heavy plain fabrics (bolting cloth, tire cord cloth etc.)Cam: for light sensitive fabrics

Take-Up: Universal 7-wheel Wretched-n-Pawl semi-positive take-up is the most widely used and well established Take-Up system offered in rapiers around the world. The well designed take-up is capable of handling a weft-density of 4-120 picks per Inch.

Let-Off: The capability of rapier looms to weave any and all kinds of fabrics has been created due to 3 different let-off options available with the machine depending on fabric.

Benefits of Rapier loom over conventional power loom

Conventional Power-Loom	Rapier loom
55-65% Efficiency	85-95% Efficiency
Max. 110 RPM (eff. 70 RPM due to lowerefficiency)	Max. 220 RPM (eff. 200 RPM due to Higher Efficiency)
Lower Output per shift	Upto 2.5 times more output per shift
Lower Output per operator	Upto 2.5 times more output per operator

High Labor requirement	Low labor requirement
'Kandi / Shuttle / Pirn-Winder' machine & operator required	Shuttle less (No Kandi, No Pirn, No Pirn Machine Operator)
High Maintenance because of extremely high vibration	Extremely Low vibration, hence lower maintenance
Higher & Faster Wear-n-Tear of components	Lower vibration leads to better & longer life
Light-Weight leading to shorter life and higher vibrations	Heavy-Duty Structure to reduce vibration thus leading to longer life
Lower Output per unit area of floor space	3 times more output per unit area of floor space
High Production Cost	Lower Production Cost
Due to lower labor productivity and lowerefficiencies and higher costs per meter of fabric.	Due to lower labor and lower area and lower power requirement per meter of fabric.

CONCLUSIONS:

Silk is a highly valued textile fiber of animal origin. It is used almost entirely for the production of high quality textiles. The sericulture industry is unique for more than on reasons. It is based on agricultural output viz., cocoons and cottage based labor intensive in nature. The industry comprises of reeling, silk preparatory and weaving, silk knitting, silk wet and processing consisting of degumming, dyeing, printing and finishing besides garment manufacturing. These activities in turn support the ancillary enterprises of marketing, manufacture and by-product utilization comprising of spun silk yarn manufacture and papae oil extraction. Thus, a lot of value is added to the product at each stage of the industry.

According to this research study it was concluded that in silk industry facing several problems with current technology such as significant consumption of electricity, large amount of firewood is being consumed through boilers, causing significant deforestation and also environment pollution caused through emission of carbon dioxide, carbon monoxide, methane and nitrous oxide, release of untreated toxic effluents from silk reeling & dyeing sectors, pollutes the water bodies and the ground waterand release of untreated toxic effluents from silk reeling & dyeing sectors, pollutes the water bodies and the ground water. If this industry adapted new Technology or up gradation of existing systems, to get more benefits such as using Non-Conventional energy i.e., solar energy appears to be, by far, is the best alternative solution to run both silk reeling and dyeing sectors in a most economical way, as the geographical location India allows almost year around sunshine. The effective use of solar energy addresses global issues such as prevention of deforestation, reduction of carbon emission, and control over discharge of unprocessed effluents. This study offers a viable solution over the issue of prevention of deforestation and pollution control due to silk industries. With the effective utilization of solar energy for various purposes as proposed, it is possible to overcome the financial barriers apart from making the silk industries eco-friendly. Similarly, handloom industry also facing several problems with existing traditional systems like production cost per kg of final product i.e., towels or bed sheets is high due to low production per loom, more breakdowns, more power consumption, more manpower cost and also the quality is poor compared with the product produced in rapier looms. If the handloom sector introduces rapier looms over conventional power looms, they will get benefits such as High productivity due to high speed and wider width of looms, reduced labour cost due to higher allocation of looms and productivity, defect free cloth for longer length, better environment due to low noise level, Pirn winding process is

eliminated, less value loss of fabrics, low consumption of stores and spares, less space requirement per meter of cloth, more colours in weft direction (upto 12) by Pick and Pick method, wider width fabrics and multi width fabrics can be woven, high degree of flexibility to suit a wide range of fibers and counts, easily adaptable for market trends, bigger flanges can accommodate 3 times more yarn, due to less beam changes lower down-time and lesser wastages, less dependency on labour skills, higher design capabilities due to microprocessor and electronic controls, Easy maintenance and less work load for Jobbers.

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