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JOINT PROGRAMME ON GREEN PRODUCTION AND TRADE
TO INCREASE INCOME AND EMPLOYMENT OPPORTUNITIES FOR THE RURAL POOR

REPORT

CLEANER PRODUCTION ASSESSMENT AND SUSTAINABLE DESIGN

SERICULTURAL VALUE CHAIN



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I. INTRODUCTION

Recently, Vietnamese economy has been developed significantly with the rate of 6-7% GDP per annum. The country has become officially average income economy from 2010. The development progress helps the export value increasing at 20% per year, also creating 1.7 mil of career and decreasing the poverty to 14%. However, during the process, the gap of income between the people in city and countryside, especially the minority people areas and mountainous districts, has been wider and wider.

The export handicraft products from Vietnam has been interested by international consumer and considered as an emerging market. From the traditional production method, the almost of the production progress has been done at the family level. In the meantime, the Small and Medium Enterprise(SME) is acting as the raw material supplier, product finishing, packaging and exporting agent. The export value would be approximately 1.5 billion U.S dollars per annum.

The most important issue in the industry is very high raw material consumption during the progress which may lead to out of the resource in the country and increase material importing. In addition, the involving component such as SME and worker did not care about the raw material storage which causes the loss of raw material rate at 10-30%. Moreover, the cost from other factors such as energy, dyeing material, sewage in Vietnam is much higher than the other production country. In addition, in the past, the industry has advantage of the low labour cost in Vietnam. In present, the labour cost has risen day by day would lead to increase price of the product. All of those issues could decrease the competitive capability of the local product in comparison with the other.

Therefore, cleaner production evaluating and sustainable product design for bamboo and rattan, sericulture, lacquer, seagrass and handicraft paper production is required to figure out the weakness point in the value chain. In the second phase, the solution for the issues should be recommended such as technical optimizing, waste recycling and effective raw material using in order to decrease the output value of products, environmental effect and help for sustainable development. In addition, the project would help the SME to design more creative product which is friendly to environment and also attractive.

The evaluating process has been taken place in all stages such as pre-harvest, post-harvest, material collecting, transportation, pre-process, processing, finishing and packaging from family scale to organization scale in Nghe An, Thanh Hoa, Hoa Binh and Phu Tho during the investigation of the project: “Green Production and Trade to increase Income and Employment Opportunities for the Rural Poor”.

II. EVALUATING METHOD

II.1 The value chain evaluation

The value chain of the industry spread along from pre-harvest, harvest, transportation, pre-process, process until finishing stages. Each stage of the chain could be taken place separately in different organizations or worker houses or together at the same place.

Data collection

- Before the investigation, the data would be collected through informative sources such as newspaper or report to figure out the most common issues.
- Data would be collected at field based on the project survey.

Interview

Questionnaire has been prepared for the common problem at different level of production such as village, commune, district and province at the investigated areas.

II.2 Quick assessment at SME

The VNCPC technical consultant works with the SME to do the assessment in order to figure out the solution of their issues. In addition, they can consult the organization about energy efficiency, effective material consumption, increasing the quality of product and improving the product designs. There are 27 SMEs in the project areas and 23 others outside of the area (Hanoi, Ha Nam, etc..) which working at the final stage of the value chain was investigated.

The assessment including:

- Baseline data
- The problem in the value chain identifying
- Modifying suggestion for more effective production
- Equipment upgrading recommendation for innovative development.

II.3 The cleaner production and sustainable design methodology

The methodology is for continuous application of total prevention and protection for whole manufacturing chain of product and service for higher productivity and reducing the risk to human and environment.

The scope of clean production is an increase of profit and trust for the organization and also a reducing in waste emission and environmental impact. Therefore, it is essential for all organization from the multinational corporation to family or group scales.

The methodology includes 6 stages as below:



The solutions in clean production could be:

- Prevent loss during transportation and processing, also called as housekeeping
- Maintain the optimized manufacturing line;
- Replace the hazardous material by the green or less of side effect material.
- Update or upgrade the equipment to improve the productivity and quality.
- Re-design the product to reduce the material consumption.

Some techniques used in the Design for sustainable (D4S):

- Choose the less impact material;
- Reduce the material consumption
- Optimize the technology
- Optimize the supply chain
- Reduce the impact during using period
- Optimize the early stage of product life cycle
- Optimize the disposal stage of product life cycle

III. OVERVIEW OF SERICULTURE INDUSTRY

Recently, the polymer industry has significantly developed lead to lots of different synthetic garment has been found. Those are much cheaper than the traditional silk but cannot replace it due to lack of some special silk properties such as softness, glossy and high moisture absorbability. With the silk material, the clothes keep the body warm in winter and cool in summer. Due to the very famous functions, silk has been considered as the queen of textile. Besides using in the textile industry to make clothes, the material is using in other industries such as defense, fishery and also hospitality. Following the report of Guangzhou sericulture and agriculture institute (2006), the average silk consumption on the world is 12 grams per person, in Europe and Japan the rate is 14 grams/person and 217 grams/person respectively. So, Japanese market is considered as having unlimited demand of silk. The world sericulture has been developed 36% from 1950s (FAO; ESCAP). The industry has supplied to the world 80,000 tons of silk per annum. However, the demand of silk is approximately 100,000 tons each year. Therefore, the supply does not match to the demand and the industry should be more invested in the future.

Recently, Vietnamese sericulture has supplied to market about 2,652 tons of raw materials that equal to 2.3% world production. The total value for the product is about 150 – 200 million U.S dollar. Most of the product is subjected to export (the add-in value in textile process is not included). In next few years, the total quantity of product is predicted to reach to 3,640 tons of product.

From the above information, the sericulture could have lots of potential and bring more income to worker than many other industries. In Vietnamese condition, the sericulture is quite suitable for the countryside farmer and can be considered as one of key methods to against poverty and the income gap in those areas. In fact, the sericulture has spread from the North to the South. In some areas, the production has been concentrated in a large area with high cultivation and productivity such as Moc Chau, Yen Bai, some other Red river delta provinces and Lam Dong.

III.1 The mulberry cultivation area

At the moment (Dec 2010), there are mulberry cultivation areas located in 31 provinces with the total cultivation area of 25,046 ha – 0.21% agricultural area in Vietnam.

The peak cultivation of the variety reached at 38,000 ha in the year 1994. After that, the industry has been faced lots of difficulty. In the period, there are two large downturns in 1995 and 2002. At the end of 1994 and begin of 1995, the exporting market is blocked lead to the price of cocoon plunged to very low level and the cultivation area was reduced to 14,194 ha. The recovery was taken place shortly until 2002. At that year, the price had dropped again and made the industry fall in the down trend for a quite long time. The trend has been changed in the year of 2009 and 2010 when the price comes up and stable. Nowadays, the cultivation area is around 25,000 ha.

III.2 Silkworm varieties and harvesting times

From the Vietnamese Bureau of statistics, total mulberry cultivation is 25,046 ha. The required silkworm egg would be 2,500,000 – 3,000,000 boxes per annum. In those, the percentage of yellow silkworm egg is around 60% and the rest is white silkworm egg. All of the yellow silkworm egg is supplied by domestic suppliers. For the higher quality white one, part of it is imported from China.

At the Red river delta area, and the beachside area in the Central, there are two cultivation seasons with different silkworm varieties. In the summer season, the yellow F1 variety usually

is used for cultivation following with a small area of the cross-breeding white F1 variety – high resistant ability. In the autumn – spring season, with the cool weather, the white variety will be used for higher quality of silk and income. In the Northern of Moc Chau, the white one can be fed all the time due to the much cooler weather. Meanwhile, the high land of Tay Nguyen, Bao Loc and Lam Dong just has rain season (from April to October) and dry one (from November to March). The TN1827 and LTQ varieties which are created by cross breeding are suitable for both seasons and can produce 51kg cocoon per egg box meanwhile the imported LQ2 variety is just fit for the dry season weather.

From the result of kinetic research, several cross-breeding varieties which have high quality and productivity have been found. Those has helped to improve the productivity of the cultivation (from 1,000 – 1,200 tons cocoon per ha to 1,500 – 1,600 tons per ha) and also reduce the importing amount from China. The good practice area could reach to 2,000 tons per ha. The average income from cocoon is from 90 to 120 million VND per ha which could guarantee the stable and sustainable production [1].

III.3 Reeling and weaving

III.3.1 Reeling

There are 11 reeling organizations in the Vietnamese Sericulture Corporation (VISERI), 8 other local companies and thousands of private reeling companies can produce total of 1.597 tons of silk threads each year. The VISERI reeling output is rated at 800 tons per annum (450 tons from the automatic reeling equipment); the other produces with mechanical machines at the level of 797 tons of threads per annum. The A to 5A quality thread quantity is about 600 tons and the rest would be evaluated at level from B to E which is much cheaper and limited demands.

The poor quality cocoon and high cost during the whole progress lead the high capacity company change from production to reeling and weaving for the overseas organization as outsourced agent. Meanwhile, the private sector with the small scale seems to be more effective and motivated on cultivation and processing. The semi-auto reeling is suitable for the low quality cocoon in the country. The produced thread is just fit for the manual weaving and export to the country which demands the cheap and low quality silk.

III.3.2 Weaving, dyeing, printing and textile

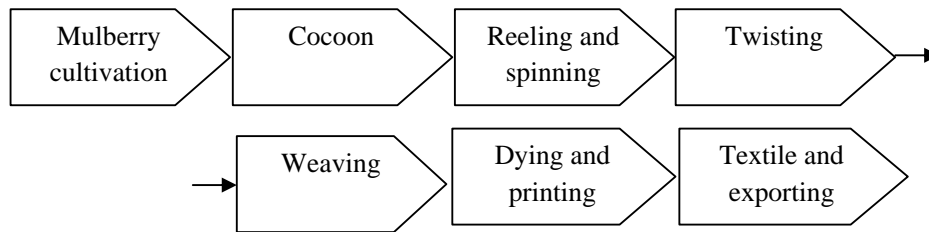
The textile industry productivity is around 5.5 million meters of raw silk per annum. As the largest organization, VASERI provides 1 million meters of the thread and the rest is from the others. The used weaving techniques are poor and low quality. The main products have produced by traditional weaving method, Jacquard method and knitting.

The dyeing capacity of the Vietnamese industry is 1.5 million meters with 1.2 million meters produced by Vikomex ltd and 0.3 million from the others. Most of the raw material has been imported from China.

IV. VALUE CHAIN EVALUATION

IV.1 Sericulture value chain

The mulberry tree has been planted on river banks for the leaf collecting. Those leaves are the food for silkworm. The fully grown caterpillar will spin a cocoon. After that, the cocoon has been transferred to silk thread removing process. The silk thread is then twisted to make the yarn which can be dyed and weaved later. In the real chain, the farmer may reel and weave at home or sell the cocoon to the others, even export it. The other process such as weaving and dyeing, the same scheme could be occurred. The real value chain can be described as bellow:



Pic 1. The Vietnamese sericulture value chain

IV.2 The value chain evaluation

IV.2.1 Mulberry cultivation

The mulberry leaf is the main food for silkworm. The tree usually planted on the river bank soil, sometimes, on the mountainous area such as Moc Chau and Lam Dong. Due to depending deeply on the market demand, the price is highly unstable. Therefore, the farmer is not so interested in it. For instance, in the past, there were some concentrated cultivation areas but because of the low income from the industry, farmer convert the orchard to the other plants. Recently, the market has been increased significantly. The cultivation area has been expanding more and more. However, the income from the cultivation is still not too impressive and productivity also is low, too. The main issues include:

- The productivity is low due to old variety of mulberry: reducing to 10-15 tons per ha from 20-15 tons per ha in the past.
- Diseases

Recommendation for improvement of cultivation:

- New variety with the higher disease resistance.
- Cultivation area planning on the suitable soil such as river bank soil
- Good soil preparation for highest productivity and better quality
- Fertilization and pesticide using as instruction.



Pic 2. Mulberry orchard (left) và silkworm feeding(right)

IV.2.2 Silkworm feeding

Recently, lots of organization uses both local and imported silkworm varieties. However, the imported variety come from several unofficially ways which may lead to the bad quality eggs and also without disease treatment. As result, at some cultivation place, the dead percentage would reach to over 50%. Therefore, in order to improve the productivity of the area, some recommendations should be focused:

- Choose the suitable silkworm variety for the area(for example, the yellow one is fit for the warm weather while the white one is potential for the cool area). In addition, concentrate on the less disease and high productivity one.
- Good storage facility to maintain the quality of the silkworm, such as aluminum box.
- The caterpillar feeding should be in separated area to avoid the contamination from the air, pesticide...
- Air conditioner for the storage room would be great.
- Periodical cleaning and sanitation.

The factors could affect on the caterpillar development as below:

Temperature :

The caterpillar just can grow up in the specific temperature range. The out range temp could reduce the growing rate. At the temp higher than 30⁰C the caterpillar could be more vulnerable to disease. The low temp could make the feeding time longer, wasting resources.

Table 1. the optimum temperature range (°C)

Silkworm	Cub	Mature
Dual- sexual	26-28	23-24
Multi-sexual	27-28	25-26

Humidity:

The humidity has indirect impacted on the silkworm though the metabolism activity and the leaf development

Table 2. The optimum humidity (%)

Silkworm	Cub	Mature
Dual- sexual	80-85	60-70
Multi-sexual	85-90	75-80

Sunlight :

The new born and silkworm cub is sensitive to sunlight. Therefore, we could turn the light on for the healthy and stronger cub.

However, at the cocoon establishment stage, the caterpillar does not like the harst light. If it happens, the cocoon is not high quality. Hence, the light should be cared by the worker for the most suitable condition which leads to the high quality and productivity..

Air:

Air and air flow in the chamber has the great impact on the development of silkworm. So, it should be good ventilation in the feeding room to avoid the CO, H₂CO₃, H₂S, CO₂, NH₃,.. remaining in the air.

The silkworm will make cocoon after 20 days of feeding. The silk thread could be spun around 300,000 rounds with the length of 1 kilometer. After the cocoon build up, the next process would be taken place in within 1 week to avoid damage.

- Good cocoon can produce 1 kg of silk thread from 7.5 kg cocoon
- Bad cocoon just can produce 1 kg of silk thread from 10 kg cocoon

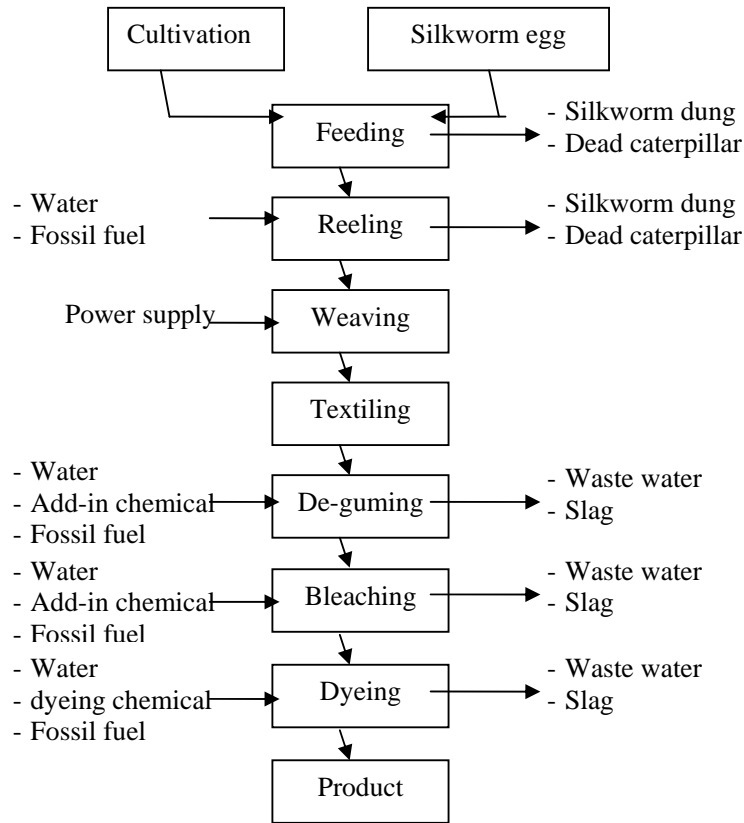
IV.2.3 Reeling

In Nghe An, Thanh Hoa, Hoa Binh and Phu Tho provinces, there is lots of reeling company. Most of them have very low productivity. The poor quality cocoon and high cost during the whole progress lead the high capacity company change from production to reeling and weaving for the overseas organization as outsourced agent. Meanwhile, the private sector with the small scale seems to be more effective and motivated on cultivation and processing. The semi-auto reeling is suitable for the low quality cocoon in the country. The produced thread is just fit for the manual weaving and export to the country which demands the cheap and low quality silk.

Reeling is the process which reels the silk thread from cocoon. The cocoon will be dipped in hot water or treated with water steam to help dislodge the threads which bonded by sericin. The thread then is removed by reeling machine or manual. The removed thread will be spun in pack with different type such as individual or spun together with other thread from 4 to 8 cocoons to make a yarn. Commonly, Production of 1 kg of silk thread requires 6.5 to 7 kg of cocoon. The manual reeling produces much lesser than the semi-auto reeling machine.



Pic 3. Manual and semi-auto reeling



Pic 4. Processing procedure

Table 3. The rate of consumption for 1 kg of silk product

No	Input	Optimum rate (2010)
1.	Raw cocoon (kg)	4 - 7.5
2.	Coal (kg)	3 - 12.5
3.	Water (litter)	35 – 240
4.	Electricity (Wh)	92.5

Most of the organization in the investigated zone does not do de-gumming before dyeing. There is only few farmer at Hoa Tien cooperative had done some experiment with the ash solution but unsuccessful which means the colour could be lost during using time. The other just does the

processing until thread weaving. The thread then has been bought by the organization in Nhaxa(Ha Nam), Van Phuc (Hanoi)

Issues:

- The consumption is large different between organisations.
- Recently, there is no fixed rate of consumption for the stage in value chain. However, from the investigation results, the housekeeping method would save lot of cost by the energy and material by applying the clean production procedure.

Manual reeling

The cocoon will be dipped in hot water – boiled by coal - closed to the worker. Under the treatment, the sericin will dissolves in water and dislodges the thread. The worker should reels unstoply the thread until the end of the cocoon to avoid breaking the thread. The after used water removes to sewage system and hot water will be added periodically. However, the bad insulation leads to very high heat loss that means the quantity of hot water to be used is large and also the sewage contains high BOD and COD.

Semi-auto reeling

Depending on the productivity of the machine, the number of thread knot will be different. For instance, the Yasilk company (Nghe An) uses the one with 25 silk thread knot and each of them reel from 6 to 8 cocoon. The hot water for the process come from boiler and the sewage come out underneath the machine.

After the process, the pupa inside cocoon will be taken out to sell to food processing organisation.

During this stage, water using needs to be paid some attention to save the energy:

- The hot water chamber should have good insulation to avoid heat loss
- The temperature should be within 80⁰C to 100⁰C all the time.

In addition

- Some cocoon still remains silk thread could be sold to the collector who re-sell to Chinese silk-processing with better machine to get it.
- Some of the manual reeling family places the coal burner too closed to the worker. That can bring negative effect to human health.
- The sewage from reeling can be used to make biogas in order to save energy and also decrease the BOD and COD levels.

IV.2.4 Weaving

In the project area, there are only few minority family do weaving by the traditional manual method with very low productivity. Besides, the yarn and silk thread could be sold to some weaving organization in Hanoi, Ha Nam and Thai Binh with the better equipment for higher productivity, quality and appearance. However, the manual weaving is still existed due to the demand of the local people and also the tourist who attracted to handmade products.



Pic 4. Manual and mechanical weaving

The recent issue for the manual weaving family is high demand but could not supply due to

- The quality of silk thread is unstable, so there is not any thread for processing
- The weaving equipment is broken but no money for investing
- The design is too simple and low quality

For the mechanical weaving organisation, the current problem is low competitive capability because of high cost and poor design:

- Old and outdated machine with lots of issues and unstable.
- High energy consumption
- No design diversity

IV.2.5 Degumming

The boiling process is used to remove all the remained contamination such as oil, gum and saturated lipid from the fabric. The process occurred in the alkaline solution with high temperature and pressure. This stage could be achieved periodical or flow by absorbing or dipping with hot steam or heat. It includes:

- Bring the washing solution to the silk thread (air removal, absorbing and/or dipping)
- Mineral element removal (dissolving or compound types)
- Other material which contaminated in or established during processes, removal.

During the boiling process the thread will swell up which can make it be more absorbable to dyeing material. The contaminated oil will be hydrolyzed and other process occurred depending on the temperature and time of treatment. The sewage is alkaline solution with high BOD and COD contain.

IV.2.6 Bleaching

The boiling off process could not remove all the contaminated material in the fabric. In fact, the material partial de-structured and needs to be continued oxidizing, hydrolyzing or removal. The white color of fabric also improves during the process. In addition, the absorbability of the silk also reaches to the peak during the bleaching process. For the color and dark fabric, there is no need for bleaching.

The solution has been used for the process is different such as hypochlorite, hydrogen peroxide... Therefore, depends on the chemical, the bleaching condition also is different too.

The sewage from this process contains alkaline solution, chloride compound and dissolved solids.

Bleaching with hypochlorite could damage the thread contained amino groups. This treatment also involves in adsorbable organohalogen (AOX) establishment. In the meantime, during the process using hydrogen peroxide treatment, the compound is self-destructing; therefore, the sewage is just water and oxygen. So, due to the environmental impact, the hydrogen peroxide is becoming more and more popular. However, the treatment needs to add silicate based or stable compounds to control the quality of process.

In fact, most of dyeing organization uses the same method as below:

- Solution: NaOH, Na₂SiO₃, H₂O₂
- Boiling to high temperature
- Dipping the fabric in the solution and stirring in 10-20 minutes
- Taking out for washing

The sewage from dyeing and bleaching processes contains lots of chemicals but there is no treatment in most of production areas. In order to limit chemical using, several non-environmental impact compounds have been used. They have been recommended from many dyeing organizations:

- *Absorbing and washing solutions: should improve the chemical absorb ability and also come over the resistant of alkaline solution. The solution is also more effective in contaminated material removal than soap. They can even be used in the acid solution but no layer making*
- *NaOH solution used for saponification*
- *Compound such as ethylene diamine tetra-acetic acid (EDTA) used to decrease the hardness in water and heavy metal ion.*
- *Dispersing agent: the compounds such as poly-acrylates and phosphoric used to remove the un-dissolved solid, soil and milk soap.*
- *Deoxidizing agent: dithionite used as a contaminated material reducing agent in aqueous solutions.*
- *pH adjustment/carrier agent: including polyphosphate compound which can be used to change the pH of the solution or waste carrier and also complex compound catalyst. The after used agent involves in the high phosphoric contains in sewage.*
- *Chloride (Cl₂), Sodium hypochlorite (NaOCl) và CaOCl₂ are the traditional bleaching agents. Nowadays, hydrogen peroxide is more popular due to its friendly-impact to environment. Sodium hypochlorite is the most powerful bleaching agent in use.*
- *The bleach stabilizing agent used to prevent the active perhydroxy anion creation during the bleaching process and ensure the high oxidizing capacity of the solution. The agent usually contains silicate which can establish the hard scales in pipes and damage the surface of fabric. In the modern equipment, the silicate base agent has been replaced with the environment friendly agent such as EDTA, DTPA (di-ethylene tri-aminapent acetic acid), gluconic acid and phosphoric acid.*
- *The surfactant agent: must be high immersion, diffusion and absorption abilities which can make the contaminated hydrophobic compounds and soil removal quicker and prevent the re-attaching process of those. In order to fulfill the requirement, the surfactant always contain anion substrates such as alkyl sulfate, alkyl suffocate, alkyl-phenol ethoxylate and alcohol ethoxylate.*

- *The Fluorescent Whitening Agent (FWA): if process takes too long, the quality of the fabric would decrease significantly. In order to avoid the impact, nowadays, the organization uses FWA for bleaching. Recently, there are more than 1,000 FWAs has been sold all over the world which based from coumarin, stilbene, pyrazolin, naphthimide and benzoxazole. FWAs can be used from the weaving process.*

Table 1. Sewage pollution in the silk production villages

No	Village	Wastewater quantity (m ³ /day)	Wastewater properties				
			pH	COD	BOD	SS	Color scale
1	Co Chat – Nam Dinh (Cocoon production)	100	-	6,076	2,400	764	4,110
2	Phuong La – Thai Binh (Dyeing)	960	8 – 9.7	320 – 900	72 – 410	14	77 – 139
3	Tuong Giang – Bac Ninh (Dyeing)	1,266					
4	Dong Yen – Quang Nam (cocoon production)	20	7.2	632	241	517	69
5	Bao Loc – Lam Dong (cocoon production)	50	7.8	1,020	780	215	466
6	Nam Cao – Thai Binh (weaving)	-	8.2	372	212	375	260
7	Thai Phuong – Thai Binh (dyeing and weaving)	-	6.9	312	272	205	195
	TCVN 5945- 1995 (B column)		5.5 – 9	100	50	100	

In addition, fabric washing process creates large quantity of the environmental harmful sewage. Therefore, the dyeing and bleaching organization use the backward washing method. The first washing tank contains the most concentrated solution and will be recycled in the next step.

IV.2.7 Dyeing

The process will help to perfectly distribute the color on all fabric surfaces. In there, the color molecule has been transferred deeply into the fabric thread for the best binding. There are several dyeing methods such as:

- Reactive dyeing: using dissolved dyeing chemical.
- Pigment dyeing: binding water proof dyeing chemical to the fabric surface.
- Block and gel dyeing: binding the dyeing chemical to fabric from the weaving stage.

Reactive dyeing is the most important part which describes below:

In the process, the dyeing material has been dissolved partly and absorbed into the fabric thread in three stages:

- The dyeing material has been dispersed in the fabric thread. In most cases, the dispersion rate depends on the concentration of the dyeing chemical in solution and also the quantity of fabric in the process. During the stage, the concentration of dyeing material decrease along with time of stage. Therefore, the dyeing rate also reduced by time until reached to equilibrium concentration.
- The absorption stage: at this time, the dyeing material concentration reached to the designed level and unchanged by time.
- Binding the dyeing material on the thread: at the equilibrium level, the color molecules usually stay not too close to the silk thread. The active molecule could move out of the fabric at any time, so the color material needs to be bonded to the fabric by chemical reaction or dispersion in the yarn.

The binding rate of the dyeing process depends on the applied chemicals and also the fabric. The level of dyeing chemicals in sewage changed due to the same reason. The absorption rate of several dyeing materials has been showed in the table

Table 5. Productivity of several type of dyeing materials

Dyeing chemical	Fabric	Productivity	Remained in sewage
Cat-ion base	Acrylic silk	~ 98%	~ 2%
Acid base	Rayon, silk and knit	95 - 98 %	2 - 5 %
Metal compound base	Nylon, knit	95 - 98%	2 - 5 %
Directed dye	Cotton, viscose	~ 80%	~ 20%
Dispersion dye	Polyester, Nylon, Acetate	~ 90%	~ 10%
Recovery dye	Cotton, viscose	~ 95%	~ 5 %
Sulfur base	Cotton, viscose	~ 60%	~ 40%
Reactive dye	Cotton, viscose	50 - 95%	5 - 40 %

Productivity of the dyeing chemical increases when the temperature of the dyeing solution, solution density reduces and the impact from catalysts and dyeing concentration. The rate also depends on salt concentration, affinity of dyeing material and dyeing material components. The next table describes technical information about the process

Table 6. Technical information

Components	Periodical dyeing	Continuous dyeing
Average dyeing proportion (2%, means 20grms of dyeing material/kg of product)	0,5 - 5%/min	50 - 150%/min
Dyeing density	4:1 - 25:1	0,4:1 - 1,2:1
Dyeing concentration	0,5 - 5 g/l	17 - 50 g/l

Time of process	20 -200 min	0,6 - 2 min
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In order to optimize dyeing material consumption which is quite high cost in the textile industry, several methods could be achieved:

- In a combination, the dyeing material should be combined at the recommended rate.
- The increase of dyeing temperature at the main stages at around 30°C should be control as slow as possible.
- The boiling rate when almost reach to limited temperature would be adjusted to fit the type of fabric and also other factors such as dyeing solution flowing and cycle of fabric.

Support agent for dyeing materials:

Beside of the dyeing chemicals, the process usually consumes other compounds called support materials. Those are necessary for the better quality dyeing process such as helping the better color distribution and stronger binding of dyeing materials. As estimation, the support material consumption would be 60-70% in comparison with dyeing chemical consumption. Including:

Dispersion compounds: applied in the process which uses the dispersion or recovery dyeing material. The dispersion material helps the dyeing chemical dispersed better in the solvent. The dispersion rate of the dyeing compound could be raised by higher temperature and also by the support materials. The dispersion compound also prevents the dyeing chemical suspending and therefore, provides the higher quality of dyeing. The dyeing material has been sold in powder or liquid forms. In the powder one, the percentage of dispersion compound is much higher than in the liquid one. Even the dyeing product already contains some, the processing organization always adds about 0.52grm dispersion material/litter of solution if the physical resistance of the fabric is high. For the fabric contains formaldehyde group, the reactive and catalyst anion base compound has been used as the dispersion material. Non-electrolyte base reactive compound could be used as support material in polyester fabric dyeing due to their potential ability in dyeing material dispersion and color distribution

Color distribution material: this support compound is compulsory for the dyeing in high temperature method. They help to distribute the color molecules to all the fabric thread and maintain the same color on all area. In the polyester fabric dyeing at boiled temperature, there is no need of the material due to the process occurred slowly and very good distributive.

There are 3 chemical groups could be used as distribution factor:

- *Carrier substrates: increases the dispersion rate. Those agents could help to swell the silk thread or distribute the color element deeply into the fabric. They could make the productivity raises to very high level which can lead to reduce quality of dye process. Therefore, the material should be supplied in to the solution at the high temperature. They include some group such as 2-phenyl phenol, ether di-phenyl, salicylic esters, methylnaphthalene... However, they also have some issues as reduce the light exposal resistance of the color, harmful for environment, thread swelled too much and not good smell.*
- *Ethoxylate base group: slow down the dye material consumption rate. Therefore, they have been used in quick dye process or dark color dyeing at high temperature. The main group would be stearic acid, ethoxylate castor, sulfur and phosphoric esters, ethoxylate alcohol or alkyl-phenol lipids.*

- *Special contribution agents: make the equilibrium level of dye material during boiling period and increase the movement of color element in high temperature condition. They contain alcohol, ester and ketone with the medium chain long.*

The moisten catalyst: *reduce the surface tension of the dyeing solution and make it easier dispersion and absorption into fabric.*

Suspension catalyst: *the quality of water is very important for the process. If the water contains alkaline and/or heavy metal salt ion, they could react to the color element to form suspended substrates. It could lead to change dye color or no smooth color distribution. The low quality water could cause other problems when washing.*

The suspended catalyst has been added to the dye tank to react to the cat-ion such as calcium, magnesium and/or metal salt in the fabric and dye solution. EDTA and the other as DTPA, NTA (nitrile triacetate) and phosphoric acid have strong ability in this reaction. The weaker catalyst like polyphosphate or poly-carboxylic acid group has been used to react with the metal ion to prevent loss of color element binding to fabric.

pH adjustment agent: *the reactive dyeing process should be achieved at pH of 4.5 which is the perfect condition for color element dispersion. The halo-carboxylic acid group could be catalyzed at high temperature. Phosphate salt has been used as buffer substrates and citric acid has been used as pH adjustment agent.*

Dyeing catalyst: *used to increase the productivity of the process for the synthetic fabric and also reduce the duration of the period which might lead to higher output. With the application, the polyester thread could be dyed in even 100^oC condition. The most important ingredients for the catalyst would be 1,2 di-chlorobenzene, 1,2,4 Tri-chlorobenzene, 2-phenyphenol di-phenyl, di-phenyl ether, methyl salicylate, diethyl phthalate, tetralin, methyl naphthalene, phthalic acid, N-butylimide and chlorphenoxy ethanol.*

The ingredient of a dye catalyst always is a controversy due to its two side effects. The volatile and toxin chlorobenzene has to be used in the closed tank. In other sample, the naphthalene, di-phenyl and 2-phenylphenol base catalysts can cause the color loss under sunlight need more treatment at 180^oC.

The impact of the catalyst such as toxic for human and other fishes; mud in sewage system also is concerned. However, due to the strong affinity to fabric threads, from 75 to 90% of the chemical has been absorbed on the fabric. There is only non-environmental harm emulsion compound existent in the sewage. The other catalyst usually remains on the fabric and be removed in the drying and stabilizing stages. Therefore, the most important part should be air pollution control.

The deoxidizing chemical: *used to prolong the color binding in the final stage. It degrades the dye chemical remained on fabric surfaces. They can divide to three groups:*

- *Sulfur based compound: composed from dithionous acid ($H_2S_2O_4$), sulfuric acid (H_2SO_4) and Sodium dithionite ($Na_2S_2O_4$)...*
- *The compound contains hydroxyl group such as carboxyl- glucose and hydroxyl acetone.*
- *Hydride $NaBH_4$.*

De-color agent: *during the dyeing process, the chance to get errors from every stage such as dyeing process, getting dirty from transportation... should be fixed as soon as possible due to economic impact. The color removal for reactive dye fabric needs to be processed at very high temperature. In the other way, the carrier and non-ion exchange color dispersion agents could*

be used but damaged fabric threads. The dye color also could be removed by Chloride and carrier compounds.

IV.2.8 Waste generation of production

In the the organisation who pollutes the environment by the emission, waste water and solid waste, the noise pollution comes from the equipment; emission from burner and treatment chamber with SO₂, NO_x, CO,... releases.

The waste water from organisation has not any treatment or ineffective treatment. Therefore, it just comes directly to the sewage system. That could cause the pollution due to high BOD contains, heavy metal...

Dyeing process is causing some environmental problems due to the raw material consumption:

- Large quantity of water consumption
- Salt consumed for color fixation
- Dye solution contains heavy metal element in its ingredients or contamination.
- The unused dye material after process could cause color problem for wastewater including salt and heavy metal remain.

Therefore, the wastewater always contains high level color elements, TDS, BOD and COD.

During the whole silk production system, the dyeing stage is very important and one key part of the total production cost. Recently, there is few manual silk production families who use the natural color element in Luc Da (Con Cuong – Nghe An); Pa Co (Mai Chau – Hoa Binh). However, the color from natural sources is just few as blue and black. The other dyeing organization uses synthesis chemical due to:

- Natural dyeing material:
 - Simply color
 - Small scale production
 - Not good color distribution
 - Color fading quickly by time in washing and sunlight exposition
- Synthesis dyeing material:
 - Large scale production
 - Better color fixation
 - More color choice
 - Environmental pollution

IV.2.9 Technology and equipment demand

Following the value chain surveying results, the application of natural dyeing material is interested. In addition, silk boiling off with the non-environment harmful chemical has been paid lots of attention. Moreover, increase productivity and quality of the production requires more invest on the equipment at different scales.

The technologies need to be researched:

- Boiling off process with higher quality and lower wastewater output
- More investigation on the natural dyeing material to solve the above issues.

The required equipment:

Large scale organization:

- Dyeing machine with low density solution

- Reeling machine

Small scale organization such as family or group of farmer:

- Reeling machine
- Manual reeling equipment
- Sewing machine

V. DESIGN FOR SUSTAINABLE SERICULTURAL VALUE CHAIN

V.1 Current situation and its issues

The interviewed organization could be classified as 2 types;

First type organization which operates at the beginning stage of the value chain, support the farmer in cultivation. After that, they collect the cocoon from the farmer and reel the raw silk thread to sell to the weaving organization or other collectors. For this type, the output is just raw material for other processing stage which is low quality, low competitive ability and unstable market.

The second type is the cooperative of the minority farmer which is famous of the handmade silk product. The organisation operates in the ending stage from reeling until finishing of the silk product. However, due to the scale is too small, most partners is the minority farmer who just works at spare time of cultivation season. That leads to the low productivity and could not fulfill the demand from market. In addition, the design and quality of the product is low and traditional which is just for souvenir at all time.

Processing would be another issue in the industry. Most of the producer is using the outdated technique and equipment which is high cost and also high emission. The environmental impact is the serious problem at all the manufacturing areas. Moreover, it causes the low productivity and difficult to change the design of product.

In most of the organisation, the heat comes from various coal burners which is un-optimized and causes the loss of 30% energy. It is also wasting the fuel to heat up the outside environment due to lack of insulation. The waste water treatment is not paid attention and caused loss of material and pollution. Moreover, the maintenance procedure has not been applied correctly which could lead to low productivity and polluted air in the manufacturing chain.

V.2 Analysis and suggestion

The weakest point in the organization which involved in the program is product design, marketing.

Most of the organization develops the product without an effective methodology or research. Hence, the new product is just simple satisfying a demand from the customer at that time. There are three different ways to do that:

- Copy the design from a rival and sell to the same market.
- Produce the product from an original sample from buyer
- Develop a new product from their point of view about the demand and sell to the market.

Therefore, the producing is in-active and has no foundation for further development which can lead the organization to nowhere.

In order to solve the issue, the organization should be more active and smart in product design and marketing with the new strategy, methodology. The company also should have the short and long terms plan and focus on the suitable niche market for it. In addition, the enterprise should establish a Department for design for sustainable with the good training staff.



There are also some organization who aware the sustainable development but lack of finance and technology. They acknowledge the concept but do not know how and where to start. The question is what aspect the program can help the enterprise to solve the issue?

From the current experience, the program should help the potential organization in the efficiency energy and material consumption and reduce the waste to environment. Development of the bio-gas in waste treatment and the solar energy should be investigated. In addition, the new material treatment should be used instead of traditional method to save the environment.

With the correctly and effectively application of Design for sustainable (D4S) in the new product design and marketing, the received profit would be much higher than current situation. However, the process would face several difficult issues such as:

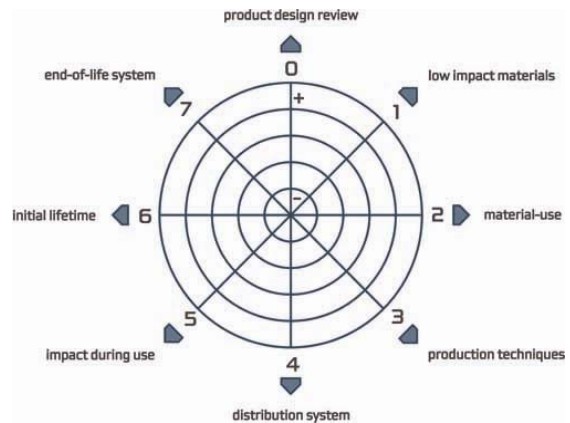
If the organization develops the complex product with multi-material or parts from different suppliers, the poor co-operation could harm the procedure timing and cost due to the supplier behavior and planning.

If the organization trying to do it all, the productivity would not be high and the efficiency is also not good.

In the case, it could not achieve its strength and reduce the weakness. Considering in whole industry, that could lead to self-competition. In order to get the best achievement, the company should discuss together to form the best networking in both marketing and support. The agreement would help the organization improves the quality and price of product though the group manufacturing and marketing. For the highest performance, the enterprise should establish a union which could do marketing research, trademark formation, support partner in technology and competitive capability and guide the organization to the sustainable development.

For the researched organization, even the assessment time was short and the scale is small, there are some recommendations:

- Investing on the new technology from the developed organisation or region. Optimized application the new method or technique could help the company to improve the quality of product and also its competitive
- Applying the solar or biomass energy in drying and heating instead of the fossil fuel to reduce the cost and environmental impact.
- Optimizing the housekeeping method and recycling the wasted energy in each stage of the process.
- Applying the modern technology in cultivation to get the higher yield.
- Establishing the union in the industry for the better co-operation between companies.



V.3 Examples in Vietnam





- *. Combination of the traditional drawing with the new design to form the fashioned product. Creation of the brocade picture... could bring more profit to the organisation than the traditional one.
- *. Beside of the traditional appearance of brocade, the design should combine the cultural sign of the target market for more attractive.
- *. Each organisation should calculate and settle down at the most suitable point in the value chain and unites with the other to achieve the best performance of the whole chain.

V.4 The development trend in Vietnam and on the world

The sustainable consumption and production has been promoted in Vietnam and on the world, especially in the city. The young people now has been more and more interested in the green product and avoided the environmental harm ones.

Recently, due to the visible impact from lot of factors to environment and human, the human and community health become the most concerned issue. Therefore, the green and harmless product would be more popular along with the economic development. In the case, the industry should build up its production capacity and introduce the sustainable product as soon as possible to get the advantage of early start.

Besides, the national government has supported in both research and finance to the organization to catch up with the trend. That has been showed in the latest regulations and financial planning of the government in Agriculture, Aquaculture and Environmental Programs such as: the emission control, hazardous chemical prohibition, reduce pesticide and fungicide regulations. Meanwhile, the supporting scheme has been developing by the national authority to meet the worldwide demand and WTO. It is the most important development due to the deadline of WTO commitment will be arrived soon. If it's not well prepared, the overseas manufacturer could defeat ours very shortly.

On the world, the concept of sustainable development has been found long time ago and lot of green product has been introduced, especially in the developed country. Lots of regulation on

green product, sustainable development and production has been applied in those countries. Therefore, in order to gain the access to those rich markets, the Vietnamese product must fulfill all the requirement and regulation. That why the organization has to do it as soon as possible.

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