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

REPORT

CLEANER PRODUCTION AND DESIGN FOR SUSTAINABILITY ASSESSMENT

IN LACQUERWARE VALUE CHAIN

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Hanoi, June 2011

CONTENTS

I. INTRODUCTION

In recent years, great development has been recorded in Vietnamese economy with the average growth of 6-7% GDP/year and since 2010, Vietnam has officially become the medium-income country. Along with fast economic growth are the 20% annual increase of export value, the creation of about 1,7 jobs and the 14% reduction of poor households. However, the gap between the poor and the rich, between urban and rural area, especially in remote and mountainous areas are becoming bigger.

Export handicraft sector attracts a lot of attention recently and is considered as an immerging market. Generally, handicraft production in Vietnam is often at household scale while Small and Medium-sized Enterprises (SMEs) supply materials, finish, pack and export products which creates the value of about 1,5 billion USD every year.

One of the biggest problems at this moment is the over usage and overexploitation of resources in Vietnam, leading to the shortage of resources for domestic production, therefore, there is the need for resource import. In addition, many enterprises and households at small production scale do not pay much attention to material preservation, causing spoilage for 10-30% materials before processing.

Formerly, Vietnamese handicraft sector has the competitiveness advantage of low labor cost; however, the cost is increasing, dimming that advantage. One of the reasons that impact on the Vietnamese handicraft's competitiveness is the excessive usage of resources, energy per product unit like the excessive consumption of coal, electricity, dyestuff, water discharging a big amount of wastewater.

Thus, the CP and D4S assessment for the whole value chain of rattan, lacquer, sea grass, silk and craft paper is necessary for evaluating current status of each sector, proposing technical innovation options and utilizing waste, properly using natural resources to save production cost, prevent environmental pollutions and ensure sustainable development. Besides, enterprises get chances to approach the concept of designing new products which are environmentally friendly and consumer attractive.

The assessment is carried out for the whole process from cultivation, harvest, collection, transportation to pre-process, process, finishing and packaging in households and enterprises located in 4 provinces: Nghe An, Thanh Hoa, Hoa Binh and Phu Tho, under the framework of project "Green Production and Trade to increase Income and Employment Opportunities for the Rural Poor".

II. ASSESSMENT METHOD

II.1 Value chain assessment

Value chain is identified from cultivation, harvest, collection, transportation to pre-process, process, finishing and packaging. Each unit of value chain can be executed in one enterprise, or each enterprise, household is in charge of one unit in value chain.

Data collection

- Before doing surveys, all data and information on current status of the chain in the project areas are collected via papers, documents to identify existing problems.
- At-site data are collected from households and enterprises through the samples which are designed for project.

Interview

Questions are developed to ask about existing problems at commune, district and province level in 4 targeted provinces of the project

II.2 Quick assessment at enterprises

Vietnam Cleaner Production Centre will work directly with enterprises to evaluate the current production status and provide consultancy on resource and energy efficiency, product quality improvement, design innovation... The project assesses 27 enterprises in 4 targeted provinces, and 23 other enterprises in other areas (Hanoi, Ha Nam…) which are in the last link of value chain.

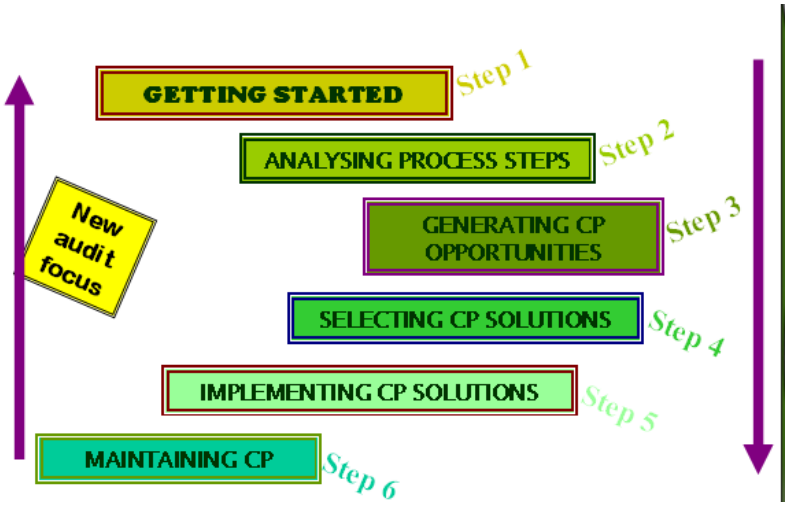
The assessment includes following steps:

- Collecting database
- Identifying unsuitable factors during production
- Proposing improvement opportunities
- Proposing necessary technology and equipment to improve capacity and product quality.

II.3. Cleaner Production (CP) and Design for Sustainability (D4S) methodology

CP and D4S .the continuous application of an integrated preventive environmental strategy applied to processes, products, and services in order to increase efficiency and reduce risks to humans and the environment.

Targets of cleaner production is to increase profits and prestige of enterprises, reduce pollution as well as bad affect on human and community's health. Experiences show that CP is suitable for all company's size from big size to household scale. CP and D4S methodology consists of 6 following steps :



Cleaner production options can be:

- Avoiding leakage, spillage during transportation and production called good housekeeping options;
- Ensuring optimum production conditions relating product quality, productivity, resource consumption and emission;
- Avoiding using toxic materials by using other materials;
- Upgrading equipment to improve production;
- Installing efficient equipment; and
- Redesigning products to reduce resource consumption.

Some basic D4S techniques:

- Selecting the materials of little impact
- Reducing material consumption
- Optimizing production technology
- Optimizing distribution system
- Reducing impacts during usage
- Optimizing initial steps in life cycle
- Optimizing product discharge step

III. GENENAL IN LACQUER PRODUCTION AND PROCESSING INDUSTRY

In the Vietnamese history, paint job appears quite early. Ancient Vietnamese residents found wild lacquer tree and know how to use its sap to caulk boats or to cover up other things to increase the their durability 2,500 years ago. During development, paint job almost go abreast with the job sculpting and carving decoration in the buildings. So that, during the feudal Great Vietnamese, paint job was quite perfect. Across the East, South, Doai, North area, paint job was developed everywhere. Ha Cau village (Dong Minh, Vinh Bao, Hai Phong) in the East was known by painting and sculpture; Dinh Bang (Tu Son, Bac Ninh) in the North was famous for the exclusive to supply glossy and smooth black lacquer that no where could match; Nam Ha area has Cat Dang varnish village (Y Yen, Nam Dinh nowaday) in Ha Nam religion; In Ha Tay area (Doai area in the past) there were a high density of paint job villages: Chuyen Mi, Boi Khe, Binh Vong, Ha Thai village, …

Lacquer is one of the painting materials in Vietnam. It is the result of study and technique development of paint job (Vietnamese paint job) from traditional handicraft to Vietnamese own lacquer. Lacquer painting uses traditional color material such as black lacquer, red brown lacquer, ochre, gold leaf and silver leaf, clam shells … paint on a black foundation of panel. In the early 1930s, the first Vietnamese artists, who studied in Dong Duong Art school, found out other material such as egg shells, snail shells, bamboo splints, … and introduce special rub technique that create unique lacquer painting technique. The term of "lacquer" and "lacquer painting" since then appeared. The lacquer painting could be rubbed some times until the desired effect are obtained. Final, the painting is polished.

Ornamental material

A lacquer painting uses rather types of material include lacquer, colour and other materials. Some common materials as follow:

- Lacquer: developed from lacquer tree, in addition, elemi, turpentine, "Do"plant is used also.
- Colour: traditional lacquer painting use two basic colors are red brown and red which prepared from inorganic minerals (i.e. ochre) not disintegrated by light and time.
- Silver material such as silver leaf, grinded silver, paddled silver, …
- Gold material such as gold leaf…
- Other material: egg shells, snail shells, "Do" powder …

Nowadays, traditional lacquer materials are replaced by industrial lacquer materials which have many advantages of plentiful color and painting production.

Lacquer ware craft villages

Lacquer ware processing always depends on weather, favorable especially in spring and early rainy days of summer. It reveals that lacquer ware craft villages are distributed according to not only area of production but also mutually dependent.

Phu Lao lacquer ware craft village (Tien Son, Bac Ninh) often uses sheets of goal and silver from Kieu Ky village (Gia Lam, Hanoi), "Do" paper from Dong Cao village, base frame or carving decoration products from Phu Khe, raw lacquer from Phu Tho, Yen Bai and elemi, turpentine from Lang Son, Cao Bang, …

Hanoi is the center where attracts materials and craftsman of lacquer ware processing art. Most of them come from traditional handicraft villages; they immigrate into Hanoi and develop to formerly Hanoi with thirty six streets and districts.

Modern lacquer ware art

Now lacquer painting using processed Japanese lacquer becomes popularly. Disadvantage of Vietnamese lacquer is allergenic, causes harmful to customers, in popular language, lacquer allergy is call "being eaten by lacquer", and painting also depends on the weather. Lacquer painting dry quickly in high humidity, but it takes a long time to dry in low humidity atmosphere. For this reason, it is rarely to use Vietnamese lacquer as material in countries which have dry climate. Meanwhile, Japanese lacquer takes a short time to dry, that helps lacquer painting can be done even in temperate climate areas. However, polishing of Japanese lacquer painting requires a clear lacquer layer to cover up, while Vietnamese lacquer painting will glossy easily if rubbed by a wisp of combings or wet hand. Nevertheless, Vietnamese lacquer painting is still preferred because of meticulosity in production as well as enjoying.

In recently, lacquer is not only used for lacquer paintingor horizontal lacquered board production but also developed to apply on high-grade interior such as furniture, bed, cupboard and so on. Lacquer ceramic now has been the favorite goods in many countries.

III.1. Background of lacquer tree cultivation in Phu Tho

Lacquer tree is grown in a number of countries in the world, but the lacquer tree in Phu Tho, Vietnam gives the resin worth the most. Sap from Phu Tho lacquer tree is far better than that from other areas. Artists and researcher on lacquer said that nowhere except PhuTho has lacquer which is at once flexible and condensed and profound in color, so that it helps Vietnamese lacquer resin to be famous for nice and stable products. They are not only well-known at domestic but also interested at many countries in the world such as Japan, China .However, like other industrial plants (tea, coffee), lacquer tree cultivation also develops up and down because of the dependent on market and price. In the past, lacquer tree was grown in districts as Lam Thao, Phu Ninh, Tam Nong, Thanh Son, but up to 1995 plantation area in Phu Tho remained only about 100 ha due to low price. Lacquer tree is now cultivated mainly in Tam Nong. For recent years, increasing in price of sap and stable consumer market has been promoted movement of lacquer tree cultivation. A lot of household cut down other plants such as eucalyptus leeches … and replaced by lacquer tree . Up to April 2007, there has been 2,262 households in the district cultivated lacquer tree with 418.8 ha of plantation area, 85.86 tons of production yield, 8.1 billion VND of overall worth, it is increased by 300 ha compared with the year of 1995; increase by 310 households, 189.3 ha, 38.86 tons and 3.6 billion of VND compared with the year of 2004. Current production and average price of 95,000 VND per kilo of sap are promoting Tam Nong lacquer tree to become a key industrial plant of Tam Nong district and enrich the farmers.

However, lacquer tree growers cultivate trees on their experiences without appropriate techniques or agents of technology research and transfer on breeding selection, multiplication, fertilization, farming technique to improve the cultivated effect. There for, lacquer tree cultivation area has not been expanded, sap yield is still low, sap quality is not uniform that make production efficiency reducing while current market request strictly for product quality and quantity. To demand the needs growers have to promote intensive cultivation, improve productivity, quality and yield of sap.

III.2. Characteristic and processing situation of Phu Tho lacquer

For a long time, on areas of communes of Tam Nong district, lacquer trees are grown on sloping hill. According to morphology, lacquer trees are classified into three groups including "la tram", "la si" and "mo ga" lacquers. But farmers do not pay attention about classification because the difference of these groups is inconsiderable. All of them are cultivated in population and "mo

ga" lacquer trees are predominating. When extracting lacquer tree to get sap, all of them will be filled in a common container. Sap of lacquer tree is called Tam Nong red lacquer or Tam Nong lacquer.

Characteristic of sap of Tam Nong lacquer tree (Tam Nong red lacquer)

- Lots of laccol
- Content of solid: 61 – 67%
- Content of black dregs: ≤ 2%
- Lacquer layer applied on the surface of painting material makes a beautiful red brown color and also is resistant to water, heat, acid and time. Traders and painters appraise Tam Nong red lacquer as the best quality product in Vietnam.

Sap from lacquer tree is mainly supplied to industry - small scale industry and restoring traditional handcraft village to produce specific exports that have a high competitive edge.

Sap from lacquer tree is supplied to domestic trading and exportation as raw material to China, Korea, Japan with the price of 5 - 9.5 USD/kg (85,000 – 160,000 VND per kg). Therefore, it creates employment to lots of people. Domestic market of sap from lacquer tree is about 20% and exports make up about 80% of total production in Tam Nong district.

Production area and yield of lacquer tree for recent years:

- 2006: 471 ha of production area; 136,100 kg of yield.

- 2007: 501 ha of production area; 155,000 kg of yield.

- 2008: 576 ha of production area; 184,000 kg of yield, equivalent to value of 27,600,000,000.0 VND

According to resolution number 11/NQ-HDND issued at July 16 2004 by Tam Nong people's council about development project of Tam Nong lacquer tree up to 2015:

- 2009: 600 ha of production area; 195,000 kg of yield.

- 2010: 750 ha of production area; 200,000 kg of yield (80% of production area is suitable for harvesting).

- 2015: 1,000 - 1,200 ha of production area; 320,000 kg of yield (80 - 85% of production area has a good harvesting). Other districts include Cam Ke, Thanh Son, Ha Hoa are considering to plant lacquer tree on some uncultivated mountainous areas. That is an open heading for lacquer tree production industry in Phu Tho province.

III.3. Biological characteristic of lacquer tree and the chemical composition of sap

Lacquer tree has specific name is *Rhus Succedanea.* It is green leaf, high and latex plant. The main chemical ingredient is laccol ($C_{25}H_{36}O_2$) and others.

Table 1. Chemical composition of sap

No.	Component	Content, %
1	Laccol	35-36
2	Polysaccharide, laccase and impurities	21-22
3	Water	39-40

Uses of sap of lacquer tree:

- Sap of lacquer tree is used as 3 types:

+ Varnish: sap is mixed with elemi, used to paint wooden furniture

+ Glue sap: sap is mixed with sawdust, used to glue wooden furniture, rattan, bamboo, wooden boat building …

+ Lacquer: sap is mixed with turpentine, color powder and other inorganic minerals, lacquer layer polished could make many glossy and nice colors.

- Uses of sap in industry:

+ Ocean traffic: shipbuilding, painting the shell of ship, boat.

+ Electrical industry: painting to metallic line for electrical isolation.

+ Food industry: Use to produce containers for liquid transportation (fish sauce, liqueur, and beverage), bulk containers using ferroconcrete with a layer of sap cover up will help to resist corrosion, ensure food safety.

+ Fine arts handicraft: used in lacquer ware production (industrial arts and visual arts).

IV. ASSESSMENT FOR CLEANER PRODUCTION OF LACQUERWARE VALUE CHAINS

IV.1. Lacquerware value chains

Lacquer tree is cultivated on hill land of Phu Tho province and mostly in Tho Van and Di Nau communes, Tam Nong district. Phu Tho lacquer tree, especially red lacquer has a high quality to use as cover layer, restore traditional products and lacquer painting production. However, 80% of raw sap from lacquer tree has been exported due to lack of initiative in processing. The 20% remaining is domestically using for lacquer painting arts after some of preliminary treatments. Value chains description as follow:

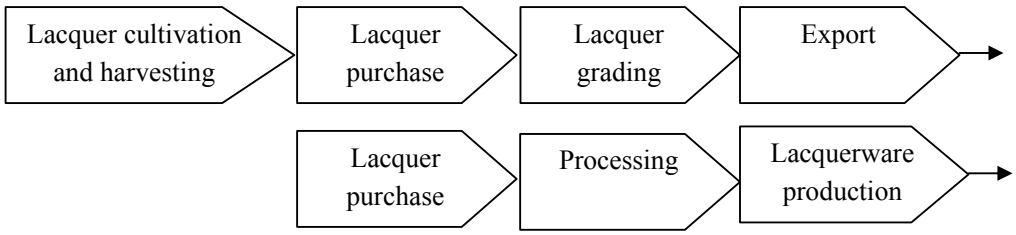


Figure 1. Diagram of lacquerware value chains

IV.2. Assessment for cleaner production of lacquerware value chains

IV.2.1. Lacquer tree cultivation

Lacquer tree is mainly cultivated on mountainous areas. Due to fluctuation in the development trend, there are very few studies on high yield lacquer tree. So, lacquer tree producer mostly rely on experience. Besides, they do not have the capital to invest in attending that result in lower and lower sap yield receiving. Sap quality is also decreased due to lack of good breeds.

Breeding selection

In lacquer production, breeding selection plays a very important role, which is the leading method in intensive cultivation system to improve sap quality and productivity. Good breed not only gives high sap productivity, high content of laccol but also satisfies requirement of processing technology, overcomes natural disadvantage condition.

Breeding selection is an integral step in lacquer cultivation, which influence rate of sprout, growing and sap yield. There are some different lacquer breeds, but “la si” and “la tram” plants have the highest sap productivity. Both of them are selected for cultivation, nevertheless it is needed to choose the seeds from luxuriant, lots of branch, lots of leaf, less of insect, less of flower and fruit trees, from which the sap flows evenly and numerously, high content of laccol. These trees often have an about 5-6 mm thick, rough and rosy shell. On fruit harvesting time from September to October, big and firm fruits are sorted and solar dried for 2 - 3 days, then seeding with a density of about 6 - 7kg seeds per hectare after rubbing the husk of seed.

Fruit harvesting

On September, ripen bunches of lacquer fruit are harvested. Good seeds then are selected for breeding. One hectare needs 12 - 15 kg fruits.

Fruit handling

Bunches of lacquer fruit are solar dried for 2 - 3 sunny days, then dry stored. By the sowing time, fruits are picked away from the bunch, rubbed the husk of seeds, sifted and winnowed. Seeds are slightly grinded in a mortar so as to thin the inner husk, then sowed directly into hollow or kept soaking then sowed into gourd.

According to the experience of producers in some areas of lacquer production, mixing the essential oils into lacquer seeds for grinding could help to protect it from termites and ants. Soaking the seed in hog-wash before breeding could help the seed to sprout easily.

Studies which were introduced in Phu Ho in 1954 show that lacquer seeds should be soaked in clean water for 48 - 60 hours, floated seeds are rejected. Soaking the seeds in 50^0C water can shorten the time of sprout 5 - 11 days. It is not recommended to soak in 100^0C water.

Cultivation seasons

According to reports on cultivation experience from experimental planting farm in Phu Ho, it is the best to dig hollow on August or September after waste burning off to clear land and hoeing up ground. This should be done on November or December at the latest because the strong sunshine on the February and March associated with high relative humidity will delay sprout development. Hoeing up ground should be done before digging hollow, then turning up for 2 - 3 times during cultivation.

Lacquer sowing time is from September to October or February. Lacquer trees cultivated on the September grow slowly but it could be restricted the ravages of cricket on the April. If sowing time is on the September, digging hollow for sowing first, hoeing up ground should be done afterwards, because as if hoeing up ground before lacquer seeds germination that encountered heavy rain, soil fill down the hollow so that lacquer seeds could not sprout. Lacquer seeds sowed on the February grow rapidly, but they are often bitten by cricket on the March, needs to attend to sapling trees in such a way that they grow quickly and rate of pestilent insect slow down.

Cultivation density

Like other plants, cultivation density has a close relationship to productivity, quality and economic effect of lacquer tree. Different lacquer breeds, soil and economy conditions need different cultivation density.

Cultivation density of effective lacquer trees at harvesting time:

+ White lacquer trees: 2,000 trees/ha

+ Red lacquer trees: 1,900 trees/ha

Determining appropriate cultivation density needs to consider to factors include breed, sapling quality, cultivation technique. Planting space also affects to cultivation density and varies from 0.1 to 0.2 m, depend on the follow factors:

+ Narrow planting space applied to poor soil, dry weather, low intensive level, poor fertilizer.

+ Wide planting space applied to fat soil, initiative in irrigation, high mechanized level, good fertilizer and high intensive level.

In addition, the effect of cultivation density to production, pestilent insect (especially pathology) and the resistant of windstorm are the basic factors to determine appropriate cultivation density to regional conditions. High cultivation density needs to be fertilized 2 more kg of muck per tree per year in order to get high productivity; this does not mean the cultivation density is the decisive factor in the increased production. The higher cultivation density, the more necessity is needed to ensure comprehensive measures of humidity and light.

Fertilization

From the results of survey conducted by Do Ngoc Dung in order to serve the lacquer tree study, it can see that in practice, lacquer production attaches importance to only sapling cultivation. Turning up the soil and fertilization are executed only from sowing time to pre-harvest time, but there is no fertilization from the beginning of harvest until the end of harvest, as a result the short time of sap of lacquer trees exploitation. In other words, lacquer trees quickly exhausted. Good fertilization let lacquer trees be luxuriant, long term youth, lots of sap, long time of sap exploitation. Fertilization make good quality and red sap with high content of laccol, lack of fertilization result in white sap.

According to report on improvement in lacquer cultivation techniques conducted by experimental planting farm in Phu Ho, it is needed to fertilize to lacquer trees as soon as they hardly sprout so that they grow rapidly. As soon as sowing, fertilize 0.1kg of ash and urine per hollow, 3 more kg of rotten fertilizer needed when the lacquer trees have 3 - 4 leaf. One year after sowing, prune away sapling so as to remain one tree per hollow, fertilize urine or 2kg of rotten fertilizer mixed with hog-wash per hollow, level the soil surface and fill down hollow. Should not use pig excrement and night soil because they cause the shell of lacquer tree to dry and hard, less of sap. Rotten cattle excrement is the best for lacquer trees.

+ Basal fertilizing: in order to increase soil temperature and humidity, induce seeds to sprout. Basal fertilizing uses rotten muck and fertilize directly to hollow.

+ Additional fertilizing: Base on the growing of lacquer trees to determine the time of additional fertilizing. It is often fertilized from sapling stage to beginning of harvest so as to let lacquer tree grow breadthwise and height to improve production.

+ Fertilizing for lacquer trees in the first year “son ho”: From February to March, at the first time of pruning, fertilize about 1 - 1.5 kg rotten cattle excrement or vegetable manure mixed with 5 - 10kg nitrate per hollow. The second fertilizing should be conducted from August to October after final of pruning using 2 - 3kg rotten muck associated with turn soil up around roots so that fertilizers are blended evenly. Hoeing up ground about 20 - 30 cm deep.

+ Fertilizing for lacquer trees in the second year “son ra”: This also should be split into two times. The first fertilizing is from February to March associated with hoeing up or plough, fertilize 1 kg of muck per hollow; the second fertilizing is conducted on the August or September, fertilize 2 - 3 kg of muck per hollow. If plough is conducted two times, the first time plough widthwise and fertilize on the top, the next plough lengthwise and fertilize along side

hollows. In case field is too sloping to plough, digging furrow drain and fertilizing as above to the roots of balanced development. Fertilizer should be mixed with 5 - 10 kg of nitrate (as a preparation for harvesting time on the February in next year). One more time of fertilizing could be done on the December uses 3 - 5 kg of muck per hollow. As much volume of fertilizer should be used as possible because fertilizing at this time strengthen the nutrition for lacquer trees to grow rapidly and have a flexible thick shell.

+ Fertilizing for commercial lacquer trees: Lacquer trees in the third year are almost beginning harvested and not fertilized any more. However in somewhere such as Phu Tho, producers keep to fertilize for lacquer trees during harvesting time, this helps to prolong time of sap exploitation to the sixth year. Fertilizing uses 2 - 3 kg of muck.

Figure 2. Lacquer tree cultivation and harvesting

IV.2.2. Lacquer tree harvesting

Lacquer trees in the third year are beginning harvested. Producers use knife to nick a V-shaped on the shell then plug an shell at the bottom of V-shaped to accommodate the lacquer sap flow in it. Lacquer tree should be harvested in the early morning to avoid sunshine that could oxidize the sap.

Harvesting tools

- Knife used to nick shell.
- Shell that lacquer sap flow in it
- Spoon used to scrape the sap from the shell
- Sap container
- Sap harvested are contained in a plastic box, and then collected in a larger plastic or bamboo box coated a sap layer in order to avoid leaking, being wet and oxidation.

Harvesting time

Lacquer tree could be harvested all year around but the highest quality sap obtained on dry season. Do not harvest in rainy day because the sap will have very poor quality when be wetted.

Figure 3. Lacquer harvesting (left) and store at household (right)

Sap grading:

They often cultivate and harvest together both of white and red lacquer trees. Red lacquer trees have high quality sap but low production, whereas white lacquer tree have poor quality sap (lots of moisture) but high productivity. Grading help to increase cost price of sap, ensure sap quality and prestige as well as convenience for sap processing later.

Sap harvesting needs to pay attention to notes:

- Do not harvest in rainny day
- Do not expose the sap to direct sunlight
- Do not let sap mix into impurity contamination

IV.2.3. Sap storage and assessment for quality

After harvest, sap is stored in household and wait for the collector. At collection agents, sap is stored also in storehouse and sold to wholesale markets or exportation.

- Storage at home:
  - Sap storage in a dark place, avoid moisture and direct sunshine.
  - Do not let sap mix with dust and impurity
- Storage at collecting house:
  - Packaging uses plastic bags
  - Storehouse must be dry and well-air ventilated
  - Avoid bumping when moving

Figure 4. Sap storage at collecting house (left) and assessment for sap quality (right)

Assessment for sap quality is conducted before trading because of many different chemical compositions presented in there such as laccol 35 - 36%, polysaccharide, lactase and impurities 21 - 22%, water 39 - 40%. Of this operation, real nature is measurement of water content by using a precision scale. A certain amount of sap is put into a small cup and using alcohol to burn it until the water evaporate totally. The remaining sap is quantified.

Assessment for sap quality using precision scale has some disadvantage as follow:

- Long time consuming to assess
- Low fidelity
- Smell of burning sap effect

Chinese traders use electronic scale which read out the exactly results quickly for sap trading.

IV.2.4 Sap processing

Because sap of Vietnam lacquer tree has the disadvantage of long time to dry, side effect to human health and lack of processing technology, raw sap is almost exported to China for processing, then traded to Japan continuously for other processing operation before imported back to Vietnam as products.

Exporting of raw sap as well as importing of processed sap result to:

+ Low added value
+ Depend on overseas market
+ No initiative in technology

Recently, a few household in the suburbs of Hanoi join in sap processing to serve lacquer painting arts but they are only small scale. In addition, the product is unstable quality due to rudimentary device, unclear technique parameters.

Characteristic of sap from Vietnam:

+ Long time to dry
+ Poor gloss
+ High content of water and impurities
+ Difficult to create more color.
+ Easy to be allergic

Table 2. Chemical composition of sap from some countries in comparison

Name	Country	Lackophenol
Rhus vernicifera	Japan, China, Korea	Urushiol
Rhus succedanea	Viet Nam	Laccol
Melanorrhoea usitata	Myanma, Laos , Thailand, Cambodia	Thisiol

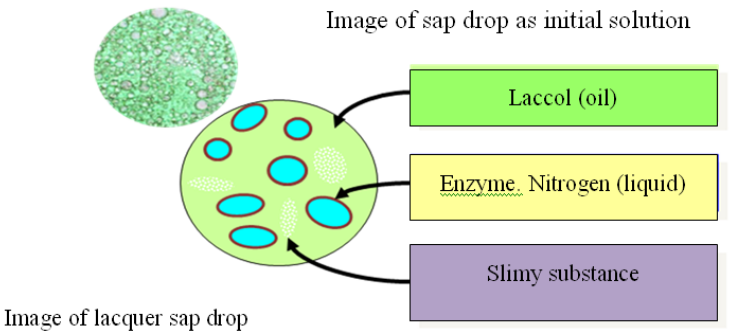


Figure 5. Image of sap drop simulation

There is only little research on sap processing in Vietnam and abroad also. Several Japanese scientists who work in University of Meiji conduct initial studies on Vietnam lacquer sap. They focus on how to shorten drying time as short as possible.

Mixing to Chinese sap to shorten drying time

Vietnam sap mixed with Chinese sap at different rate could help to shorten time to dry. This is showed in the table 3.

Table 3. Drying time of mixed sap

Sample No.	Rate of constituent, % weigh		Drying time (hour)		
	VN	China	No stickled dust	Not wet to touch	Hard dry
1	100	0	16,4	18,8	>24
2	90	10	15,5	17,0	21,6
3	80	20	14,8	16,2	20,9
4	70	30	13,3	14,9	20,4
5	60	40	11,1	13,1	18,6
6	50	50	9,7	10,9	14,6
7	0	100	2,2	3,3	8,9

Drying condition: 25 - 28^{0}C, relative humidity 70 - 75%, 77µm thick film.

Adding chemical constituent to shorten drying time

Table 4. Drying time of Vietnam sap added chemical constituent or acetone

Sample No.	Additive (1)	Rate of additive (2) %	Drying time (hour)		
			No dust sticked	Not wet to touch	Hard dry
1	-	-	19,1	21,7	>24
2	Laccol	10	<24	-	-
3	Laccol	50	<24	-	-
4	Urushiol	10	<24	-	-
5	Urushiol	50	<24	-	-
6	VNAP	1	19,0	21,4	<24
7	VNAP	5	18,9	20,9	<24
8	CNAP	1	18,6	20,9	<24

(1): Laccol: chemical constituent of liquid extracted from Vietnam raw sap

Urushiol: chemical constituent of liquid extracted from Chinese raw sap

VNAP: acetone powder extracted from Vietnam raw sap

CNAP: acetone powder extracted from Chinese raw sap

(2): Rate of additive added to Vietnam raw sap

(3): Drying condition: 25 - 28^{0}C, relative humidity 70 - 75%, 77μm thick film

Adding lactase to shorten drying time

Table 5. Drying time of Vietnam sap added lactase

Sample No.	Additive	Drying time (hour)		
		No dust sticked	Not wet to touch	Hard dry
1	-	19,2	22,3	>24
2	Laccase Daiwa Y120-1	8,7	9,8	13,4
3	Laccase Daiwa Y120-2	18,1	22,1	>24
4	Laccase Daiwa Y120-3	10,6	11,8	18,5
5	NS - 44002	11,3	15,5	21,3
6	NS - 44003	7,5	9,9	12,3

Rate of lactase added is 1%.

Drying condition: 25 - 28^{0}C, relative humidity 70 - 75%, 77μm thick film.

Conclusion

Several results as above show that mixing with Chinese sap, chemical constituents or acetone could help to shorten drying time of Vietnam sap.

Sap processing is proposed as follow:

Latex → filtering → Kurume operation (include grinding, stirring, supply drying heat) → mixing color.

However, in order to have sap processing completed technique parameters needs detail researches from scientist for applying in sap processing household or business.

IV.2.5. Processing lacquer works

Lacquer is a unique painting art of Vietnam. Lacquer technology only has the same general principles but differs in experience and techniques of each individual, each family as well its changes in painting techniques are different to statue making, object decoration, and golden painting ... It could be divided into several stages as: binding, decoration, grinding and polishing.

Binding

Previously, the wood core binding (objects to be painted) used paper made from timber that was more durable than fabrics. Binding way is as follows: use alluvial (today usually granite powder) mixed with paint, grind with paper and then bind, heal the cracks of the wood panel. Each paint layer is coated with a paper layer (or cloth) and then fully dries wood for binding and painting the upper and lower surface. This stage is to ensure waterproof of the panel, no termite

damage and no environmental dependence on wood shrinkage. The more thoroughly processing the panel, the longer life it has. Between the binding and painting times, there is a grinding time – dry or water grinding.

"Ket, thi"

After the panel is bonded and framed, handicraftsmen will inspect the entire surface of the processing details, if the surface is scratched, rough, "Ket" will be conducted. This stage has the usage of making the surface completely smooth. After "Ket", first "Thi" and second "Thí" will be conducted. The stage is to make details to have deep gloss for stage decoration.

Decorating

When the above panel is made (or carved patterns), handicraftsmen have to conduct stage of pasting/sticking materials and coloring the works such as eggshell, gold, silver, ... then painting and grinding and last color.

In addition to lacquer manufacturing, enterprises also make a range of decorated lacquer products with the following figure

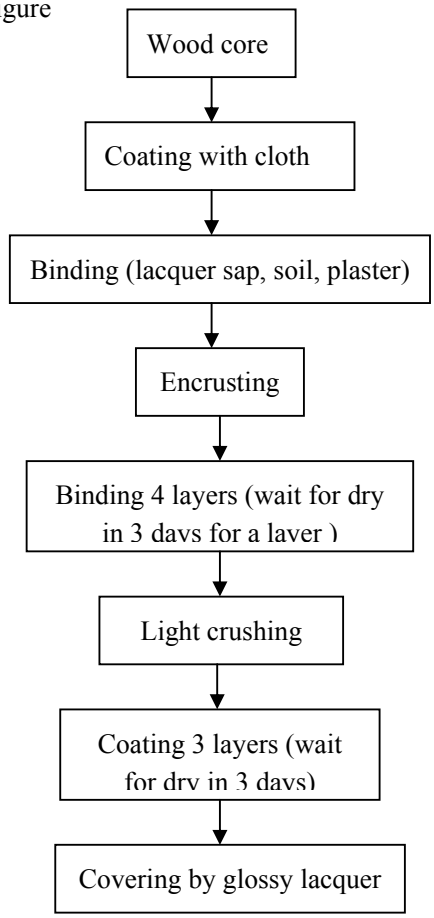


Figure 6. Diagram of decorative lacquer production

Manufacturing the core

Making normal frame with bamboo wooden materials which are easily damaged by termites should be well treated

Layers of a frame should be fitted to avoid being shrunk, cracked and broken

Figure 7. Making a frame (left) and basal painting (right)

Creating primer/basal paint layer

Paint used to create basal paint layer should be plastic and sticky, avoiding warping the layers together when shrinkage.

When the paint surfaces are not flat, grinding paper will be used, which producing dusts that affects human health

Water scraping/grinding

This stage uses lots of water to grind, producing large amount of waste water.

Workers rarely use protected cloths.

Drying duration cannot be controlled, especially when it is raining or humid.

Figure 8. Water scarping/grinding (left) and shiny painting (right)

Shiny painting

Using several solvents with high evaporation capacity which are highly toxic especially for workers regularly exposed to the work.

IV.2.6 Environmental Issues

For the value chain of gardenia trees, the most pressing environmental issue is the stage of product grinding.

- Dry grinding makes dust pollution for workers and surrounding environment

- Water grinding discharges a small amount of wastewater, only about 2-5m3/day/enterprise, but waste water contains high levels of pollutants. The waste water contains small abrasive dust to increase the content of sediment. Concentration of COD and BOD5 in the waste water of the villages are respectively higher than limit from 2-5 times and 5.5-8.5 times. Most of households and enterprises have no wastewater treatment system before discharging into the environment.

- The solvents from the shiny paint and glue: are easy to evaporate and affect human health.

IV.2.7 Demand of technology and equipment

The investigation in the enterprises under the lacquer tree value chain showed that the most needed thing is to have good lacquer producing technology equivalent to imported lacquers.

The technologies needed to be researched include:

+ Quick Drying Time

+ Highly Glossy/Shiny

+ Able to mix color diversely

The equipment required to support:

Company Size:

- Equipment to test paint processing

Collecting household size :

- Electronic equipment to check paint quality

V. SUSTAINABLE PRODUCT DESIGN FOR VALUE CHAIN OF LACQUER

V.1 Current status and unsustainable issues

The actual observation showed that an unreasonable issue for lacquer industry is that: when saying about lacquer, two things are mentioned as the Ha Thai Lacquer village in Thuong Tin, Ha Noi, where there is a long traditional lacquer and focus of the famous enterprises in the field of paintings and lacquer products; and most of current lacquer facilities purchased Chinese and Japanese paints. The discrepancies is that Vietnam has a nationally and internationally famous lacquer village, but most of the paint products used in this industry are imported from abroad, while the total area of gardenia trees in Phu Tho now is up to several thousand hectares. In 2009, only Tam Nong district had 494 hectares of gardenia trees with the production of 125.5 tons. So far, gardenia farmers in Phu Tho paint have to sell gardenia latex to traders at low prices who will export it to China. Lacquer enterprises in Phu Tho is gradually eroded, either transferring to make a counterfeit lacquer, or moving the business to the other available products in the same category as art painting or rock painting, ...

Products in the lacquer industry are currently very rich in terms of styles, materials and practices. These products have achieved a specific position in both domestic and export markets. The active enterprises have been self equipped with the necessary capacity from design to production and exports; they regularly participate in fairs and exhibitions abroad with the aim of learning and expanding network of customers and the dealers. Thus, their products have created high added value and credibility in the market. However, the problem that businesses are referred to as the saturation of the lacquer products in the market, it is because most of the lacquer products are works of art for decoration with low use value as well as product features.

Besides, production activities for the profit of some businesses should be included. By making "new" lacquer paintings, which are printed by inkjet printing onto plastic sheets, then pressing onto the timber and proceeding with the editing side, spraying a protective coating to the surface. This will shorten the time and cost of products, but also reduce the quality and longevity of products, thereby losing customer confidence in the product and losing the traditional lacquer skills of the lacquer industry.

V.2 Anylysis and recommendation of improved solutions

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:

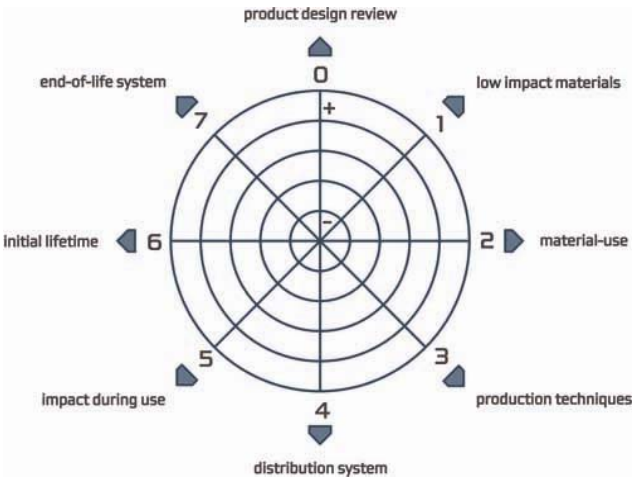
- Copy the design from a rival and sell to the same market.
- Produce the product from an original sample from buyer

- 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.

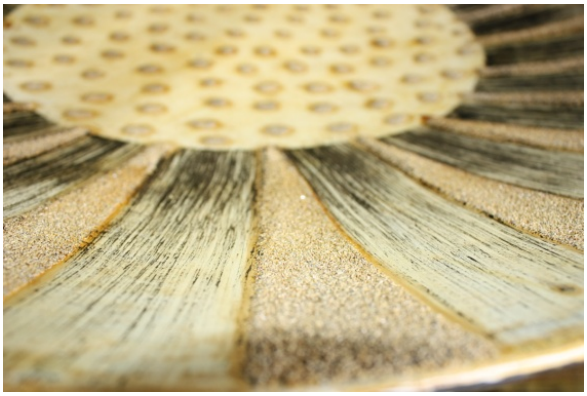
If the organization trying to do it all, the productivity would not be high and the efficiency is also not good. In the case, it could not achieve its strength and reduce the weakness. Considering in whole industry that could lead to self-competition. In order to get the best achievement, the company 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.

Besides applying the proper methodology for product strategy and business strategy, developing inner strength of each enterprise, building an effective support network based on the profits of the entire chain. Enterprises should further take advantage of union organizations to learn about the development trends in Vietnam and in the world, through these organizations to build brands, trade promotion for enterprises, improving capacity competitiveness for enterprises in a sustainable manner.

For lacquer enterprises under the project, it could be divided into two groups:

Group 1 includes the households with planting gardenia trees in Phu Tho, it is needed to have support from organizations, individuals and enterprises to identify how to process and produce paints from the domestic gardenia resin sources. It both creates a stable output for households in the current gardenia growing areas and produce domestic high-quality paints with lower prices than import. Regarding social issues, it will contribute to creating jobs for the current gardenia growing areas in Phu Tho and other provinces, promoting high-quality gardenia trees in Vietnam.

Group 2 includes enterprises making paintings and lacquer products: Enterprises should find and access to methods to develop new products in the world, to find and create new attractions for the product, to promote used value and value added of the products. At the same time, enterprises should be developed under the direction of a combination of lacquer with the other arts, with more varied materials such as pearl inlaying, washing the metal, ceramic, rattan, ... to enrich the types of products, adding value to products



Product design and production converges 3 factors:

1- The art and beauty of lacquer.
2- Usefulness of the product a part from decorative use
3- Combining a variety of materials into lacquer products

V.4 Analysis of development trends in Vietnam and 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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