



**TOGETHER**  
*for a sustainable future*

## OCCASION

This publication has been made available to the public on the occasion of the 50<sup>th</sup> anniversary of the United Nations Industrial Development Organisation.



**TOGETHER**  
*for a sustainable future*

## DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

## FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

## CONTACT

Please contact [publications@unido.org](mailto:publications@unido.org) for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at [www.unido.org](http://www.unido.org)



**J**OINT PROGRAMME ON GREEN PRODUCTION AND TRADE  
TO INCREASE INCOME AND EMPLOYMENT OPPORTUNITIES FOR THE RURAL POOR

# REPORT

## CLEANER PRODUCTION ASSESSMENT AND SUSTAINABLE DESIGN

### SEAGRASS VALUE CHAIN



**Vietnam Cleaner Production Centre**  
4<sup>th</sup> floor, Building C10  
University of Technology, Hanoi  
Dai Co Viet street, Hanoi, Vietnam  
Tel: (84.4) 3 8 684 849  
Tel/Fax: (84.4) 3 8 681 618  
Email: [vncpc@vncpc.org](mailto:vncpc@vncpc.org)  
Web: <http://www.vncpc.org>

**Hanoi, June 2011**

**TABLE OF CONTENTS**

<b>TABLE OF CONTENTS</b> .....	<b>2</b>
<b>I. INTRODUCTION</b> .....	<b>3</b>
<b>II. EVALUATION METHOD</b> .....	<b>4</b>
II.1. The value chain evaluation .....	4
II.2. Quick assessment at SME.....	4
II.3. Cleaner production and design for sustainable methodology .....	4
<b>III. OVERVIEW OF SEAGRASS INDUSTRY</b> .....	<b>6</b>
III.1 Nga Son seagrass production .....	6
III.2 The seagrass processing industry .....	7
III.3 Bio-characteristics of seagrass .....	7
<i>III.3.1 Variety and classification</i> .....	7
<i>III.3.2 Bio-physical characteristics</i> .....	7
<i>III.3.3 Biological development and life cycle:</i> .....	8
<b>IV. SEAGRASS VALUE CHAIN EVALUATION</b> .....	<b>9</b>
IV.1 Seagrass value chain: .....	9
IV.2 Value chain cleaner production evaluation .....	9
<i>IV.2.1 Seagrass cultivation</i> .....	9
<i>IV.2.2 Harvest</i> .....	11
<i>IV.2.3 Seagrass splitting</i> .....	12
<i>IV.2.4 Seagrass drying</i> .....	12
<i>IV.2.5 Material and product preservation</i> .....	13
<i>IV.2.6 Mat and other product processing</i> .....	16
<i>IV.2.7 Dyeing</i> .....	17
<i>IV.2.8 Demand of techniques and equipment</i> .....	17
<b>V. DESIGN FOR SUSTAINABLE SEAGRASS VALUE CHAIN</b> .....	<b>19</b>
V.1 Current situation and its issues .....	19
V.2 Analysis and suggestion .....	19
V.3 Some sample of Design for sustainable.....	21
V.4 The development trend of seagrass in Vietnam and on the world.....	21
<b>REFERENCES</b> .....	<b>22</b>

## **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, HoaBinh and PhuTho during the investigation of the project: “Green Production and Trade to increase Income and Employment Opportunities for the Rural Poor”.

## II. EVALUATION 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:

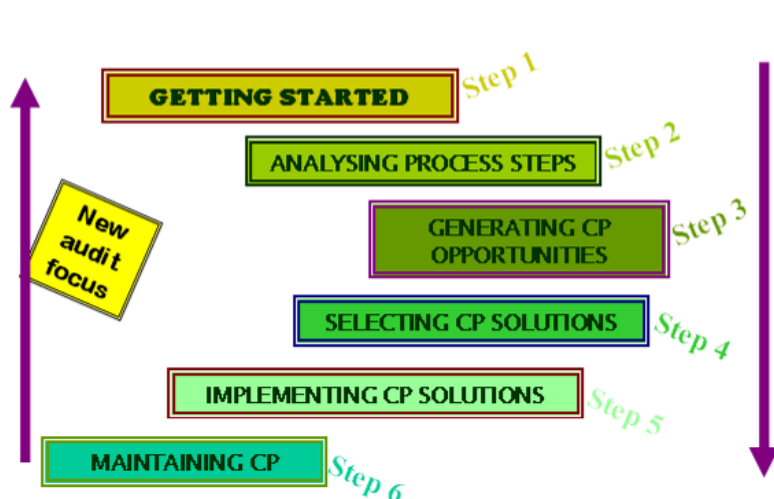
- Baseline data
- The problem in the value chain identifying
- Modifying suggestion for more effective production
- Equipment upgrading recommendation for innovative development.

### II.3. Cleaner production and design for sustainable 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 SEAGRASS INDUSTRY**

The seagrass has imported from China, cultivated and handmade produced in Vietnam during the king Le Thanh Tong reign (1060-1497) by Mr Pham Don Le. The industry has been raised mostly at the beachside areas. The total cultivated area is around 10,950 ha(1994) and the main areas are Hai Phong, Thai Binh, Quang Ninh, Nam Ha, Ninh Binh and Thanh Hoa provinces with area of 4,700ha. In there, the biggest cultivated area is 2,400ha in Thanh Hoa. The seagrass could be used to make lots of produces such as: mats, shoes, hand basket and hammock. The low quality seagrass has been used in traditional house roofing, paper powder making and also energy generator as fuel. The seagrass products is not just consumed in domestic market but also interested from international markets. From 1920s, the seagrass products exported to Hong Kong reaches to 1,500 tons. In the decades of 50s and 60s, the split seagrass has been exported as raw material to many countries and brought high income to the producer.

The seagrass industry always plays an important role in Vietnamese agriculture. During the 80s and 90s, the industry had reached to the peak production. The split seagrass had been exported to China, Japan and Korea with the 7-8 fold value in comparison with rice cultivation value from the same area. However, the farmer also had faced several downturns in the past. From the first years of 21 century, the industry has been developed gradually and become more diversity in product which leads to higher value.

Recently, the industry has been invested and paid more attention from the local authorities and also the private sector in all the areas, especially in Thanh Hoa. In the Northern of Vietnam, the production concentrates at Nga Son – Thanh Hoa and Kim Son – Ninh Binh. Their products have been exported to not only Asia regions but also Euro countries. With the more diversity and attractive product, the industry has been stable and significantly developing [1].

#### **III.1 Nga Son seagrass production**

Until the year of 2000, the combination from the good natural water source from Len, Can and Chinh Dai rivers and the irrigation system in the area, supply enough water and bring nutrition to the plant development. In addition, the disease was not available and the cultivation had well planned which lead to the high quality and productivity of the crop. Moreover, the export market had expanded and the demand risen dramatically has leded the cultivation develop very quickly to reach to the peak of 27,600 tons in 2002 with 2-3 harvest times per annum in some regions.

In 2000s, due to the climate changes, the sea level has raised and affected on the salt contents in the soil with an increase of 15-20%. In the production area, some diseases has arrived such as :beetle, borer, brown plant hopper (English name) with the high coverage and negative effect. Being affected from the above reasons, at some cultivation areas in Nga Tan, Nga Tien and Nga Thuy at Ngu Ham 3 river bank region and other areas at the Ma and Hoat riversides, there was no harvest. In 2005, the total harvesting quantity was just 20,000 tons (especially in Nga Tan area, the production plunged from 2,995 tons in 2002 to 779 tons in 2005).To solve the situation, in 2006, the local authorities have invested tools and equipment for farmer such as industrial water pump system, bills discount and supporting fund for soil renovation, etc... In addition, the farmer in Nga Tan, Nga Tien and Nga Thuy has been encouraged to recycle the salted and the abandoned land for cultivation. Moreover, the water system has been maintained to prevent the effect from the seawater and supply enough water for the crop. During the period, the land level of 270 ha in 328 ha in Nga Tan district has been decreased down 25 centimeters than usual. All of the actions have helped to increase the productivity to 26,000 tons in 2007.

However, from 2008 until now, the exporting has got some issues. For example, in 2006, 1 kg of seagrass could exchange to 3 kg of groceries but now 3-4kg of seagrass is equal to 1 kg of groceries. The exported quantity is too low, then it affects to production and the farmer lives. That leads to lot of farmer has abandoned their land or change to the other job.

### **III.2 The seagrass processing industry**

In the 80s, due to the European communist countries – the most important export market of seagrass product – collapsed, the seagrass industry mostly shut down which bring lots of difficulty to the farmer here. In order to deal with the issue, the Nga Son authority has planned to increase the groceries cultivation area to supply local need, meanwhile, finding replaced exported markets. The local economy has recovered gradually, the seagrass processing has developed significantly. From the time of simple product processing, the producer such as SMEs has designed more diversity and attractive products.

In 1990s, in the area, there were 1,170 SMEs in various industries but in 2008, the number is just 8,700. In there, there are 6,630 SMEs operated in seagrass industry with approximately 10,400 workers (79.84% of local labour force). The processing value reached at 11.2 billion VND in 1990 (fixed price in 1994) and 81.4 billion VND in 2007 with exported value of 6.5-7 million USD. Beside of the local raw material consumption of 25,000 tons, the SMEs have imported material from other areas with quantity of 7355 tons per annum, and the peak was reached in 2005 of 11,654 tons. The exported market has expanded from China to Eastern European countries, Japan and Korea, etc...

Recently, there are still some issues in the industry. The water supply system has been maintained but has not been good enough for the cultivation in the area. Besides, the cultivation has lots of problems such as planning is depended on the farmer who followed market demands, using the inorganic fertilizer and also diseases. The traditional variety has been deteriorated: bigger size, softer, decrease in strength, different color distribution. Moreover, the quality of product had not been cared; the design is still not creative and diversity by time. The production is still controlled by the Chinese demand. There is no registered trade mark for the famous local product. Therefore, the received value from the product is low. In the recent years, the other materials such as water-fern, banana tree, etc... have been used as substitute for seagrass with the proportion of 15-20% total productivity. That also affect to the seagrass cultivation in Nga Son. The seagrass processing SMEs just concentrate on postharvest stages but not pre-harvest one. Therefore, there are not many investments have been established on seagrass cultivation. In addition, other factors such as climate changes, weather, salt content increasing in soil, diseases have impacted on the productivity and quality of the seagrass. The export market is fluctuating and declining that has not encouraged the farmer to cultivate and produce.

### **III.3 Bio-characteristics of seagrass**

#### **III.3.1 Variety and classification**

Seagrass belongs to *Cyperaceae* class including 85 subclasses with over 4,000 species. In Vietnam, there are 30 subclasses with 240 species. The most popular varieties are white flower (*Cypeustojetjomis*) and gray flower (*C. Corymbosus*) seagrass. Nowadays, the white flower variety has become more popular due to higher productivity and quality.

#### **III.3.2 Bio-physical characteristics**

The plant can be visually divided to two parts: underneath and exposed parts

*a. The underneath part:*



The body of the plant is usually in the part. There are 5 – 8 knots on the body. Each knot has the leaf cover and grows up by time, then the new branches will come out from those knots. Therefore, each body can develop 5 -7 branches which grown as exposed parts. The root also come out from the knot and then could reach to 1 meter deep in the soil but usually spread at the layer of 20-25 centimeters of deep. The larger the root spreading the stronger and higher development the plant is.

*b. The exposed part:*

The last knot which is nearest to the surface of the soil will grow up as different type of leaf, flower and fruit. This part is the main material for the seagrass industry.

The floral axis is triangle shape; the bottom could be more round than the other and the length of the round body depends on the height of the plant.

Cultivation depends on lots of factor of condition such as: weather, water supply, etc... Moreover, the technical method of cultivation plays an important role in the plant development.

**III.3.3 Biological development and life cycle:**

The plant life cycle is quite short of 3 -4 months. Therefore, the number of harvest season could be more than one per annum. Nowadays, in Thanh Hoa and NinhBinh, the harvest time could be two: Fifth-month season and harvesting season.

The development of the plant could be divided to stages:

- Shoot establishment.
- Branching
- Growing up
- Flowering

*a. Shoot establishment:* the shoot has been established from the underneath mature knot. The knot after harvesting time and fertilizer period will be grown enough to let the shoot come out.

*b. Branching:* the process has taken place very soon after the shoot coming out. Branching is occurred periodically for 7 – 10 days per interval.

In fact, in the Northern areas, especially Thanh Hoa province, when the environment is suitable (rainy, temperature > 25<sup>0</sup>C; pH 6 -7 and salt content of 0.15 -0.2%), the water level is just enough, with the right cultivation method, the productivity of plant is highest. Branching happened in March and April for the Chiem harvest season; July and August for the Mua harvest season. The other should be removed to achieve the best cultivation.

*c. Growing:*

The period happens in 35 – 45 days and has great influence on the quality of seagrass. The best condition for the development stage would be temperature in the range of 25 -30<sup>0</sup>C; rainy weather and enough water. The fertilization should be right as the instruction for seagrass at all manners such as time and quantity especially with the ammonia fertilizer to help the plant develop with the highest rate, best quality.

*d. Flowering:*

When it is flowering, the plant stops growing. Flowering and seed establishment would be the indicator for harvesting season (the color of the tree changes from smooth bright green to hard yellow-green)

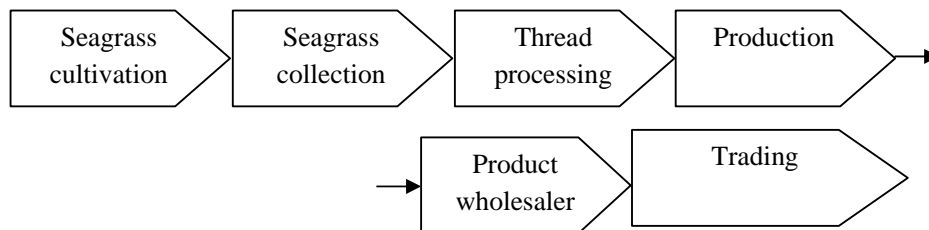
The harvest season time:

- Fifth-month crop season is from the end of May to June
- Harvest season is August

## IV. SEAGRASS VALUE CHAIN EVALUATION

### IV.1 Seagrass value chain:

The plant is usually cultivated at the beachside area. Seagrass after harvest will be classified and dried; then tied in bunch for transport and using. The seagrass could be used for processing such as mat maker, hand bag, etc... some of the seagrass threads have been reeled and exported to China. Therefore the value chain could be described as below:



**Pic 1.** Seagrass value chain

### IV.2 Value chain cleaner production evaluation

#### IV.2.1 Seagrass cultivation

The plant is one kind of grass family which grown at the high humidity area. The root is underground and the exposed body is no knot and soft with triangle or round shape. The leaf has the end come from the ground and cover the body of the tree as the cover tube. The leaves organized in three rows along the tree body. The small flower comes from the leaf side and could be combined in bunch.

In order to improve the productivity and quality of seagrass, several factors should be considered:

##### a. Soil selection

The plant is long life, so with the first seeding, we can cultivate for years. The quality and productivity of seagrass depends on lots of factor but the most important thing is the soil should be suitable and supportive for the plant in its whole life. The area needs a good and active water supply system; high nutrition soil of 40 – 60 centimeters layer with thick mud. The salt content should not higher than 0.2% and pH in the range of 5 -8.

##### b. Soil preparation

Technical steps:

- Weed removal
- Ground preparation (height decrease)
- Orchard ploughs deep and rakes carefully.

With different type of soils, there are different ways to prepare specifically due to the cause:

- + The old cultivation area (which is cultivated for years or the ground is too high or the salt content is too high) produced low quality and productivity of seagrass should be treated.
- + The new cultivated area: depending on the concentration of mud, salt content, etc... Weed removal, water supply system establishment and ground preparation should be done before seeding.
- + The converted cultivation area(from rice, vegetable, etc.. ) should be treated to get the designed condition for seagrass development.

- Notice: after the soil preparation, irrigation needs to be applied to make the ground softer which is very helpful for the plant growing.

*c. Seeding*

For an area of 1 ha, the seeding requires 10 tons of new young shoot. It should be clean, disease free and collected from the year 3 of cultivation. The popular variety cultivated in Nga Son (Thanh Hoa) and Ninh Binh is the white flower one. The shoot should be chosen from the mother tree which has round and strong body and the leaf length is 1.5 – 2 meter.

The shoot must contain both the underneath and exposed parts. Depending on the real condition, the shoot could be collected from same or different orchards to supply to the new cultivation area.

The shoot should be separated and washed. The exposed part needs to be in range of 20 – 25 centimeters. Storage condition has to protect the shoot from drying. In Thanh Hoa, the shoot will be collected after harvest due to the healthier and better protection.

*d. Cultivating time*

Seagrass can be cultivated all year. However, in order to get the best result, the plant should be seeded in March or April for Chiem season and July and August for Mua season.

*e. Density of crop*

The seeding period and density of the crop always have impacted on the crop lifetime and productivity. If the density is too low, there is a chance for weed development; otherwise, the tree will be small and low productivity.

- The optimized density
  - The traditional orchard or old river bank, 20x20cm or 18x20cm and each block should contain 3-5 branches
  - The new riverbank area, 20x30cm or 30x30 cm with 5-6 branches/block.
- The deep of cultivation
  - In the orchard, cultivation at deep of 3 -5 cm
  - In the riverside with waves, 5 – 7 cm or 10 cm

*f. Fertilizer*

The seagrass is long life cultivated crop. So, the nutrition demand is quite high, especially the Nitrous fertilizer. The best experience is using both organic and inorganic fertilizer to get the highest quality and productivity.

The specific fertilizer requirement:

- For the new orchard:
  - Orchard preparation: manure 10 – 20 tons per ha. Phosphate fertilizer demand is 3000 - 4000 kg/ha. The manure could be substituted by the Lamson complex organic fertilizer with the quantity of 1000-2000kg/ha.
  - The fertilizing time should be at 3 points:
  - Branching: 40% Nitrous demand
  - When the tree reaches to 40-50cm of height: 20% Nitrous demand
  - The fast growing stage before harvesting: 35-45 day/time

The urea requirement would be 500 – 700 kg/ha. The HuuNghi premium complex fertilizer – Thanh Hoa type 16 -16 – 8 or 15 -7 -5 or 10 – 10 -5 could be used as replacement with the amount of 500 – 800 kg/ha. In addition, the Lamson organic fertilizer with high urea contained

could be applied at the time the plant growing fastest rate. In the other method, the LS-HC fertilizer supply should be 1000 – 2000kg/ha and 250 – 300 kg of urea/ha.

Cautions: the orchard should be clean, high water contained and cool weather at the time of fertilizing – a light rain is the best chance.

- The traditional orchard:
  - The fertilizing time should be at the point:
    - After harvest (for the root and underneath part recovering): manure + complex fertilizer
    - Branching: urea and complex fertilizer
    - When the tree reaches to 35-50cm of height: complex fertilizer
    - Leaf growing stage: urea
    - The amount application is the same with the new orchard procedure, at some stages could be done at the higher quantity due to the long time cultivation such as orchard preparation and growing periods.

Cautions: weed removal should be done before all the fertilizing.

#### *g. Disease prevention and protection*

Insects and rat are the main problems for the cultivation. Recently, the most popular insects in the crop planting would be borer and locusts.

The very first method is prevention: good water system; orchard cleaning and weed removal should be applied immediately after harvest. In addition, some pesticide could be used at the orchard preparation stage to kill the insect still stays in the area where already got that problem in last season.

The protection method: do assessment on the orchard to calculate the percentage and concentration of insects to determine the amount of pesticide needed. The pesticide which is volatile and absorbable could be more effective in the area such as: Trebon; Conphai; Sutin and Chess.



**Pic 2.** Seagrass orchard

#### ***IV.2.2 Harvest***

After seeding 6 months, the crop is harvestable. Depending on the area, the crop could be harvested 1 or 2 times per year and the productive life of plant would be 4 – 5 year.

The timing of harvest should be set at:

- The right mature of the crop
- The suitable weather for highest performance processing.
- Good preparation for the next season.

Nowadays, the climate change leads the weather becoming unpredictable. The factor has got a very important influence on the cultivation and productivity.

- The plant should be cut closely to the ground as possible.
- Classification depends on the length of the leaf(Grade 1: 1.75m; Grade 2: 1.65m; grade 3: 1.55m; grade 4: 1.45m; grade 5: 1.35; grade 6: 1.15 – 1m; grade 7: 1 – 0.6m)
- Also quality classification: no disease, strong and tough.



**Pic 3.** Seagrass harvesting (Left); classification (right)

#### ***IV.2.3 Seagrass splitting***

The seagrass after harvest needs to be split and dried. In the past, the stage cost lots of time due to manual splitting which is low productivity and high loss. Recently, new inventory semi-automachine which has built-in motor and blade (containing 2 wood rollers 120mm diameter and 350 – 400mm length and a centre iron blade) can split the plant to two parts. However, this equipment needs 2 labours to operate – one for feeding and one for product removal. The most recent machine which has productivity higher than the old one 6 – 8 times but require just one person for operating, now is on trial at some cultivation areas.



**Pic 4.** Semi-auto machine (left) and the automatic one (right)

#### ***IV.2.4 Seagrass drying***

The purpose of this process is decrease of water content and avoiding mold development. The traditional method is solar drying (normally 3 day under sun-light). However, if there is a rain, the method could not be applied and also combining with high humidity in the air would lead to the mold growing quickly. In the past, there was several times which loss due to mold development has reached to 50 percent.



**Pic 5.** Seagrass drying on ground

In order to secure the input for processing and avoiding the weather effects, there are several researches on the drying technology:

- Drying chamber used heated-air from coal burner.
- Drying by the waste stack-air from brick-factory.

However, due to chance to have a brick-factory in the area is rare and the cost of the drying chamber is too high, there is just few organization has applied.

After drying, the material has been kept in storages or sold to collectors. Because of no storage facility, the loss in raw material and products in most of the farmer and small cultivation organization is high, especially winter period.

#### ***IV.2.5 Material and product preservation***

In the area, the farmer and company use the nylon bag to prevent the humidity in the air effects on the product and material. This method is not effective enough to protect the product from the humidity.



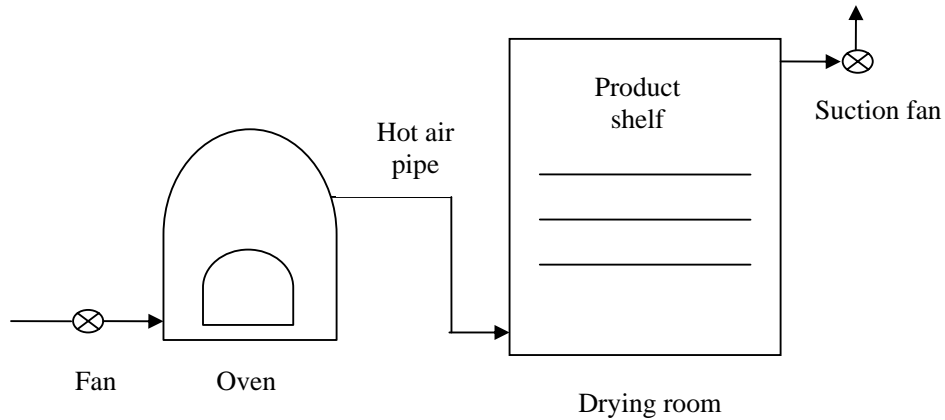
**Pic 6.** The high humidity effect on product (left) and the nylon cover (right)

In order to solve the problem, something need to be paid attention when build the storage room and product arrangement:

- Use the transparent panels on the roof to collect the heat and light from the sun.
- The door must be sealed when it raining, high humidity and opened when it dry.
- The raw material should be wrapped tight by nylon or other covers
- The material and product must be placed higher than ground at least 10cm.
- Humidity removal system established in the storage room – if possible.

In addition, some other techniques could be applied in the period:

*a. Storage in combination with drying:* because of the humidity in air, even the product or material already dried, the hot air should be provided frequently to dry them again. Commonly, the organisation build the in-direct drying system as below:



**Pic 7.**The drying system chain design (above) and the real one (below)

However, the data collected from the applied organisation showed that the coal consumption is too high which is due to:

- The coal size is not uniform. Therefore, there are un-burned coal in the waste.
- Coal has not been stored well and absorbed humidity from the air leads to longer time of burning and waste of heat.
- The burner built from the common brick which no insulation causes more heat loss.
- The drying chamber must be designed for the highest contact capability of the hot air to the product such as z shape.
- The door of the chamber must be closed tight.
- The product arrangement should keep the small distance between products for the air go through and contact to all surfaces of them.

During the storage period, the chamber could be used as storage room and periodically supply hot air to re-dry the product.

*b. Cool preservation*

Storing product at 10 - 15°C and humidity below 14% condition. The electrical based system can maintain the natural colour of product but high cost. Therefore, only the exporting

organisation could apply.



**Pic 8.** Cool room at Nga Son – Thanh Hoa

### *c. Gluing preservation*

Recently, lots of the exporting organization uses the water base preservation adhesive for product formation and also mold and humidity prevention. The most popular glue is polyascera which can cover all the surface of product. There is still a problem in using the method as it could be damaged during the transportation and the mold could develop again.

Adhesive application: dipping in; spraying and dipping and pressing. Depending on the shape of product, the different method would be applied. Dipping would lead to higher loss of glue as the extra still bond to the product after application.

#### Cautions

- Dipping:
  - Used for the simple shape product with just few corners.
  - Hanging on the rack above the adhesive tanks for a while to get back the extra glue.
- Spraying:
  - Using the suitable spraying gun and the spraying head which just concentrate on the small area such as product.
  - No application in wet weather.
  - Application must be done in closed room.

Due to the extra glue remaining in the thread is too high, the processing company has tried to improve the performance as adding the pressing part to recover the no need glue. However, the equipment is just suitable for the flat item processing.





**Pic 9.** Dipping and pressing at the Vinh Long Co.ltd

#### ***IV.2.6 Mat and other product processing***

The seagrass has been using to process many different products. The most popular and traditional product in the region is mat. Recently, due to the demand of market, the design is becoming more diversity and new product such as handbag, mirror and basket has been found.

##### ***IV.2.6.1 Mat processing***

There are two type of production: manual and automatic weaving. The manual process is low productivity (4 mats per day) and requires at least 2 labours to get the job done. In the past, the demand was high but now the consumer prefers mattress over the mat. However, due to lack of financial investment and having spare times, lots of producers still use the manual method.

The larger organization which is much wealthier has invested the automatic weaving system with higher productivity (15 minutes for each mat). However, due to the high cost of the machine, each enterprise just has one or two systems. Most of them come from China and the last is local product. The weakness of the system is that the thread must be dipped in water to make it softer. The action could lead to the product easy to absorb humidity and mold growing during storage.



**Pic 10.** Manual weaving(left) and automatic weaving machine(right)

The mat would be re-checked and border cut then transported to the collector organization.

##### ***IV.2.6.2 Other products***

The insufficient length seagrass for the mat would be used for other product processing such as basket, handbag and cushion. The product is mostly handmade; the carpet could be processed by the automatic machine. Due to the high cost of mat weaving machine, all of carpet is done at the group and family level. The collector company will receive them and do finishing and storage for sell or export.

The handbag or basket also is done at the lower level at family or group scale with the dyed thread from exporting company. The finishing stage would be taken place at the organization.



**Pic 11.** Manual weaving products



**Pic 12.** Product qualification (left) border sewing (right)

#### ***IV.2.7 Dyeing***

Depending on the product, the organization chooses the thread dyeing or product dyeing. Most of the product has been designed with the combination of various colours. Therefore, the thread dyeing becomes more popular.

The chemical dyeing has been used in all areas. The dyeing compound has been dissolved in water to form the dyeing solution. After that, the solution has been boiled to 70-80<sup>0</sup>C and applied which can dispersed the dyeing pigment deeply in the thread. The after used solution would be discharged directly to the environment without any treatment. The main reasons are:

- No add-ins ingredient such as: colour stabilizing, dispersion, etc... could lead to the longer dyeing time, loss of dyeing chemicals.
- Lack of dyeing plan: frequent color changing can cause loss of dyeing chemical

#### ***IV.2.8 Demand of techniques and equipment***

From the result of enterprise interview about the value chain, the most necessary thing needs to be invested is the seagrass drying and storage in order to maintain the quality of the material and provide seagrass for all year production.

The technique needs to be investigated:

- Efficiency seagrass drying
- Solar drying
- Mold prevention

The equipment needed:

- Enterprise scale:
  - Mat weaving machine
  - Seagrass automatic splitting machine

- Group or family scale:
  - Mat weaving machine
  - Seagrass automatic splitting machine
  - Storage facility.

## V. DESIGN FOR SUSTAINABLE SEAGRASS VALUE CHAIN

### V.1 Current situation and its issues

The most popular and important issue in the seagrass organization is no clear active development planning. Most of the organization works on the contract from the traditional buyer. Moreover, the design also comes from the buyer and the manufacturer's job is just simple as replication the design at the ordered quantity. Therefore, the profit is not so good due to the price has been called by the buyer.

Most of the manufacturer produces the seagrass mat for military units, prisons and other organisations. The product is low price and the disposal rate during process is high.

Besides, the manufacture issue also exists in the organization. Currently, they use the mat weaving machine originated from China with high productivity but the output quality is low and unable to produce the complex product.



Due to the soft layer in the middle of the thread, during the processing and using, it absorbs dust and humidity and becomes vulnerable for infection of mold. In order to prevent it happen, SO<sub>2</sub> fumigation has been applied. The method has been prohibited in the developed country but the developing country as there is no substitute method. The heat supply during the process chain comes mostly from coal boiler which is not optimized and loss is estimated at 30%. In addition, the insulation is not enough to maintain the heat and cause a loss of 20-30% to the around environment. Moreover, the maintenance procedure has not been applied correctly which could lead to low productivity and polluted air in the manufacturing chain.

The industry has been invested by the national government with many development programs which has brought several improvement at the begin stages of the value chain. Good results in pre-harvest stages such as seeding, cultivation and harvesting has been document and transferred to the local farmer in Thanh Hoa, NinhBinh... However, the other stage has not get the attention such as processing. So, the profit from seagrass is not so good for the industry.

### 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 aneffective 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:

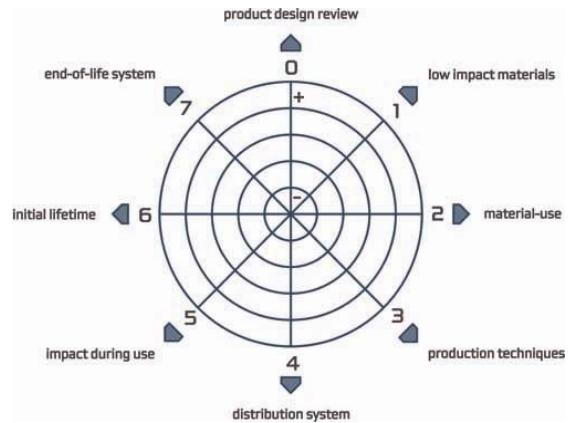
If the organization develops the complex product with multi-material or parts from different suppliers, the poor co-operation could harm the procedure timing and cost due to the supplier behavior and planning.

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, trademarkformation, 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:

- Replace or upgrade the weaving machine to improve the productivity and quality of product.
- Innovate and develop the new product which can be dyed with natural material and combined with other material to form more diversity products.
- Do research on the waste reusing or recycling to reduce the cost of process by converting bio-mass to energy...
- Do research on mold and termite development on the product, dust prevention during process and using.



### V.3 Some sample of Design for sustainable



Seagrass is potential for cultivation and creating the high quality green product. Nowadays, from the plant, they can weave the thread for textile, make environment friendly and no human harm furniture. From the combination from the seagrass thread and silk, lots of innovative product has been found.

### V.4 The development trend of seagrass 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.

**REFERENCES**

- [1]. Thanh Hoa Department of Science and Technology. The technical guideline in seagrass cultivation
- [2]. Communist party of Vietnam online newspaper. Seagrass development in Ngason from 2008 to 2015.