Implementing Green Supply Chain Management for agro-industries in emerging countries: The case of Thanh Hoa Luong bamboo sector

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Abstract

The purpose of this study is to first identify a Green supply chain management system which can be suitably, efficiently and effectively applied for agro-industries in emerging countries and then to introduce a specifically designed model for the Luong bamboo sector in Thanh Hoa Province-Vietnam. To do so, a brief literature review on Supply chain management (SCM) and Green supply chain management (GSCM) for agro-industries in emerging countries has been carried out. In addition, several studies on key determinants and reasons for the success of Anji County bamboo sector, the most successful bamboo sector in the world, were also conducted. Concurrently, several field-studies in districts of Thanh Hoa Province were organized to have a deep knowledge of the current situation of the bamboo sector in Thanh Hoa Province and identify their advantages and disadvantages. All were explored for designing a suitable, applicable and affordable GSCM for Thanh Hoa bamboo sector. Finally, some improvement proposals were introduced to all related main stakeholders including farmers, input traders and collectors, processing managers, output traders, state entities as well as other organizations such as donors and NGOs: all should be implemented together with real efforts from such entities in order to achieve a successful, sustainable bamboo sector in Thanh Hoa Province.

Key words

Supply chain management; Green supply chain management; Sustainable production and processing sector; Semi processing; Anji bamboo sector; Thanh Hoa bamboo sector

Introduction

Several years ago, most economic entities carried-out businesses with the focus on their own profits and had little or no concern for the environment and natural resources: to do so, they applied Supply Chain Management (SCM) to improve their economic performances. Now, great changes in the world's climate and scarcity of existing natural resources create great concerns for them from not only academic scholars, government entities, stakeholders, but also enterprises. Global warming, unpredictable bad weather and decreasing of natural resources at an alarming rate also attract serious concerns from societies from all around the world. Therefore, stricter regulations have been implemented by concerned authorities all over the world especially those in developed countries. Products without environment and natural resource concerns cannot be sold in those countries. In addition, "green" products can be sold at higher prices and can penetrate difficult markets like the EU or US markets.

Green Supply Chain Management (GSCM) is a key factor for sustainable and environmental issues of business enterprises (Hsu et al, 2013): it consists of SCM adding "Green" concerns. However, strict environmental standards increase production costs resulting in less business profit. The economic profit versus environment and natural resources conflict has been a hot debate not only among economic scholars, environmentalists, politicians, policy planners and business persons but also on the media and among stakeholders. Porter & Linde (1995a) identify this conflict as "*ecology versus economy*". On the one hand, strict environmental regulations result in better environment and sustainable natural resources; on the other hand, costs for protecting, preserving resources and treating wastes of enterprises consequently reduce profits and competitiveness.

Porter & Linde (1995b) argue that corporate innovative solutions offset costs caused by stricter environment and resources regulations' implementation and have better profits by using more productively all inputs (raw materials, energies and labor). One striking example is the Dutch flower industry by growing flowers inside advanced greenhouses where flowers grow on nutrition liquid and rock wool instead of on the soil reducing costs of fertilizers, herbicides and pesticides. Other examples are Scandinavian Sunds Defibrator and Kamyr pulp-and-paper industries: they have gained international markets by selling innovative-environmental-technology pulping and bleaching equipment. 3M by its redesigned production process gains an annual addition profit of USD 2.4 million with an implementing cost of only USD 250,000 (Porter & Linde, 1995c).

The main purpose of this study is to design a general agro-industrial GSCM model for emerging countries and then to propose an efficient GSCM bamboo processing model for Thanh Hoa bamboo sector.

This paper is structured as follows: The theoretical background with a literature review is presented in the first part followed by a proposed model of a GSCM system in an emerging country context and a typical model of a GSCM agro-industrial system. In the second part, the case of the Luong bamboo sector in Thanh Hoa Province in Vietnam is presented and analyzed. Next, an efficient specifically-designed GSCM bamboo processing system and a diversified product processing workshop model for Thanh Hoa bamboo sector are introduced. Defining roles of involved entities in Thanh Hoa GSCM model are also identified. Finally, some policies and regulations with some recommendations for a successful implementation of GSCM in Thanh Hoa bamboo sector are proposed.

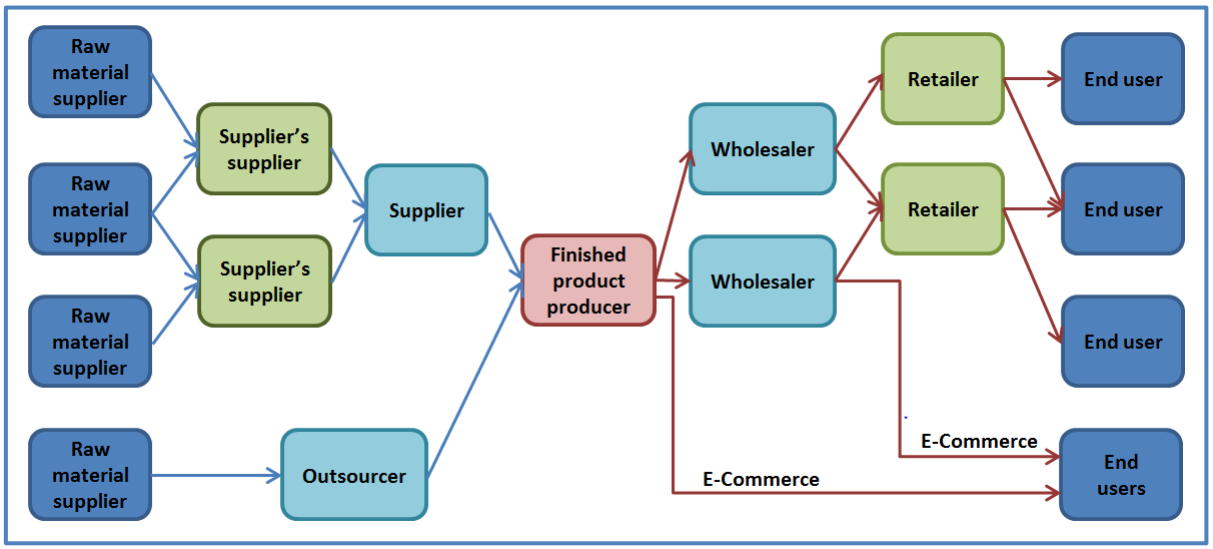
1. Theoretical Background

1.1 Literature Review

First appeared in 1982 by Oliver K. (1982), Supply Chain Management (SCM) became popular among scholars in the 1990's after the publication of several articles and books related to this subject namely the famed "The competitive Advantage of Nations" (Porter M.,1990) under the related term "the value system". Managing "the value system" is SCM in a broad sense. In fact, the initial concept of SCM can be traced back to the early 20th century with the amazing implementation of the *Assembly Line* of Henry Ford - the founder of Ford Motor Company.

SCM can be defined as the management of the whole upstream, production and downstream flows from input materials, semi-finished goods, finished goods and related information to end-users. Hervani and Helms (2005) define SCM as the management of a coordinated complex network of related processes in delivering a final product to an end-user. In short, SCM can be defined as the management of the whole processes from natural resources to final goods sold to end users. One striking example of the excellent implementation of SCM is Total Quality Management (TQM); TQM (based on Deming's theory) was first applied by Japanese car manufacturers and other key industrial manufacturers with many impressive successes in quality. TQM helped Japanese cars to penetrate and compete successfully in American and European car markets. Only after being flooded with Japanese cars in their own local markets did American and European car makers apply TQM. TQM creates less or no defective products resulting in less input resources by efficiently using inputs and helps reduce production energies, labor force, and waste which are important criteria for GSCM requirements. However, TQM lacks after-use product treatment which is an important criterion of GSCM.

Exhibit 1: A complex Supply Chain Management with its supply and demand network



Global warming being at an alarming rate, growing degradation of the environment, overflowing waste sites, highly increasing pollution levels, increasing scarcity of natural resources all over the world have fostered growing social awareness over the sustainability of all production, processing, manufacturing activities and related services. The after effects of all above problems have generated strong pressure from stakeholders towards producers, suppliers, manufacturers, distributors on their cleaner responsibilities over their products and services. It means that SCM cannot completely fulfill its duties in modern societies; as a

direct result, the "green" paradigm appeared around the late 1980s, early 1990s among public debates (Comasito and Troisi, 2014). Therefore, green supply chain management (GCSM) appeared as an acceptable solution for both environmental management and supply chain management through that avoiding environmental degradation, preserving natural resources and at the same time providing economic benefits. Penfield P. of the Whiteman School of Management defines GSCM as "*the process of using environmentally friendly inputs of transforming these inputs into outputs that can be reclaimed and re-used at the end of their lifecycle thus creating a sustainable supply chain*" (Lakshmimeera and Palanisamy, 2013). Srivastava (2007) defines it as "*integrating environment thinking into supply-chain management*". In short, GSCM can be defined as SCM adding "Green".

1.2 Factors of Green Supply Chain Management

GSCM generally consists of green design, green production, green procurement, green manufacturing, green distribution and reverse logistics.

Green design

Designers create new products which consume less input materials, less energy and labor forces, avoid or reduce using harmful materials for manufacturing them. Besides, these products must comply with environmental regulations such as less energy consumption, easily recyclable parts, recovery of materials, etc. Green design products should also have low weight, low volume for storage, easy to transport and handle, recyclable packing and innovative design if possible. Above all, they should meet all expected demands not only from customers but also stakeholders.

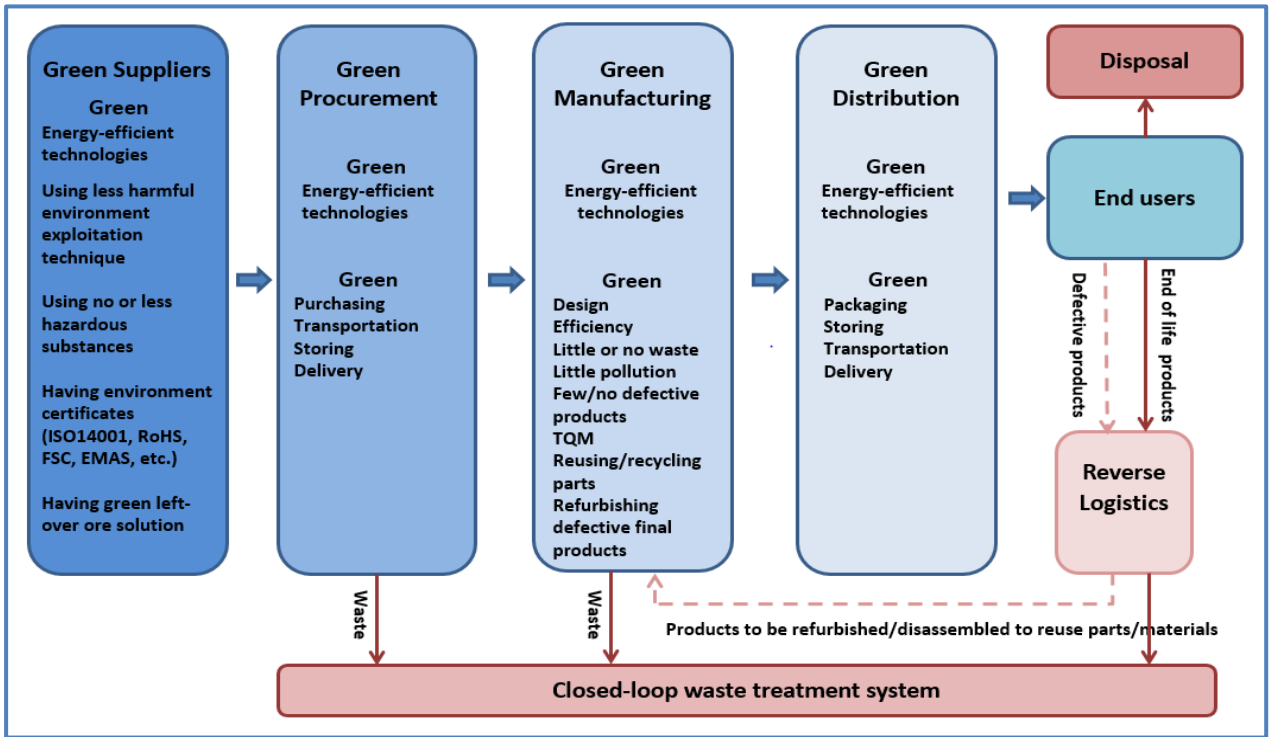
Green production

Green producers use energy efficient technologies that mean reducing the use of labor forces, electricity power, fossil fuel and other forms of energies for exploiting material and natural resources. Besides, they implement advanced techniques which are less harmful for the environment by reducing or not using hazardous substances (e.g. using highly toxic mercury and cyanide for extracting gold from ores for mining). Moreover, they must have environmentally suitable solutions for the leftover ores after extracting materials. The facts that they have environment certificates such as ISO 14000 environmental management family, RoHS certificates (EU legislated restriction of the use of certain hazardous substances in electrical and electronic equipment), WEEE (Waste electrical and electronic equipment) (Chiang et al. 2011), FSC (Forest Stewardship Council), EMAS (Eco-Management and Audit Scheme), etc. prove that they fully meet the international environment standard requirements.

Green procurement

Green procurement can be defined as purchasing raw materials, components or parts from green partners who meet the environmental quality standards by providing environment certificates and then supplying them to manufacturers. Besides, all internal transportation of materials, components and parts and storage must follow energy-efficient technologies using all green procurement processes that consume less energy by using advanced technologies (efficient consumption of electric power, fossil fuel etc. by using economical vehicles and equipment), decreasing defective materials and costs from large volume's storage by applying just-in-time (JIT), applying informatics for orders and inventory management (EDI, ERP, etc.).

Exhibit 2: Model of a Green Supply Chain Management system



Green manufacturing

Green manufacturing can be defined as a whole production process which consumes less or no harmful substances (e.g. lead, cadmium, mercury) but input materials with low or no impacts on the environment. Besides, it produces efficiently with low energy consumption (electric power, fossil fuel, labor force) and low input materials, manufacturing less or no defective products (TQM) and generating no or less waste resulting in reduced pollution. In addition, green manufacturing produces more products by re-using parts and components of defective final products and repairing newly sold but defective products: these are provided through reverse logistics. By doing so, it reduces not only input costs, energy costs, but increases product output and improves the reputation of the enterprise over customers and the society.

Green distribution

Green distribution consists of green packaging and green forward logistics. Green packaging includes smaller in size, shape and weight but suitable and safe packing for product delivery. Smaller in size, shape and weight of package reduces costs for manufacturing, storage, transportation and postage. In addition, it is made from recycled material and can be re-used.

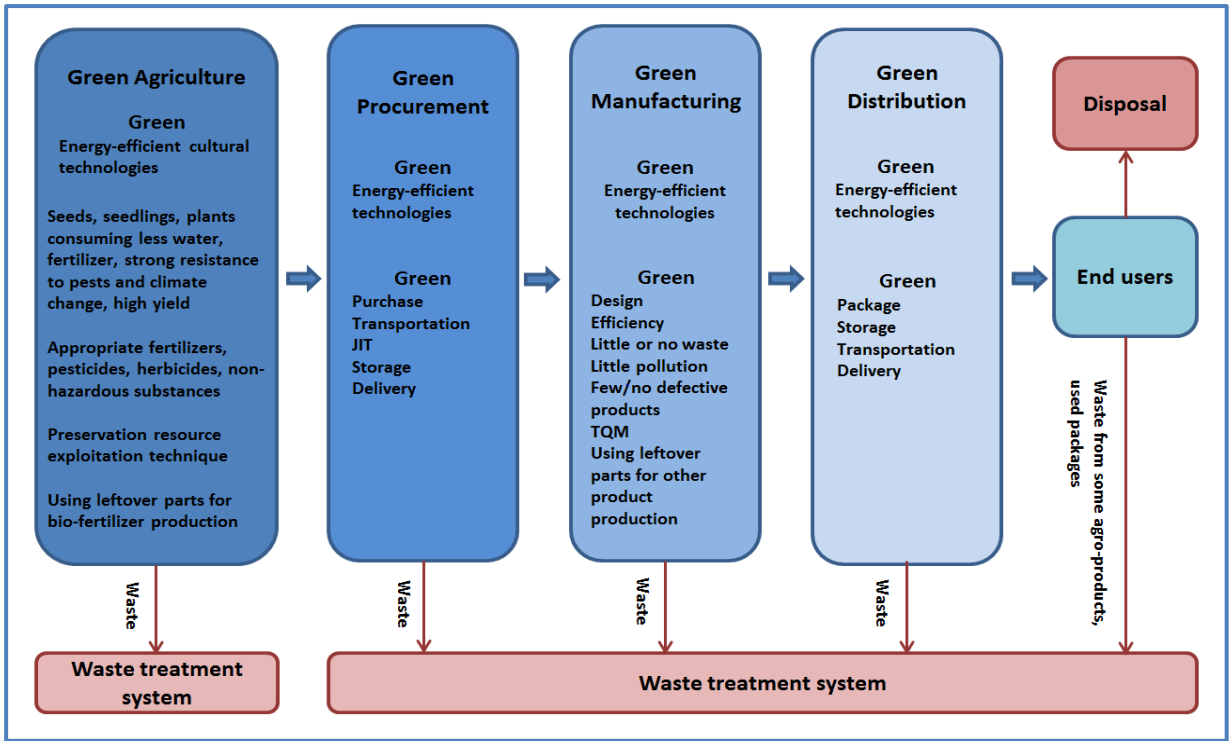
Green forward logistics

Green forward logistics minimizes delivery intermediaries by directly sending goods to end-users if possible. Fewer intermediaries reduce transportation and storage costs, delivery time and energy usage. End-users can directly order through e-commerce (order via the internet and pay by using internet banking systems, credit or debit cards etc.) and receive final products by post or logistics companies such as DHL, FedEx or EMS, etc. Besides, green forward logistics uses electric forklift and transportation means for transporting final goods within premises and environmental-friendly means for home or premise delivery.

Reverse logistics

Reverse logistics is a retrieving process of products from end-users for re-using some components, precious materials, parts of the end of life defective products or products having environmentally harmful substances. Reverse logistics also withdraws defective products which are under period of warranty and then sends them back to factories to be reworked (if the products were sold in a short time) or to be repaired. For other defective products, reverse logistics sends them back to factories for recycling, re-using some components, parts or precious materials such as gold, silver etc. if possible. In addition, reverse logistics removes some used but environmentally harmful products such as rubber tires, lead or nickel-cadmium batteries or laser toner cartridges, etc. These materials can be very harmful for the environment if they are not properly disposed of. All the remaining parts are finally sent to a closed-loop waste treatment system.

Exhibit 3: Typical model of an Agro-Industrial Green Supply Chain Management system



Agro-industrial Green supply chain management is a special sector because of its inputs. For increasing yields, large quantities of chemical substances have been used and among them some hazardous substances such as chemical fertilizers, herbicides and pesticides. In addition, packages of these substances (bags, bottles, cans, etc.) need special treatment. Most agricultural leftovers remain on the fields after harvest; they can be used for bio-fertilizer production enriching the soil fertility and reducing pollution.

Disposal

End-users normally throw away their broken down or obsolete products; however, environmental-concerned enterprises can retrieve these products for recapturing some value or for proper disposal (Nilawan C. et al, 2010).

2. The Case of Luong Bamboo Sector in Thanh Hoa Province

2.1 Short profile of Luong Bamboo Sector in Thanh Hoa Province

Thanh Hoa Province is located in the Northern Centre of Vietnam. It has an area of 11,136km^2 with 3.481 million inhabitants, a density of 313 inhabitants/km^2 and an average GDP per capita of USD 1,365 in 2014 (Thanh Hoa Statictics Office, 2014a), 66.5% of the average Vietnamese GDP per capita of USD 2,052 (World Bank, 2014). The Thanh Hoa Luong bamboo sector with a total area of 69,000 hectares (2006), covering over 55% of total Luong bamboo areas in Vietnam, is located in North-West hilly and mountainous districts mainly Quan Hoa, Ba Thuoc, Ngoc Lac, Quan Son, Lang Chanh, Thuong Xuan and Cam Thuy districts. Those districts, covering a Luong bamboo area of 64,246 hectares and a population of more than half a million inhabitants and a GDP per capita of USD 639 (Thanh Hoa Statictics Office, 2014b), can be considered as the Luong bamboo zone. Most local inhabitants are 75~85% Thai and Muong minorities (Thanh Hoa Statistics Office, 2014c) with low education and skills resulting in having the lowest income among the districts of Thanh Hoa Province and also of Viet Nam despite having an abundant and good quality Luong bamboo resources. (*Luong: Dendrocalamus Barbatus)*

In contrast, Anji County, China, has 461,800 inhabitants (www.anji.gov.cn., 2013) and 54,700 hectares of Moso-*Phyllostachys heterocycla*, a biennial bamboo species, quite similar in many aspects to the bamboo region in Thanh Hoa Province. Bamboo production yields are also the same: Thanh Hoa 13T/year, Anji County 23T/2 years (Tran, An V. 2012). However, Anji County generates an impressive annual bamboo turnover of USD 2.03 billion (Xuan T., China Daily, May 05th, 2013) although the economic results of the Luong bamboo of Thanh Hoa are much lower despite having far lower input costs (salary, buying price of bamboo culms).

Exhibit 4: Some figures of the bamboo product markets in 2007

	Global	China	Vietnam	Laos	Cambodia
Market share (USD) in 2007	7 billion	5.5 billion	250 million	4 million	7 million

Marsh J. and Smith N. (2007a)

Costs in 2007	China (Moso bamboo)	Vietnam (Luong bamboo)
Raw bamboo culms	USD 100/ton; USD 80/ton*	USD 37/ton
Labor	USD 150/month	US50/month

Marsh J. and Smith N. (2007b); *Mekong bamboo Sector Feasibility Study (2006)

From these figures, we can see that Vietnam out-competes China in input costs which represent 75% to 80% of the total production costs. However, despite having this advantage, the cost of a semi-processed bamboo slat for flooring production in late 2008 was USD 6.5 cents in Anji but USD 6.8 cents in Thanh Hoa (Groupe de Recherche et d'Échanges Technologiques GRET, 2012a).

Exhibit 5: Main bamboo products in Thanh Hoa-Vietnam and in Anji County-China

Thanh Hoa bamboo zone	Bamboo paper pulp, paper, votive paper	Shaved and unshaved slats, flooring, panel	Bamboo chopsticks, toothpicks, skewers	Bamboo furniture, handicrafts, utensils
Anji County*	Bamboo filament splitting (#1,000 firms)	Bamboo flooring (20 firms)	Bamboo craft fans	Bamboo shoots (canned, dried, salted)

* Chen S. et al (2011a)

2.2 Methodology

The study was performed based on field studies in Thanh Hoa's districts, field visits at markets, supermarkets, research centers, studies of other researchers on applying GSCM and SCM in agro-industrial sectors mainly in bamboo sectors, focusing on Anji County - the most successful bamboo sector in the world - and related bamboo studies in northern Vietnam. Visits were conducted at concerned authorities, state and public organizations such as NGOs, cooperatives, companies manufacturing bamboo products located inside and outside Thanh Hoa Province consuming significant Luong bamboo resources or producing large bamboo products. In addition, some visits at foreign supermarkets, producers, forestry research centers were carried out. A literature review has also been explored to find relevant key data and information factors in designing a suitable GSCM model for Thanh Hoa bamboo sector.

Field studies:

We have conducted several visits at farmers' plantations to collect data related to their incomes from bamboo cultivation, selling prices, loans or money in advance by buyers, bamboo planting areas, yields, fertilizing, watering, applying pesticides, marking bamboo trunks and harvesting methods. At the same time, observations were noted on their bamboo situations to compare what they said to what they really did; photos have been taken, too. Bamboo traders, collectors were also interviewed to identify how they collect bamboo culms, their buying prices, payment methods, storing, selling methods and delivery methods, means of transportation, selling prices and buyers. At workshops/factories, we collected data and information through directly questioning managers, technicians and workers, taking notes, drawing drafts of production chain and shooting photos.

Exhibit 6: Gathering data and information for concerned issues during visits at related entities

Actors	Pre activities	Main activities	Post activities	Payment methods
Farmer's plantations	Number of bamboo clumps/ha; number of bamboo culms per clump; growing techniques;	Names and volume of fertilizers /herbicides /pesticides, watering and traceability techniques	Harvest techniques, pre-processing products or not, volume, prices, buyers; leftover treatment	Payment in advance, deferred payment, cash
Bamboo Collectors/ Traders	Selective method, payment method for farmers; transportation means	Semi-processing methods, storage	Delivery methods, transportation means, volumes, prices, buyers, leftover treatment	Payment method from selling bamboo culms/poles, cash
Processing firms	Selective methods, storage, buying prices	Main production activities, products, packaging, leftovers treatment, chemical waste treatment	Delivery methods, transportation means, volumes, prices, buyers, e-commerce	Payment method from selling bamboo final products
Wholesalers	Storage, buying prices	Products, distribution channel, volumes, prices, buyers	Delivery methods, transportation means, e-commerce	Payment method from selling bamboo final products
Retailers	Storage, buying prices	Volumes, prices, buyers,	Delivery methods, transportation means	

At markets and shops, we took notes of buying prices, selling prices, turnovers of bamboo products if possible and shot photos of all bamboo products. Supermarkets and markets in Vietnam as well as abroad are places where we could find new bamboo products both incrementally and radically designed; some interesting samples of bamboo products were bought. At last, we conducted interviews with concerned entities including governmental

entities, state and private organizations such as local and foreign NGOs operating in this sector.

Secondary data and information were gathered at bamboo congresses, workshops, international and state organizations, NGOs, business documents, media and the internet.

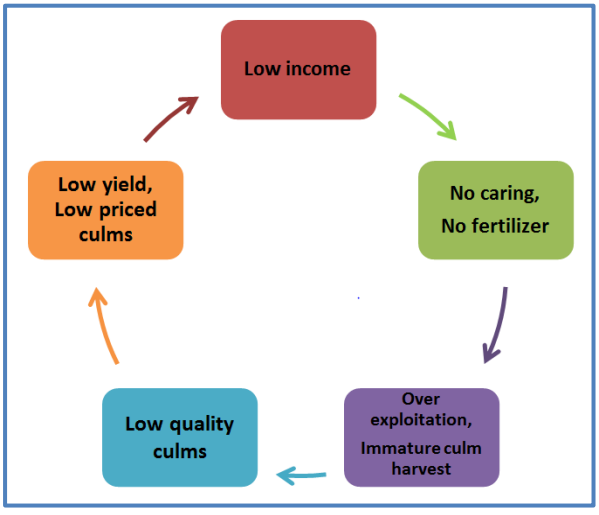
2.3 Findings

2.3.1 Bamboo cultivation

Most Luong bamboos were planted during the 1970s and the rest are natural mixed bamboo forests. Unlike Moso bamboos in Anji County, there is little intensive bamboo cultivation in Thanh Hoa Province. In the past, farmers only grew new bamboo plants with the help of 327, 30A, 661 state programs, KFW4-GTZ-German program, Luong Development Program (LDP program), etc. on fertilizer and seedlings (Kim , Ly L. 2009; GRET 2012b; Hoang, Yen T. 2015a). Now, they rarely use fertilizer for bamboo cultivation despite large propagation of bamboo cultivation technique for increasing yield from various entities including state and NGOs resulting in low bamboo culm yield. According to Maoyi and Xiaosheng (2006), farmers in China annually use 200kg of fertilizer (mostly Nitrogen) for one hectare of bamboo plantation. WenYan and Naixun (2013) propose 150kg of Nitrogen in the first 2 years and 350 kg N plus 15~30 tons of organic fertilizer in the third year for each hectare of bamboo.

Most state programs such as 30A, 661 etc. have got weak results due to complex procedures to get financial aids, weak supports for seedlings, fertilizer and particularly weak on-site cultivation training from these programs. In contrast, around 6,000 ha of on-farm trials on Moso bamboo in Anji County-China were carried out with state financing including all studies related to bamboo cultivation (GRET-Bampar project, 2012c).

Exhibit 7: Vicious circle of poor Thanh Hoa bamboo growers (Nguyen, Dung N. and Martin J. 2015)



On average, each Thanh Hoa bamboo farmer has around 1.54 hectares of bamboo (ADB, 2006a). One hectare has about 250 bamboo clumps with 2,500 bamboo culms of different ages: about 3 culms per clump are harvested annually at the age of 2.5~3 years old as mature culms. Bamboo quality depends on the age of culms: a best quality culm is around 2.5~3 years old and it can be sold at the highest price. However, 80% farmers are poor Thai and Muong minorities: whenever they need money for their daily expenses, they cut some culms to sell without regard to bamboo culm age. It is really a vicious circle for poor farmers.

Traceable technique (fully applied in Anji County) is not applied except in some experimental plots under LDP-GRET programs. Bamboo culms are marked at 1 year of age

with the name of the owner: this technique is essential for assuring a good quality and a sustainable development (each clump must have at least 2~3 bamboo culms of 3~5 years old and a number of around 10 culms/clump for a stable growth). An over 3 years old bamboo culm with 36-38cm circumference can generate VND 13,663 value added instead of a less than 3 year old one with 30-32 cm circumference generates only VND 4,993 (Sara, M. 2010a). Another problem from immature culm exploitation is from the construction sector: it annually consumes around 60% of the total culm output of the province with no regard for the culm's age. There is limited control from state entities over immature culm exploitation. Semi-circular platforms for preserving water on steep slope surface have also been applied by LDP-GRET programs but still at an experimental level.

In Anji, there are stricter and more accurate solutions for culm harvest control through "*Neiyou*" (traceable technique) and by issuing harvest quota certificates for monitoring harvests including strict harvest season and culm maturity (Maogong, Z. et al, 1998a). Harvest quota certificates should be implemented together with traceable techniques in Thanh Hoa bamboo sector. In the long term, this certificate can be an important criterion for acquiring a certificate of origin (C/O) and proof of legally harvested farmed products complying with the Sustainable Agriculture Standard for qualifying green credits LEED v.4 Standard in 2014 (Leadership in Energy and Environmental Design, Bowyer J., et al 2014). With these credits, Thanh Hoa bamboo products can enter difficult but large potential markets like the US and EU. In 2005, 5.1 million m^2 of Chinese bamboo flooring were exported to the USA and the EU (Lugt, V. D. and Lobovikov, 2008). Leftover parts of bamboo (leaves, twigs) after harvest are left on the soil without treatment. One bamboo hectare annually generates about 4.8 tons of wastes (ADB, 2006b).

There is no trace of "mulching" in Thanh Hoa: mulching is an effective method for preventing weed growth, preserving soil moisture and adding organic matter to the soil. Farmers do the munching by covering a layer of soil, leaves and organic material on the surrounding surface of bamboo clumps. Mulching improves the growth of bamboo plants especially in the dry season (Kamesh S and Nipan K. D. 2007).

2.3.2 Bamboo procurement

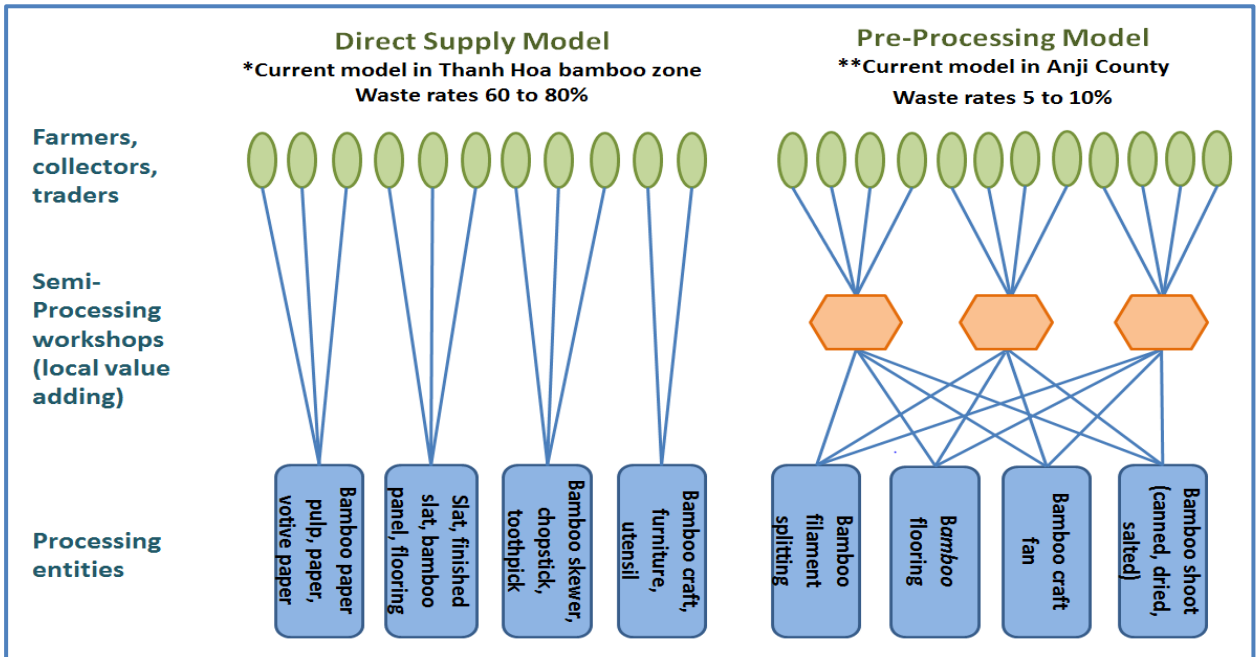
Bamboo growers sell their bamboo culms directly to nearby workshops; culms are normally transported on people's shoulders or cattle carts in mountainous regions or small trucks in flat regions. Otherwise, they sell them to collectors. Bamboo rafts are used for transporting bamboo resources located near rivers or large streams. Each village has 2~3 collectors. Then collectors resell them to big collectors or traders: each commune has around 2 big collectors. Big collectors are the ones who have better resources, financial capacities and good access to markets; they can be rich farmers with good relationships and prestige with other farmers, buyers or workshops. Normally, they give cash in advance and/or fertilizers to farmers and later receive bamboo culms once harvested as payments. Most arrangements are made without binding written contracts but based on trust and prestige built over time. The collector's margin for each transaction is 10~15%.

Traders can be divided into 2 groups: traders operating within district or some nearby districts and traders selling culms outside Thanh Hoa Province. Traders have financial capacity to give cash in advance to collectors; in addition, they usually have their own trucks for transportation. The trader's margin ranges from 20 to 28% due to the lack of primary processing, transportation cost and cash advance for farmers through collectors (margin for trader is around 28%, Bampar project 2012d). Approximately 70% Anji's farmers engage in bamboo pre-processing or processing, generating significant non-agricultural incomes (Bampart project 2012e). Unlike Anji County, there is no semi-processing process for adding value before delivery to workshops in Thanh Hoa. Therefore, they deliver whole culms to

processing workshops increasing both volume and weight to be transported. Most collector and trader hubs are located along the National Road 15, Provincial Road 217 and banks of Ma River, Luong River: the main arteries of Luong culms transportation (Baulch B and al., 2009).

Storage: Due to rapid deterioration of culms' quality, harvested bamboo culms are quickly delivered especially culms transported by floating rafts.

Exhibit 8: Bamboo supply chain management in Thanh Hoa Province and Anji County-China



*Hoang, Yen T. (2015b), GRET (2013), Thanh Hoa Newspaper (2008), Nguyen, Dung N. (2011);
** Marsh J. and Smith N. (2007), Chen S. et al. (2011a)

2.3.3 Bamboo processing

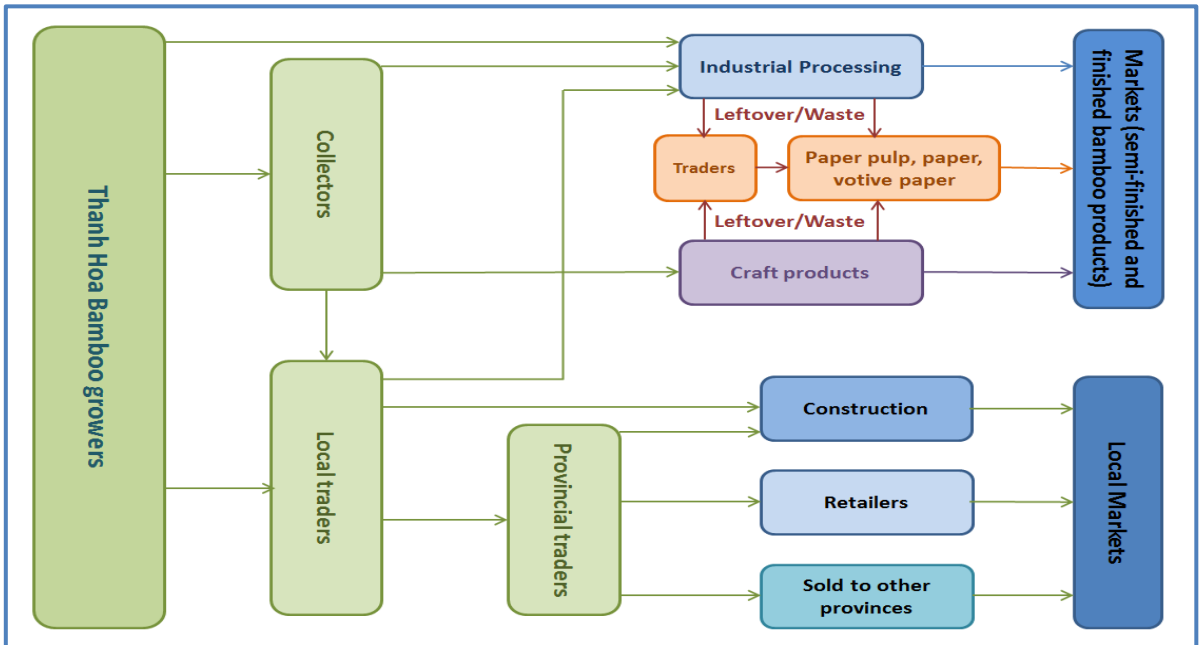
A Chopstick subsector: Chopstick is the most popular product in Thanh Hoa due to available markets, low-cost equipment and low requirements on bamboo quality. However, it is the second lowest value added products after the paper subsector. Workshops normally use the upper part of bamboo culms for producing chopsticks but whenever markets for slats face difficulties, workshops use the whole culms for producing chopsticks. There are 2 kinds of chopstick processing in Thanh Hoa: semi-finished and finished chopsticks. Semi-finished chopsticks are mainly sold to companies outside Thanh Hoa Province to be reprocessed into final products; then they are sold to markets under other brand names.

Some factories in Thanh Hoa can produce finished chopsticks such as Xuan Duong and Quan Hoa Cooperatives - Quan Hoa District, Tat Minh Ltd. Co. - Lang Chanh District, etc. Tat Minh Company, Lang Chanh District, produces bamboo chopsticks for exporting to Taiwan (Ngoc Huan, 2013). Bamboo barbecue sticks and skewers are also produced by some companies for foreign markets. Chopstick production generates about 78% bamboo leftovers (Sara M. 2010a): one part is used for producing paper pulp. Bamboo knots are used for semi-active charcoal production or used as household combustible. The rest is burnt at site, thrown on land fields or into nearby rivers and streams generating pollution. Besides, producers use sulfur, a toxic chemical substance, for fungus preventing and for chopsticks whitening.

B Slat, panel and flooring subsector: Slats, panels and floorings are the second highest value added products after bamboo handicraft products and furniture. Slats offer much more

profit than chopsticks but markets are limited. There are 2 kinds of slats: unshaved and shaved slats. Producers normally use the lower and mid part of culms for producing slats. Slat production requires mature bamboo culms having grade Phao, 1, 2, 3 (local grades for culm circumference from 22.5cm to 34cm) for reducing defective products. Some workshops produce slats for their own demand in producing boards, panels or flooring like Trieu Son factory. Some parts are sold to Processing and Exporting Forestry Product factory-Trieu Son District, Thanh Hoa Province for producing flooring for export and panel for local markets. The rest of slats are sold to companies located outside Thanh Hoa for board, panel and flooring productions such as Tien Dong-Ha Noi, The Bamboo Factory - a French FDI in Hai Duong Province, etc. Semi-finished slat production generates around 16% waste of the total culm input (Survey of Le, Mung T. and Nguyen, Thong M. at Thanh workshop, 2008); shaved slat production from semi-finished slats also creates additional wastes ranging from 38.6% to 45.2% of input depending on slat sizes. Slat production harmfully uses sulfur for preventing fungus and whitening slats (Survey of Le, Mung T. and Nguyen Thong M. at Song Ma Cooperative, 2008).

Exhibit 9: Value chain and processing map of Thanh Hoa bamboo sector



C Paper and paper pulp subsector: Paper is an emerging bamboo processing subsector to salvage all leftovers from other bamboo processing subsectors: leftovers in Thanh Hoa production range from 40 to 70% of the total bamboo input. According to Renard O. (2012), up to 75% processed bamboo can be lost as waste. In the past, most leftovers were thrown away mostly into rivers and streams causing water pollution; this situation still currently exists but at a lower level. The paper sub-sector has been the last to appear in the Thanh Hoa bamboo sector but it now appears at several bamboo workshops due to abundant and available bamboo leftovers not only at their workshops but also at nearby bamboo processing firms and large demands from Vietnamese paper industries. However, it is the lowest value added subsector and creates the highest pollution rate because of using a large volume of Soda caustic (NaOH) - an environmentally harmful chemical. Some small workshops illegally discharge polluted water directly without treatment into nearby rivers and streams. By doing so, they earn high profits: they can earn a 75% profit over total input expenses.

Markets for paper pulp and paper of all kinds are available because each year Vietnam imports a large volume of paper of all kinds (USD 1.75 billion in 2013, Vietnam General Statistics Office) and also paper pulp for local paper production firms (USD 221.6 million in 2013, Vietnam General Statistics Office). However, it requires high investment capital for equipment, building tanks and high cost polluted water treatment system. Time for each paper pulp batch is around 7 days so one tank can produce 3 production cycles in a month.1 kg of bamboo leftover produces 0.32kg of dry paper pulp. Paper pulp production requires a lot of caustic soda (NaOH): 160kg for 30 tons of bamboo leftovers (Le, Mung T. and Nguyen, Thong M., 2008). Polluted water after production is a big problem for the environment because most local workshops directly discharge their polluted water into nearby rivers. Among 7 paper workshops in Quan Hoa District, only Duyet Cuong Co., a FDI Taiwan company producing votive paper for export, has an adequate polluted water treatment system.

The rest discharges polluted waste and water into the Ma River without adequate treatment. In November 2013, Quan Hoa District authorities imposed fines for 5 workshops operating in Quan Hoa District and in January 2014, Provincial authorities imposed a VND 47.5 million fine on a processing cooperative for illegally discharging polluted water into Am River and temporarily closed the paper pulp processing chain until having an adequate water treatment (Van Hung, 2014).

D Furniture and handicraft subsector: The furniture and handicraft subsector generates the highest value added products and they can be sold at high prices. However, furniture products (table, desk, chair, wardrobe, filing cabinet, etc.) and utensil products (cutting board, spoon, tea box, etc.) require skillful workers for making them. Handicrafts need dexterous workers besides woodwork professional skill. Local workers in upland districts where large bamboo resources are located cannot meet these requirements. These craftsmen can only be found in Thanh Hoa City or Ha Noi City. In Thanh Hoa City, a lot of beautiful furniture and artistic objects are made and showed at showrooms along Ba Trieu Street. Customers for these products are high-income persons, Vietnamese expatriates or foreigners because of their high prices. During our surveys in Ho Chi Minh City (HCMC), we could not find bamboo furniture or artistic objects made in Thanh Hoa although HCMC is the largest and highly potential market for such products. Some low-priced bamboo products such as chopsticks and toothpicks can be found at supermarkets and markets but they are strongly competed by similar imported Chinese products.

2.4 Policies, regulations, roles of related entities and recommendations for successfully implementing GSCM in Thanh Hoa bamboo sector

2.4.1 Green bamboo production: State and NGO entities should organize more training courses on bamboo cultivation particularly on intensive cultivation (fertilizers, traceable technique, watering technique, harvesting technique etc.). Training for farmers on applying semi-circular terrace technique on steep slopes over 15 degrees for preserving water in the dry season would be carried-out. Seedlings, fertilizers, and foods should be freely given to these participants as direct supports, too. Some farmers have applied new cultivation techniques such as farmer Le, Thu X., trainee of Luong Development Program (LDP), and some 300 other farmers in Thuong Xuan District: they spent about VND 10,000 (USD 0.45) for fertilizers for each bamboo clump (USD 115/hectare). After 3 years, he received three times as much revenue from bamboo than in the past when no intensive cultivation was applied; costs for fertilizers and labor were less than 1/3 of total revenue. It means that intensive Luong cultivation gave him twice as many earnings compared to non-intensive cultivation

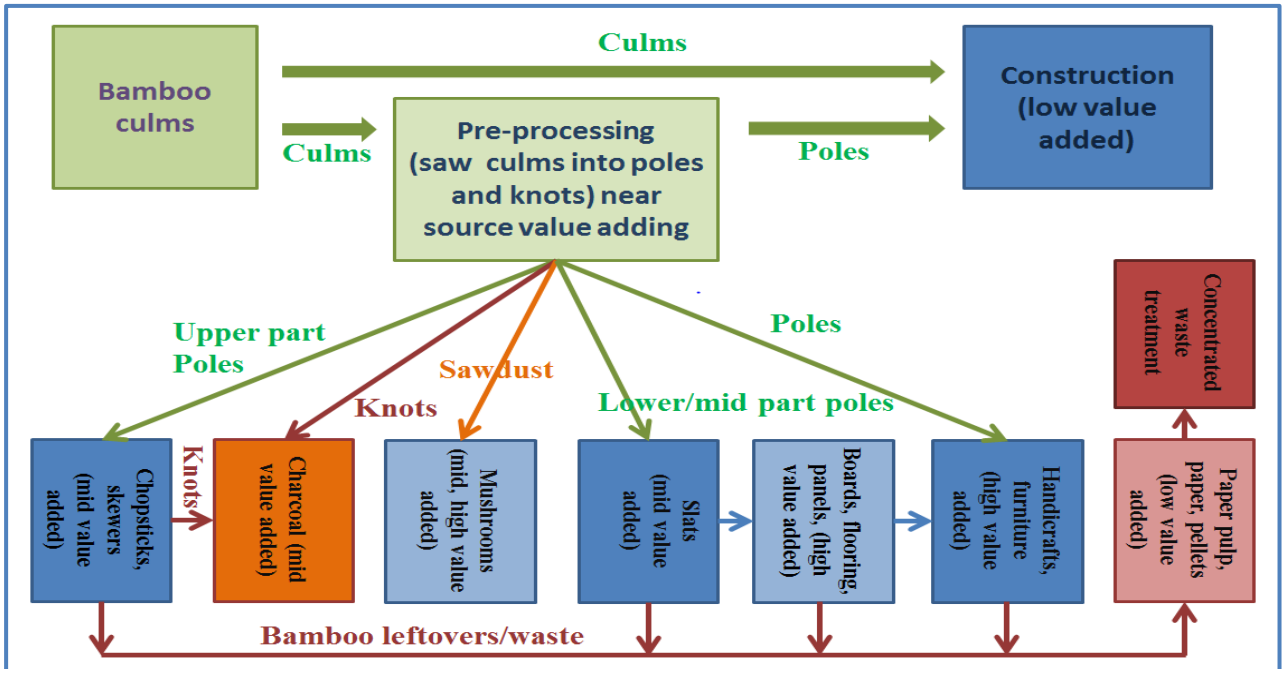
(Hoang, Yen T., 2015c). Visits at these plantations should be organized as at-site training courses for farmers.

Planted Luong culms date back to the 1970s: it means that new seedlings with higher yield and stronger resistance to climate change and insects should replace the old ones by giving free seedlings with culture and harvest technique training to farmers. Strict control over immature exploitation should be implemented based on traceable techniques: only farmers applying traceable techniques receive fertilizers as subsidies. Strict control over bamboo culms transported to outside provinces should be carried out, too.

The top of bamboo culms and leaves can be used initially to produce fertilizer (mix with cattle excrement) or compost fertilizer. Later, chemical substances can be extracted from leaves like those in Anji. Producers can make brooms from twigs and top logs for local and foreign markets. In 1997, Anji produced 5.5 to 6 million bamboo brooms from which 50~60% were exported to Japan (Maogong, Z.et al., 1998b). The rest can be used as household comestible.

2.4.2 Green procurement: To reduce waste and increase profits for farmers, collectors, traders and processors, semi-processing should be carried out by large plantations, collectors or traders.

Exhibit 10: An efficient GSCM bamboo processing system for Thanh Hoa bamboo sector



By doing so, the Thanh Hoa bamboo sector particularly in the production and procurement sectors can get the following benefits:

- Semi-processing of several bamboo products reduces waste, effectively uses culms and decreases volatile culm price risks through having more different outputs.
- Pre-processing of multiple bamboo products reduces risks through diversification of outputs, generates stable outputs for bamboo growers. It helps growers to sell different types of culms (grades, quality, and parts of culm) through different channels.
- Creating flexible operations capable of making and selling 4~5 types of products at one time and switching productions based on processors' demands. It allows

processors to buy the exact part of culms that they need for their particular products, effectively reducing waste and both volatile buying and selling prices.

- Finally, semi-processing close to plantations creates cost efficiencies for the bamboo value chain by reducing costs for storage, transportation (less waste but more useful bamboo volume to be stored or transported) and economies of scale.

In Anji, bamboo culms are semi-processed before being sold to processors. It is the main reason for little waste in Anji (less than 10%, Bampar project 2012f).

2.4.3 Green manufacturing: All equipment is made locally or imported from China but most is outdated generating a lot of defective products and waste. Imported up-to-date processing equipment is proposed for increasing quality, consuming fewer inputs (materials, labors and energy) and reducing waste. Imported equipment, of course, requires high capital investment but in the long run, costs can be outweighed by higher revenues from lower input costs, better quality and higher selling price products. High quality products not only compete with imported Chinese products but also open new foreign markets. Most workshops and firms in Thanh Hoa buy whole culms and produce 1 or 2 kinds of products. By doing so, they generate a lot of unused bamboo parts, spend more money on raw material expenses and transportation costs creating financial problems and at the same time generating lots of bamboo leftovers and waste.

Due to high investment capital and strict control over polluted water treatment, a concentrated polluted water treatment factory should be built in Quan Hoa District or in the nearby planned industrial zone in Ba Thuoc District. All polluted water after paper pulp and paper production should be transported to this factory to be treated.

Anji has got striking economic results but it is now facing pollution problems because it has no effective wastewater treatment systems. Polluted water is directly discharged into rivers and underground water systems severely damaging the eco-system. The volume of COD_{Cr} in discharged water containing from 3,000 to 21,400 mg L^{-1} far exceeds the 500mg L^{-1} according to GB8978-1996 standard. Less severely, fuel gas from boilers meets the Emission standard of air pollutants (GB13271-2001) and the processing dust outside firms can meet the Integrated emission 1.0 mg m^{-3} standard of air pollutants (GB16297-1996) (Chen S. et al 2011b). The situation in Thanh Hoa bamboo sector is less severe because it is on its initial stage.

Finished product processing is proposed to replace all semi-finished processing due to far higher value added products. Interviews of GRET at several workshops in 2010 showed that processing of finished chopsticks generated revenue 9 times higher than processing of semi-finished chopsticks from a bamboo culm grade B 24kg (VND 7,055 and VND 770 respectively. Tran, An V. 2012). In remote areas where difficulties arising for finished product processing, workshops for semi-finished products can be set up as satellites for finished product processing firms.

An efficient diversified bamboo product processing workshop model can be designed based on data from LDP Statistics in 2008 and 2010.

Despite creating high value added, bamboo filament splitting for bamboo fabrics is not proposed for short-term strategies because of complex procedures and time. According to Du Dongliang-Manager of Tan Zhuzhuang Manufacturer, Anji, it takes 17 steps and 100 days to turn bamboo poles into yarn (Nilsson E. 2013). Besides, the process generates a lot of polluted water due to excessive use of Hydrogen Peroxide ($H_2O_{2)}$ and dyeing chemical substances which are highly non-environment friendly (Chen S. et al. 2011c).

Exhibit 11: An efficient diversified product processing workshop model for Thanh Hoa bamboo sector

Indicators	No of culms processed in a workshop		Culms used to produce chopsticks	Culms used to produced slats	Waste/ byproducts to produce paper pulp	Sawdust (sold to mushroom workshops)	Loss during production
	No of culms	Weight					
Number of culms/day	702 culms	18,245 kg	1,754 kg	7,017 kg	5,824 kg	1,614 kg	2,035 kg
Number of culms/year	147,420 culms	3,831.45 tons	368.34 tons	1,473.57 tons	1,223.04 tons	338.94 tons	427.35 tons

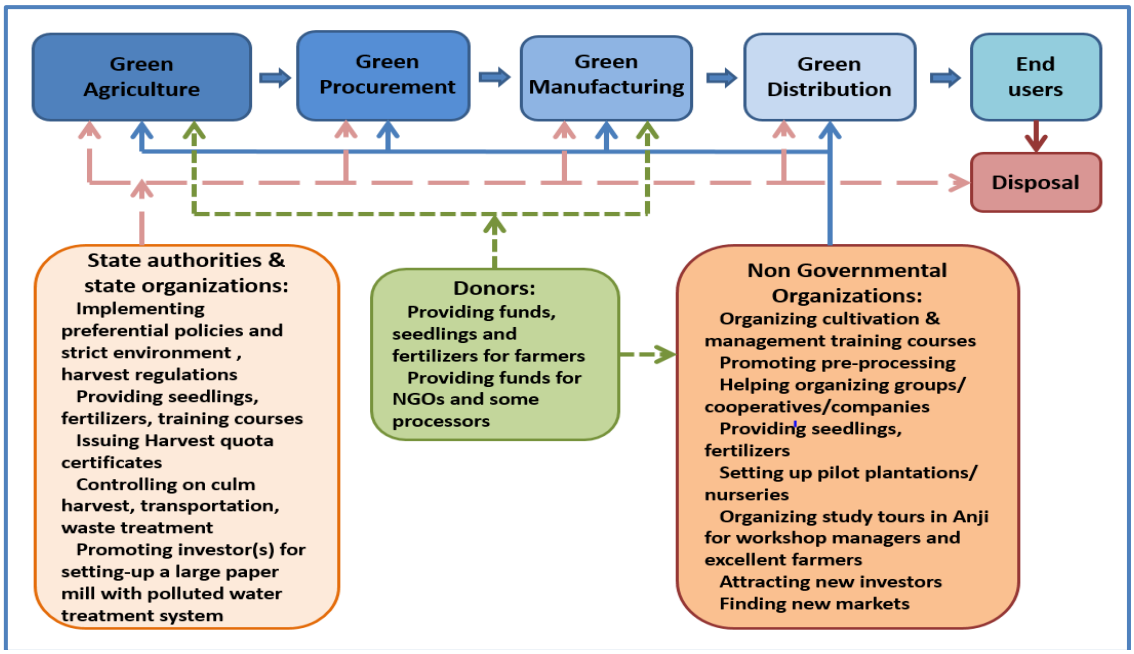
Note: 21 working days/month; 10 working months/year Source: LDP-GRET Statistics 2008 and 2010.

In contrast, semi-active charcoal and wood pellets are promising products made by bamboo knots and leftovers for Thanh Hoa bamboo sector due to available markets from Japan and Korea and low investment capital.

2.4.4 Green distribution: Thanh Hoa bamboo sector has a weak distribution channel: most semi-finished products are sold to outside provincial firms and then these firms produce finished products and sell under their brand names earning higher profits. Large local markets still exist: in 2009 Vietnam imported 207,000 tons of bamboo products with a value of USD 222.718 million in which 172,732 tons with a value of USD 185.878 million were imported from China (http://comtrade.un.org). Some Thanh Hoa products are sold locally or in northern not southern Vietnam where there is a large demand for bamboo products especially in bamboo construction panels (500,000 m^2/year), furniture, handicrafts, disposable chopsticks and even toothpicks. Our surveys in Ho Chi Minh City in 2010 and in 2014 showed that there are a large demand of disposable chopsticks and toothpicks from food street vendors, small restaurants, take-away food shops, supermarkets and low-income household families. Bamboo toothpicks demand also exists: from January 01st to November 15th 2010, 1,118 tons of low-quality Chinese toothpicks with CIF USD130/ton were imported through Saigon Port. (Youth Newspaper, November 15th 2010).

Besides, a new trend in using bamboo as construction material and exterior, interior decoration at cafeterias, restaurants and even houses needs large quantities of bamboo culms.

Exhibit 12: Roles of related entities in a proposed Thanh Hoa bamboo GSCM model



2.4.5 General recommendations:

State authorities have the leading and decisive role for setting up a sustainable GSCM Thanh Hoa bamboo sector by issuing adequate policies and regulations. State authorities and officials should promote bamboo culture by giving land to poor farmers with long-term land use rights or long-term land free of land rentals. Besides, new high-yield seedlings and fertilizers should be freely given to them as state supports, too. Bamboo cultivation on steep slope land and bare hills would receive special support from the State even in finance and foods as afforestation costs. Furthermore, strict regulations on bamboo exploitation should be implemented to ensure sustainable bamboo resources especially tight control over bamboo transportation for outside construction demand. Harvest quota certificates like those from Anji should be considered to ensure a sustainable development (see above Findings: Bamboo cultivation).

Besides, a concentrated polluted waste treatment should be built with strong support from State investment policies. They should be more favorable than those implemented for investors (e.g. free land rental for 11~15 years after the project goes into operation, tax exemption for 4 years and tax reduction for some following years, etc.) investing in Nghi Son Economic Zone-Thanh Hoa (Thanh Hoa Preferential investment policies, 2014). In case it is needed, a joint venture or public private partnership (PPP) company can be considered. By doing so, polluted problem can be adequately solved.

Construction of a large paper mill in Quan Hoa District should be seriously considered to replace an USD 103 million paper mill project in Hau Loc District, Thanh Hoa. This project, Chau Loc Paper Mill, was started in 2003 with a projected annual capacity of 60,000 tons of paper and 50,000 tons of pulp. However, the investment license for this project was revoked by Thanh Hoa authorities in June 2014 (Ngoc Minh. Thanh Nien News, 2014). The failure of such project is predictable because a paper mill, as an input material intensive sector, should be set-up in the heart of input resources not in a coastal district. In this case abundant bamboo leftovers, waste and water are decisive success factors for a large paper firm. A more feasible project is proposed: a large paper mill should be set up in Quan Hoa District or in a nearby adjacent part of Ba Thuoc District for consuming all bamboo waste of the region. It will have a large polluted water treatment system which can treat not only its own polluted water but also others generated by other paper pulp and paper workshops. Investors can be Vietnam Paper Corporation (investor of Chau Loc Paper Mill), or other local or foreign investors. This project should have special policies and top priority from concerned authorities because it not only consumes all bamboo leftovers of the region generating more value added but also solves polluted water which can damage the eco-system.

NGOs with financial help from donors besides their current activities should set up more experimental plots: each district would have at least one plot with an adjacent bamboo nursery. Such experimental plots are ideal places for introducing to farmers how to carry out cultivation activities efficiently and for cultivation training. In the long term, these places can be used as semi-processing hubs. In addition, NGOs with financial help from donors should organize some study tours in Anji for workshop managers, technicians and for some highly-educated young farmers. These farmers will become trainers for other farmers when returning home and then setting up their own demonstration plantations.

Bamboo growers should establish their own cooperatives or farmer groups at least one in each commune so that they can have a higher position in negotiation with collectors and traders. Besides, cooperatives/groups help promote new cultivation techniques, harvest (traceable technique) and build up semi-processing workshops. Through that they can reduce the volatile selling prices by having different consumption channels. Cooperatives/groups also facilitate loan procedures from banks and even get larger loans. In the long term, they can

produce bamboo brooms from twigs and top logs for both local and foreign markets instead of using them as household combustible.

Collectors and traders would set up cooperatives/groups to reduce "price wars" and can satisfy a large demand from customers. In September 2013, Iktus, a Korean Company, ordered a large bulk bamboo products of an annual supply of about 2 million bamboo poles; however, no one in Thanh Hoa Province at that time could meet its requirements both in volume and demand criteria (Service of Agriculture and Rural Development, 2013).

Processors, in turn, can establish their associations at district or inter-district level to efficiently and effectively distribute bamboo culms resources based on their demands and criteria. By having such entities, they can have higher bargaining power over providers, buyers and product distributors and satisfy large orders from customers. Associations can boost marketing processes which are currently weak especially in the South Viet Nam with a large potential demand from low value added products like disposable chopsticks and toothpicks, mid value added products like construction panels, boards and bamboo poles for construction and decoration, to high value added products like handicrafts and furniture.

3. Conclusion

The objective of a USD 2 billion turnover from bamboo products like that of Anji's is still far ahead: there are many obstacles to be overcome to reach this target. All stakeholders including State authorities, officials, NGOs, business persons, processors, traders as well as farmers in Thanh Hoa should give their best and persistent efforts in order to have a sustainable and efficient GSCM bamboo sector.

To conclude, Thanh Hoa bamboo sector is now on Medium value & bulk processing model; the target of a new industrial model with a wise distribution of premium, medium, low value added products and bulk processing is still far ahead (Enterprise Opportunities Ltd., 2006b). This target needs real efforts of all concerned stakeholders. Anji is a good example for bamboo SCM and resources preservation but not GSCM due to its inadequate concerns on pollution (see above Green manufacturing). Therefore, Thanh Hoa should avoid Anji's type of development with low concern for pollution (Chen S. et al 2011c) and prevent serious unattended consequences. Semi-processing is an initial but crucial step to be carried out for successfully implementing GSCM in Thanh Hoa by efficiently consuming input resources and significantly reducing waste. A good and wise implementation of GSCM in the Thanh Hoa bamboo sector is essential to increase economic performance and at the same time Thanh Hoa can preserve its natural resources and eco-system.

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