

# **PROGRESS REPORT FOR RESEARCH PROJECT**

**CST 498-6/ IIT 474-6**

## **Development of New Supply Chain Models and Ontologies:**

**A study of Sri Lankan minor export crops - Cinnamon, Turmeric  
& Ginger**

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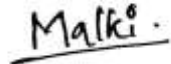

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## Project Title

Development of New Supply Chain Models and Ontologies: A study of Sri Lankan minor export crops - cinnamon, turmeric & ginger

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## Abstract

**Purpose:** The Turmeric, Cinnamon and Ginger trade holds a minor exports crops in the Sri Lankan market. Currently, it is critical to achieve competitive advantage of sustainable supply chain management in Sri Lanka. Being the leading supplier of true the Turmeric, Cinnamon and Ginger to the international market, Sri Lanka is still unable to cater the global demand. Our research tries to map the supply chain and identify the influencing factors and their performance on sustainable Supply Chain Management in the turmeric, cinnamon and ginger crops by developing supply chain models and ontologies.

**Research Method:** The methodology used for constructing a general-purpose ontology for supply chain management is presented along with the resulting ontology and an ontology based SCM model. We focus on Gampaha District and industry insights were drawn from 574 turmeric famers, 2043 cinnamon farmers and 1033 ginger farmers. Primary data was collected by doing interviews with farmers who were selected from a database of DEA which were complemented by direct observation in the field. Secondary data were collected from the Department of Export Agriculture in Gampaha District and Export Agriculture Department Board regarding supply chains of those export minor crops.

**Findings:** Build effective supply chain models for the turmeric, cinnamon and ginger crops. The supply chain model includes functions, actors and products. The supply chain has inbound logistics and outbound logistics. Gampaha has a quality performance on both customer-facing supply chain and firm level businesses. The ways of increasing annual export revenue and the profitability of selected three crops.

**Keywords:** Turmeric, Cinnamon, Ginger, Supply Chain, SCOR model, Ontology

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## List of Abbreviations

1. <b>SCM:</b>	Supply chain management
2. <b>SCOR:</b>	Supply Chain Operations Reference model
3. <b>CSC:</b>	Cinnamon Supply Chain
4. <b>EDB:</b>	Sri Lanka Export Development Board
5. <b>SLCARP:</b>	Sri Lanka council for Agricultural research Policy
6. <b>GDP:</b>	Gross Domestic Product
7. <b>B/L:</b>	Bill of Lading
8. <b>DEA:</b>	Department of Export Agriculture
9. <b>NCPHT &amp; VA:</b>	National Committee Post Harvest Technology and Value Addition

## **Chapter 1: Introduction**

### **1.1 Background of the study**

Traditional minor export crops supply chains in Sri Lanka that engage in moving spices from the producer to the consumer are prone to various sources of inefficiencies. Farmers in spice producing areas are unable to attract competitive buyers.

Demand and Production of turmeric, ginger and cinnamon had increased during the last two years and they were stable during the last years to present. Nearly 50 percent of the production of turmeric and ginger comes from Kurunegala, Kandy, Gampaha and Kegalle districts. And cinnamon comes from Kandy, Matale, Belihuloya, Haputale, Horton plains, Negombo, Matara, Kalutara and Rathnapura areas. The demand for turmeric, ginger and cinnamon has increased in the country and the prices have also increased.

Supply chain management (SCM) implies managing the relationships between the businesses responsible for the efficient production and supply of products from the farm level to the consumers to meet consumers' requirements reliably in terms of quantity, quality and price. In practice, this often includes the management of both horizontal and vertical alliances and the relationships and processes between firms. Agri-supply chains are economic systems which distribute benefits and apportion risks among participants. Thus, supply chains enforce internal mechanisms and develop chain wide incentives for assuring the timely performance of production and delivery commitments. They are linked and interconnected by virtue of shared information and reciprocal scheduling, product quality assurances and transaction volume commitments. Process linkages add value to agricultural products and require individual participants to coordinate their activities as a continuous improvement process. Costs incurred in one link in the chain are determined in significant measure by actions taken or not taken at other links in the chain. Extensive pre-planning and coordination are required up and down the entire chain to affect key control processes such as forecasting, purchase scheduling, production and processing programming, sales promotion, and new market and product launches etc.

Following are the components of an organized supply chain:

- Procurement or sourcing
- Logistic management - Transportation, Material management, Warehousing and Logistics Network modeling
- Organizational management - Long term storage, Packaging technology, Cold chain management, Energy efficient transport and Quality and safety

## **1.2 Problem Identification**

Currently, it is critical to achieve competitive advantage of sustainable supply chain management in Sri Lanka. The important areas that have a strong impact on sustainable Supply Chain Managements are risk, uncertainty, strategy, innovation, relationship, infrastructure, regulation and technology. These factors have been studied within the manufacturing sector in developed countries; there is a lack of research on Agri-supply chains in Sri Lanka with respect to the concept of sustainable Supply Chain Management. Supply chain management processes of these three crops contain various documents such as delivery order, dock receipt, bill of lading (B/L), sea waybill, etc.,” states A multiple. Employees in the supply chain department continuously store and process these documents for various reasons, yet, this is a time-consuming, manual task that inhibits businesses to reach operational excellence.

Therefore, our research tries to map the supply chain and identify the influencing factors and their performance on sustainable Supply Chain Management in the turmeric, cinnamon and ginger crops supply chain in Sri Lanka. Importantly, early research suggests that mapping the supply chain represents a significant research gap not only in Agri-supply chains but also supply networks in general.

## **1.3 Significance of the study**

Individual suppliers, producers and marketers who are associated through a supply chain coordinate their value creating activities with one another and, in the process, create greater value than they can, when they operate independently. The Sustainable supply chains create synergies in one of three ways:

- Expand traditional markets beyond their original boundaries and thus increase sales volume for members



- Reduce the delivered cost of products below the cost of competing chains and thus increase the gross margin for the working capital committed by members of the chain
- Target specific market segments with specific products and differentiate the service, product quality or brand reputation of the products delivered to these market segments and thus increase consumer perception of delivered value.
- Connected supply chains supported by automation technologies provide the opportunity to free employees from these menial, manual tasks. The tasks are often carried out on pen and paper by employees in the warehouse, taking up valuable time and often leading to human error when recording and submitting information. The benefits of automation, both in and out of the warehouse include increased efficiency - manifested by increased fill rates and decreased cycle times, as well as increased warehouse throughput time, reduced labor and operational costs, elimination of human error, and improved inventory management.

#### **1.4 Objectives of the research**

Our primary aim is to, Develop supply chain models for each selected crop - Turmeric, Cinnamon and Ginger.

The objectives are,

1. To find out the factors that can be automated in the developed models.
2. To develop a design guideline for the software / system developers in relevant fields.
3. To Develop separate ontologies for each developed model.

#### **1.5 Expected Outcome**

According to the aims and objectives of our research, our expected outcome is to;

- Building effective supply chain models for the desired three crops.
- Ensuring that the selected area (Gampaha) has a quality performance on both customer-facing supply chain and firm level businesses.
- Helping the GDP of the country by increasing annual export revenue and the profitability of selected three crops.

## **Chapter 2: Literature Review**

According to prior studies we identified the gaps between theory and practices in order to develop a supply chain model for a particular crop including Turmeric, Cinnamon and Ginger.

### **2.1 Theoretical background**

#### **Supply Chain Management**

Supply chain management is described as the integrated planning, coordination, and control of all processes and activities throughout the supply chain in order to offer a value-added service while lowering the overall cost of all supply chain stakeholders (Van et al., 2000). It has been suggested that the supply chain management field lacks appropriate theoretical basis, leading in simplified conceptualizations of supply networks and their settings, and that theory may be useful in unearthing some of the complexity that characterizes supply chains (Dubois et al., 2004).

The supply chain management idea often focuses on reorganizing the supply chain to increase material and information flow efficiency and effectiveness (Alvarado and Kotzab, 2001). Supply chain management has grown more crucial in a globalized corporate environment as the focus has shifted from individual cost savings to overall revenue growth and performance (Chandra, C. and Kumar, 2000). Many manufacturing and service companies throughout the world have discovered that shifting costs to other supply chain partners in upstream or downstream nodal points does not improve the focal firm's competitive advantage (Harland, 1996).

#### **The SCOR model**

Users can utilize the SCOR Model to address, enhance, and communicate supply chain management practices inside and across all relevant stakeholders. The SCOR framework tries to include components of business process design, best practices, and benchmarking into one framework. The SCOR Model was created to describe the business activities involved in meeting a customer's demand at all stages. Using a standard set of concepts, it may be used to define and enhance both small and complicated supply chains (Peter Bolstorff, 2011).

Farm produce logistics are characterized by a wide variety, big quantity, relative independence, consumable and value-added processing, and significant digitalization in modern agriculture.

The SCOR model (Supply-Chain Operations Reference-model) of agricultural products based on the Internet of Things has been proposed through the improvement of the logistics model of traditional agricultural products, taking into account the features of modern agriculture and farm produce logistics (Liangang, 2014). Turmeric, Cinnamon and Ginger are small-scale, non-traditional minor crops.

### Turmeric

Turmeric is a highly valued crop due to the wide-range of uses it has in various industries. Turmeric is one of the multi-use commodities, which has commercial, economic, cultural and medicinal significance across the globe (Abeynayaka *et al.*, 2020).

In Sri Lanka, the turmeric production is concentrated in the intermediate and wet zones. The main issue of the turmeric market is the inefficiency of turmeric production and it has led to Production instability in turmeric production over the years. This inefficiency is inseparable from the constraints that occur in managing turmeric farming that are linked to the aspects like input availability, production technology, market price and the delivery of necessary support services (Apasinghe, 2013). This implies the need of a good SCM in the turmeric production as well.

### Cinnamon

Sri Lanka is one of the leading exporters of cinnamon in the world. The cinnamon supply network connecting the producers and the export market has not been properly optimized and results in inefficiencies. Ceylon cinnamon comes from a plant called ‘*Cinnamomum Zeylanicum blume*’ which is indigenous to Sri Lanka where 85% of the world's production is generated (Sugathadasa *et al.*, 2021).

The cinnamon supply network in Sri Lanka is not properly optimized and it has influenced many inefficiencies and risks in the cinnamon SCM. The researches which have been done previously have identified certain risks in this supply chain. Five critical risk factors were identified related to quality control, communication, timing of product delivery, inventory, and lack of technology which demands immediate mitigation strategies (Sugathadasa *et al.*, 2021).

EDB state that Ceylon Cinnamon is categorized into four major grades - Alba, Continental, Mexican and Hamburg based on the diameter of the quill, where the most expensive (Alba) has a 6 mm diameter quill.

### Ginger

In the ancient times ginger has been widely used as a medicine in Chinese and Ayurveda medicine but in recent years, Ginger has been cultivated as a commercial crop in Sri Lanka. There are many local and introduced varieties of Ginger grown in Sri Lanka such as local ginger, Chinese ginger and Rangoon ginger. The supply chain of Ginger can have several problems due to the actors of that supply chain. Wimalaratana(2018) has mentioned the price fluctuations, unavailability of quality seeds, scarcity and high prices of fertilizer and other inputs, and inefficient extension services as the major issues in the ginger market of Sri Lanka. These issues can arise due to the lack of a proper SCM in the Sri Lankan context at present.

One of the most popular herbs around the world, Ginger (*Zingiber officinale*) is an intricate part of Sri Lanka cuisine and traditional medicine. Aromatic, pungent and hot with hints of sweetness and zest, ginger grown in Sri Lanka belongs to three varieties;

- Sri Lankan Ginger - With small rhizomes and white fibrous flesh Sri Lankan ginger has a stronger flavour and aroma compared to other varieties which makes it more suitable for use in producing beverages and confectionery like ginger beer, ginger tea, gingerbread and ginger toffee.
- Chinese Ginger - Large rhizomes with pale yellow watery flesh, Chinese Ginger has low notes of flavour and fragrance and is ideal for pickled ginger.
- Rangoon Ginger - Medium-sized rhizomes with multiple fingered mild notes of flavour and fragrance

## **2.2 Previous work**

### Turmeric

Returning to the turmeric story, Sri Lanka's primary turmeric import source was India. In 2017, 97% (USD7 million) of Sri Lanka's turmeric imports came from India. Media reports show that Indian farmers and merchants have raised concerns over Sri Lanka's turmeric ban. While these

concerns have no immediate damage on the country's exports, Sri Lanka should still be cautious to avoid the Trump administration's blunder of getting into a series of tariff battles with crucial trade partners.

The primary data obtained through FGDs was related to the package of practices in turmeric cultivation, cost of production and other challenges faced at the farm level. The primary data obtained through personal interviews of market participants and officials focused on the trends in market arrivals, issues faced in the market, infrastructure and price related aspects. The hazards due to adulteration of these products pose a serious problem to consumers. On the other hand, farmers are not able to get remunerative prices for these products due to wide price fluctuations.

### Cinnamon

The traditional supply chain of spices in Sri Lanka is characterized by decentralized purchasing, low quality product purchases and sales, the presence of a number of intermediaries without essential functions, such as traveling collectors, village traders, wholesale buyers, commission agents and auction brokers and weak linkages among the different value chain actors. This has resulted in low value added in the chain, lack of quality concern, poor incentives for the farms to make investments and sluggish growth of the sector (Institute of Policy of Sri Lanka, 2017).

This setup has been dominating spice marketing for a long time without any changes until now except for certain isolated attempts of entrepreneurial firms who have integrated backwards towards the cultivation while linking smallholders' farms into dynamic modern supply chains.

### Ginger

Samaratunga (2006) has mentioned that the expanding supply chain through food city concept island wide has a significant impact on the spices market in Sri Lanka where this enables to overcome certain problems that farmers had regarding the market. Ma's Foods have introduced an innovation that is basically a "business model" change with limited "collective action strategies by farmers" that fulfills these consumer demands while effectively integrating the farmers in the supply chain.

## 2.3 Gaps in knowledge

### Turmeric

The average Benefit Cost Ratio (BCR) of 2.08 indicates that turmeric production was found to be a profitable venture in the study area. It implied that one rupee invested in turmeric farming would yield more than double the amount. Moreover, these findings are in conformity with the results attained by other studies [4,6,10,11,12] with regards to efficiency of use of capital in turmeric production. However, the majority of the farmers in the study area were still following conventional means of cultivation that led to the higher cost of cultivation. Hence, it is necessary to instruct the growers to use novel and superior techniques to minimize the cultivation cost. This would make it possible in further enhancing profitability of turmeric cultivation.(Abeynayaka et al., 2020)

Asian countries consume much of their own turmeric production, except for Japan and Sri Lanka. Major importers are the Middle East and North African countries, Iran, Japan and Sri Lanka<sup>19,56</sup>. These importing countries represent 75% of the turmeric world trade, and are mostly supplied by the Asian producing countries.<sup>56</sup> Europe and North America represent the remaining 15%, and are supplied by India and Central and Latin American countries. <sup>56</sup> Taiwan exports mostly to Japan. <sup>19</sup> The United States imports of turmeric come from India at 97%, and the rest is supplied by the islands of the Pacific, and Thailand.<sup>13</sup> Tables 3 and 4 show turmeric imports by the United States, United Kingdom and Japan. Quantities and prices for these countries were stable over the period 1997-2002.

However, the increasing demand for natural products as food additives makes turmeric an ideal candidate as a food colorant, thus increasing demand for it. Additionally, recent medical research demonstrating the anticancer and antiviral activities of turmeric may also increase its demand in Western countries.

### Cinnamon

Technology and marketing solutions are suggested concerning the total value chain activities. A considerable number of people are involved in the Cinnamon industry. Most of the existing cultivators fall under the small holders' category and the processors earn high salaries. Upon suggested improvements these sectors will receive a better living with the improvement of the

economy of the country. Since this crop is native to Sri Lankan soil it will provide many value additions to the economy (Thanthirige and Lanka, 2011).

Being an indigenous crop to Sri Lanka with less diversified product ranges the cinnamon industry does not show a significant development. Various countries incorporate cinnamon products as a raw material for manufacturing other diversified products while the others use in the same raw form for final consumption. Being an inherited crop that is not possible to grow successfully in any foreign country, the comparative advantage it could provide to Sri Lanka is very high (Hettiarachchi *et al.*, 2020).

Large-scale exporters have succeeded in introducing value-added products to the international market. Upstream actors of the cinnamon value chain have a weaker compliance level on quality standards and certification than downstream actors. Lack of traceability and improper pricing mechanisms hinder the compliance levels of the upstream, while price premiums, competition and brand loyalty attract downstream actors.

Growers sold their harvest to collectors at farm gate or the collecting centers near the cultivation area. Growers also directly sold the harvest to the processors or exporters. Growers always sold the harvest for the highest offer since the prices are volatile in the industry. Collectors offer the price based on the quality of the cinnamon. The supply chain issues faced by the collectors are poor hygienic conditions in transport, lack of knowledge for quality standards and high transportation cost (Yoon J, Jang H, 2020).

### Ginger

Samaratunga (2006) has mentioned that the expanding supply chain through food city concept, island wide has a significant impact on the spices market in Sri Lanka where this enables to overcome certain problems that farmers had regarding the market. Ma's Foods have introduced an innovation that is basically a "business model" change with limited "collective action strategies by farmers" that fulfills these consumer demands while effectively integrating the farmers in the supply chain.

Traveling collectors, village traders, wholesale buyers, commission agents and auction brokers unnecessarily extract exorbitantly high profits while suppressing the farmers' price. This has resulted in low value added in the chain, poor incentives for the farms and sluggish growth of the sector. This setup has been dominating spice marketing for a long time without any changes until

now. Rapid and ongoing changes are occurring in the domestic and export procurement systems in terms of increased quality due to the development of high-quality retail markets, bulk procurement by domestic manufacturing firms, increased quality awareness on the agenda and the reality of the global trading system. This phenomenon has been further influenced by urbanization, income increases, increased migration of Sri Lankan citizens, increased female participation in the labor force, etc. These factors have created a new demand pattern shifting the focus towards continuous supply of high quality, value added products with improved processing, packaging and labeling.

The impact of modern and restructured markets has had a number of repercussions on small-scale spice producers who are unable to keep up with emerging marketing trends. This situation has triggered the need for new innovative practices working with smallholders in improving their ability to face restructured market conditions (Samaratunga, 2006)

Rahman *et al.*, (2009) pointed out the problems in ginger cultivation where the study focused on Methods used in ginger cultivation with special reference to Indian ginger hub Northeast region. As it is discussed most farmers are still dependent on traditional methods and natural resources. But continuous usage of land with no proper developments may tend to decrease the level of productivity of ginger. As it was reported decreasing rhizome yield from 1:8 from 1:4 (seed rhizome to harvest rhizome). According to a survey report, about 60% of farmers in SIKKIM commented that wilt and soft rot were major limiting factors in ginger cultivation. In ASAM 30% yield loss was due to rhizome rot and that has become the major challenge in organic farming. This has led to giving up ginger cultivation among farmers.

National Committee Post Harvest Technology and Value Addition (NCPHT & VA,) Sri Lanka council for Agricultural research Policy (SLCARP), National priorities in post-Harvest & value Addition Research in Agriculture, (2011-2015), states that ginger as one of the prioritized crops and following objectives are supposed to be reached as it is set by a legal body in National Agricultural Plan in 1999 as follows,

- Income and employment generation
- Generation of foreign exchange rate
- Economic efficiency



- Satisfaction of Future domestic needs
- Satisfaction of nutritional requirements of low income groups.

This further provides reasons to cultivate ginger and to encourage ginger farmers in the local context since increasing ginger cultivation causes various economic results(Wimalaratana, 2018).

## **Chapter 3: Materials and Methods**

### **3.1 Methodology**

The supply chain management ontology has the goal of providing a framework to better formulate, understand, analyze and share a company's supply chain management model. Therefore, ontologies can be regarded as precious tools that can be used to increase the efficiency of supply-chains.

The methodology used for constructing a general-purpose ontology for supply chain management is presented along with the resulting ontology and an ontology based SCM model. The ontology may be enhanced by including supply chain performance drivers and by including other concepts such as forecasting, warehouse location, aggregate planning, etc. More effort can be devoted to synchronizing the ontology with the SCOR (Supply Chain Operations) model in which the operations of the supply chain are classified as plan, source, make, deliver and return, as is used in our ontology.

### **3.2 Field Investigation**

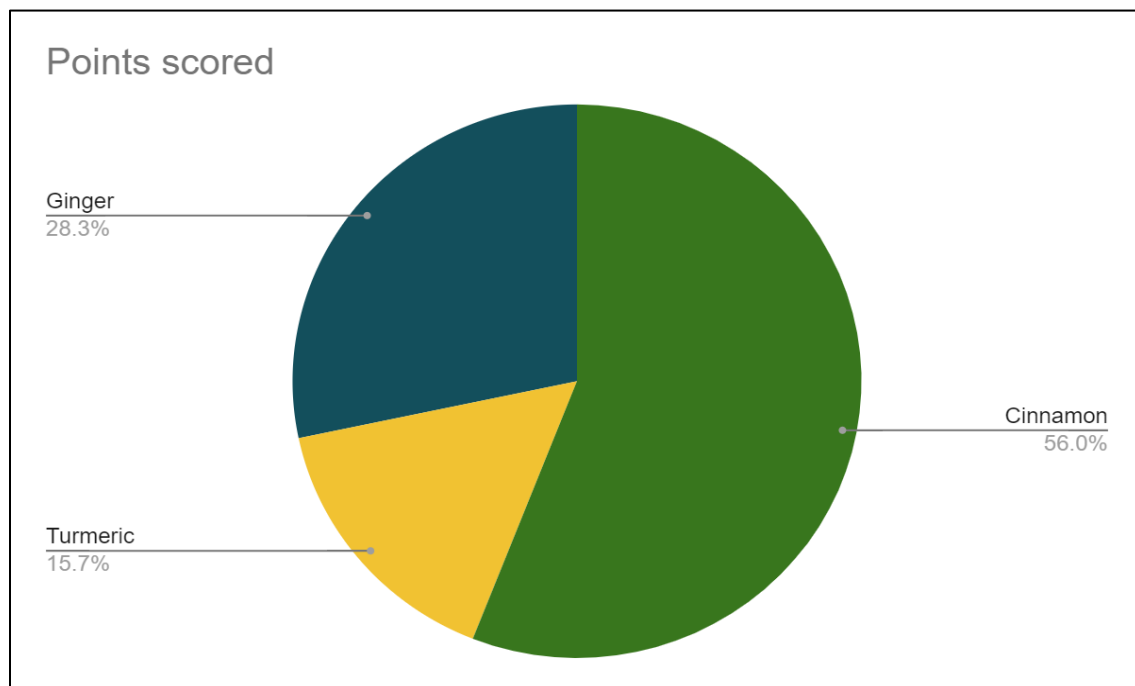
First, it is important to identify the area that our research needs to be done. Then we selected Gampaha district because turmeric, cinnamon and ginger cultivation is at moderate level and the total number of farmers in each crop is greater than five thousand.

To develop Turmeric, Cinnamon and Ginger supply chain models we collected secondary data from the Department of Export Agriculture in Gampaha District and Export Agriculture Department Board regarding supply chains of those export minor crops. The data collected as documents, booklets and interviews.

The data include:

- Details of farmers (Name, address, contact number, number of extents, harvest, and employees, technologies, machinery, agrochemical supplements)
- Details of Collectors (Name, address, contact number)
- Details of exporters (Name, address, contact number, amount of exports, warehouse location, valued products)

Following chart includes the total number of farmers who registered in EAD in the Gampaha district office to get an idea of how to spread these crops in Gampaha district.



*Figure 1: Total Number of Farmers in Gampaha District*

Primary data was collected by doing interviews with farmers who were selected from a database of DEA which were complemented by direct observation in the field. These methods allowed for more in-depth exploration of value chains and yielded information that facilitated deeper understanding of the constraints and opportunities in the respective supply chains. Selection of the sample of producers and collectors was done in consultation with DEA and its district officers in order to ensure optimum representation of the stakeholders that are small, medium and large. We have listed questions and asked them from farmers to get more data about the supply chain.

The data include:

- Raw materials, seeds, fertilizer
- Cultivation of crops
- Selling method for buyers
- Transportation method
- Problems when supply done

Currently the farmers do not know about what happens to their harvest after selling collectors. So, we did oral interviews with a few companies. The companies were selected from the DEA database.

### **3.3 SCOR Model Verification**

SCOR focuses on the measurement and assessment of the outcomes of supply chain process execution. A comprehensive approach to understanding, evaluating, and diagnosing supply chain performance consists of three elements: Performance Attributes, Metrics, and Process / Practice Maturity. Elements, as distinct from the Levels in the Process and Metrics hierarchies, describe different aspects or dimensions of performance.

- Plan - develop strategies for managing resources and balancing demands and supplies. A set of metrics to monitor the SC efficiency has to be proposed.
- Source - choose a set of suppliers for producing goods and services.
- Make - goods and materials are transformed to final products. This step is the manufacturing portion of the supply chain. Production scheduling, testing, packaging, etc. are the activities that take place at this step.
- Deliver - coordination of orders from customers, developing a network of warehouses, distribution and transportation of products to customer, invoicing system to receive payments from customers. This part is known as “logistics”
- Return - deals with the problematic of defective products, how they can be returned to producer and how customers are dealt with to satisfy their requirements on problematic products.

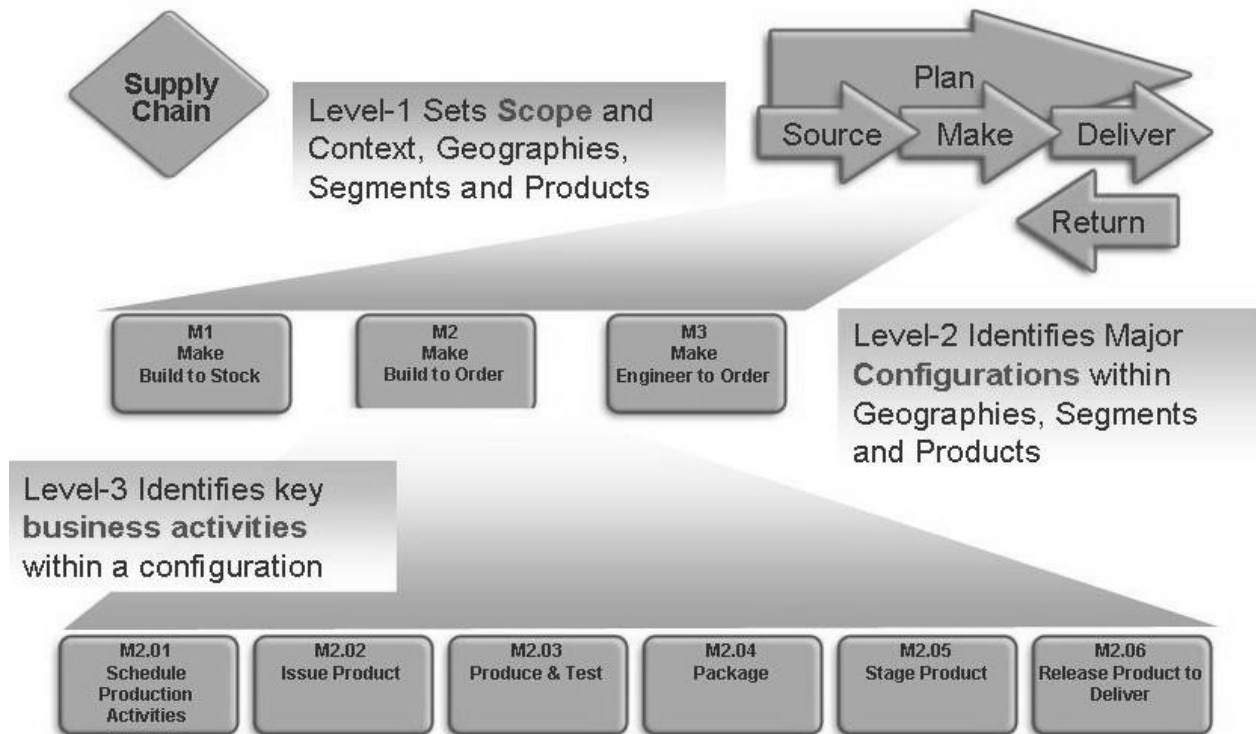


Figure 2: SCOR Framework Level

### 3.4 Tools and Technologies

- Hardware: Computers /laptops, Mobile phones, Wi-Fi adapters
- Software: Protégé
- Technologies: Ontology development technology
- Languages: OWL language

## Chapter 4: Progress of the Project

We have developed three supply chain models for turmeric, cinnamon and ginger crops as flowing;

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### 4.1 Turmeric Supply Chain Model

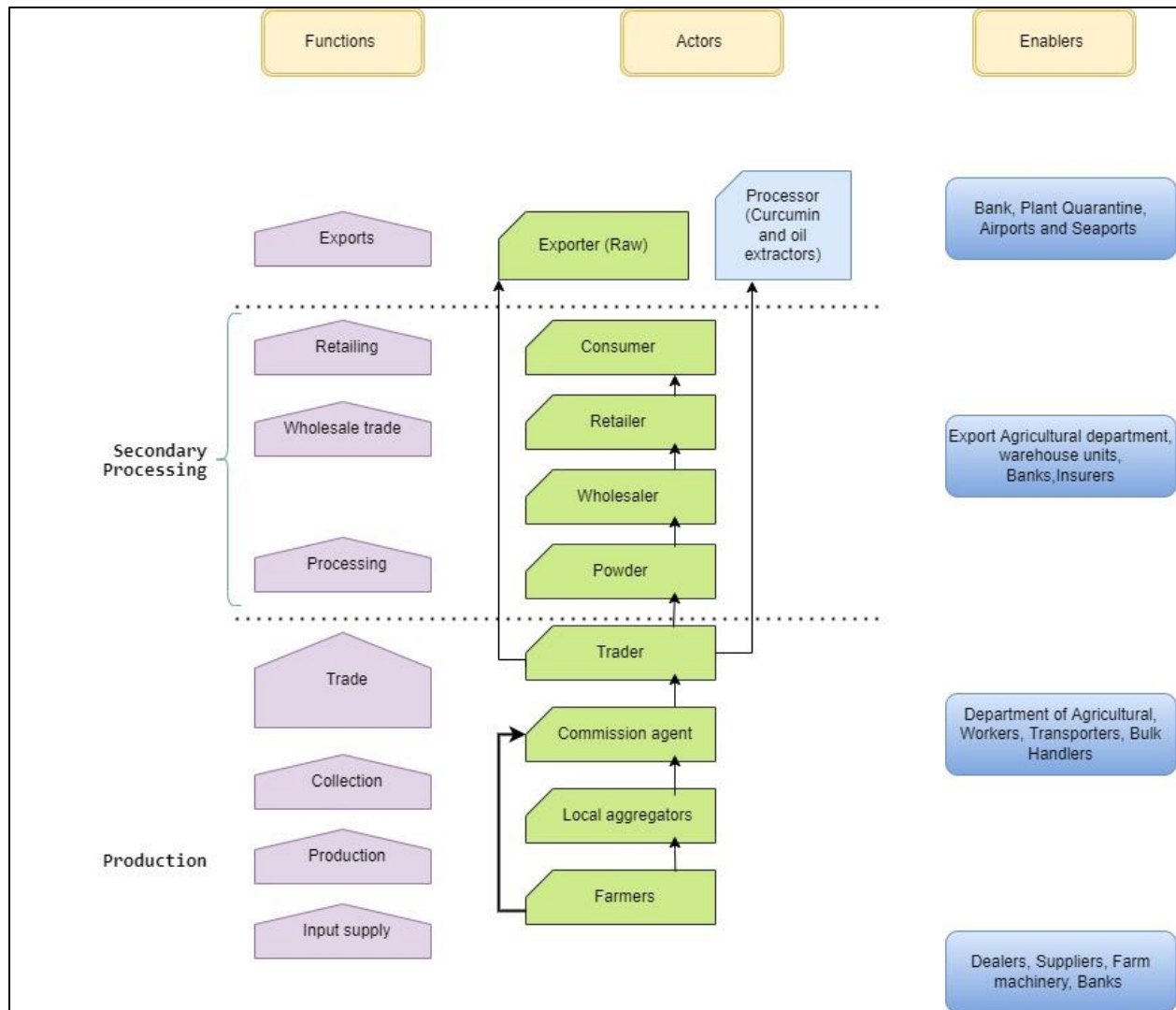


Figure 3: Turmeric SCM

#### 1. Functions

The turmeric value chain involves functions such as input supply, production, aggregation, processing, trading and exporting. The major inputs in turmeric are seed, organic manure, fertilizers and pesticides apart from credit and insurance support. Technical knowhow and

improved practices are inputs provided by the Export Agricultural department. Most farmers produce turmeric for commercial purposes and the concept of turmeric for seed material is not prevalent in the study area. Primary processing at household level involves harvesting, cleaning, separation of rhizomes, boiling and drying in order to make dried turmeric. Commercial processing is usually done in major market centers. Trading usually consists of collection, local trading and regional or national trading. Some traders and processors are also involved in export of fingers which are converted into value added products such as curcumin, essential oil and supplements. The product reaches the domestic consumers through wholesalers and retailers.

## **2. Actors**

### Input Suppliers

Seed is the major input in turmeric cultivation. Most farmers use their own seed and rarely procure seed from markets. Manure, fertilizers, pesticides and labor are sourced from the nearby places. Manure is another important input whose availability is dwindling due to a lesser number of animals being maintained by farmers than previously.

### Farmers

Most farmers cultivate turmeric for commercial purposes. Most farmers in the area of study cultivate as little as half an acre to 4 acres. Apart from commercial motives, there is a ‘sentiment’ associated with turmeric cultivation. These farmers usually supply dry turmeric which is processed at farm to local traders at nearby regulated markets.

### Small village level traders/Local Aggregators

Small traders residing in the same village or neighboring villages are involved in turmeric aggregation. They are frequent visitors to wholesale markets and deal with farmers and commission agents. Generally, they deal with small quantities and sell at nearby markets as farmers. They are aware of price information and try to take advantage of the price arbitrage and offer a better price for the small lots.

### Commission Agents

In major markets, commission agents play a crucial role and act as a conduit between farmers and traders. The role of commission agents starts much ahead of harvest of produce. At times commission agents provide credit to farmers and this is one probable reason for the farmers to depend on them heavily during the disposal of produce at the market.

#### Local traders

In turn, the local traders deal with odd commission agents during the harvest season for their trading needs. Produce from other areas is also brought to the market by aggregators or group of farmers for better price realization. Kesamudram, Kandy and Kegalla are the other major markets in Sri Lanka.

#### National level traders / Exporters

Traders source produce from local traders. Traders place orders for bulbs while those buy fingers. Most exporters deal with traders in Japan, Europe, Middle East and North America, which are major export destinations for turmeric.

#### Processors

The major processed product of turmeric is turmeric powder which is mostly used for culinary purposes. Turmeric powder is also used for rituals, as a cosmetic and in medicines. Most processors are involved in three major spice commodities i.e. chilli, turmeric and coriander which enables them to run the mills all 9 through the year, thus optimizing establishment costs. Most processors are of the opinion that standalone turmeric mills would not be economically viable.

### **3. Enablers**

#### **Enablers and Facilitators**

In a supply chain, the enabler includes all chain-specific actors providing regular support services or representing common interest of the supply chain actors. For example, functions at the enabler level include public research and technology development, agreement on professional standards, promotional services, joint marketing or advocacy and other support service providers.

#### **Enablers in Production and Local Processing Functions**

At the farmers' level, District Agricultural Officer and The Department of Export Agriculture are working to disseminate different technologies in turmeric farming and processing. Agricultural Research Station is working on maintaining different varieties and developing new technologies for turmeric cultivation. Financial institutions like public sector banks are involved in providing credit and insurance facilities. Banks-both public and private sector are also involved in providing credit facilities for establishing cold storage and warehouses. Some local players are involved in offering services for boiling fresh turmeric and converting into dry turmeric.

### **Enablers in Trading and Export Functions**

At traders' level, Agricultural Market Committees (AMC) facilitates trading activities through open auction method with/without the involvement of commission agents. AMC are also facilitating trading activities by providing technology and establishing collection center at higher level, Export Agricultural department under the Government of Sri Lanka assist in export of goods and maintain the export related data



## 4.2 Cinnamon Supply Chain Model

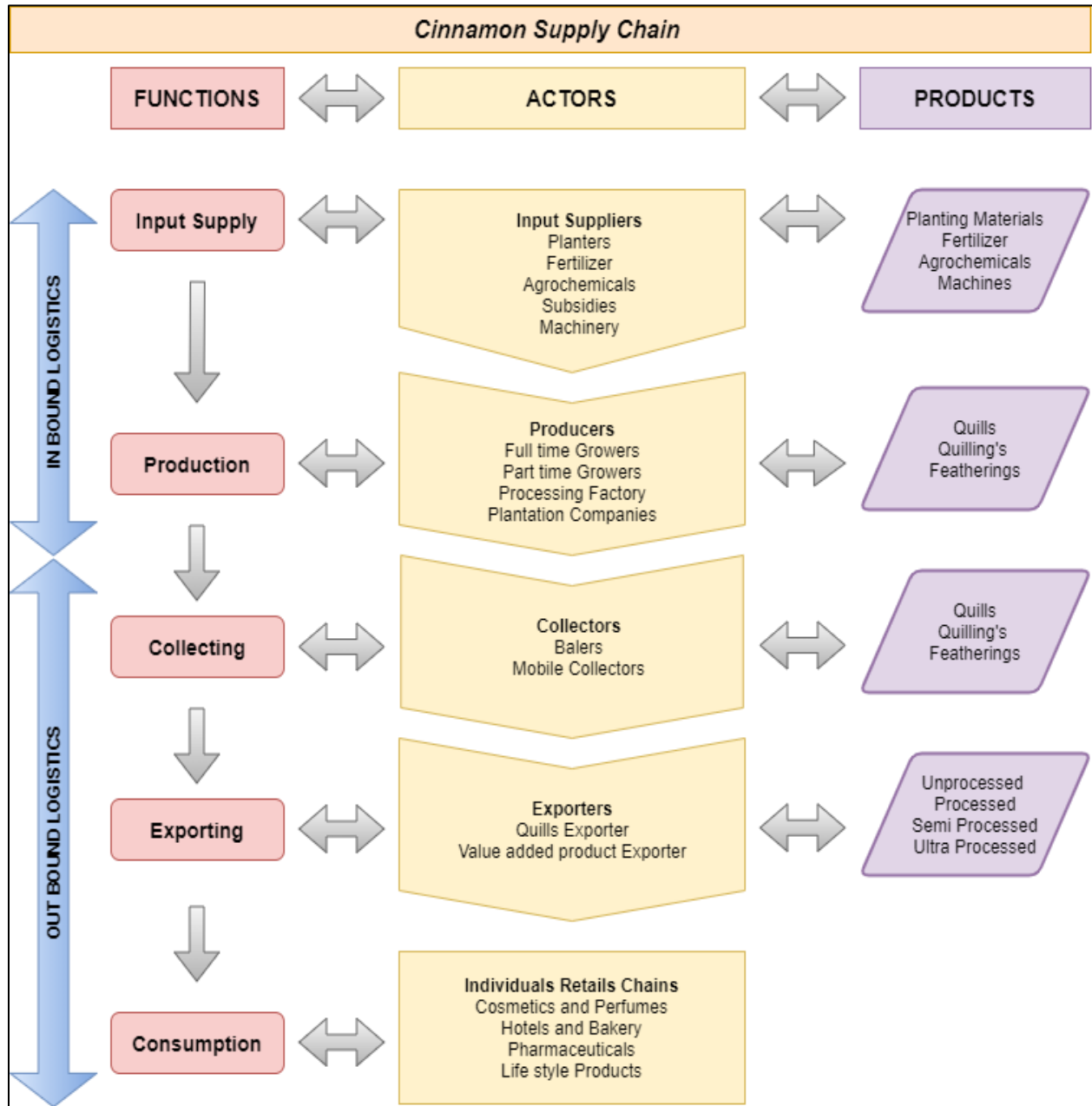


Figure 4: Cinnamon SCM

There are major three categories in the cinnamon supply chain includes; functions, actors and products collected by various data sources. By using those collected data, develop the Ceylon

cinnamon supply chain model for Gampaha district. Input supply, production, collecting and trading, exporting and value addition and consumption were identified as the main functions of the developed CSC.

Cinnamon sector is highly complex covering a long supply chain in Sri Lanka which includes Full time growers, part time growers, processing factories, companies, mobile collectors, traders and dealers at village level, commission agents and exporters. The supply chain is characterized by mobile collectors, and is the most important link in the traditional marketing channel that purchases the products from the small growers and sells to larger collectors especially outside the village.

Villages have transport and facilities are limited. They make direct cash payments to the producers. Cinnamon grown and produced in Sri Lanka has a long-standing reputation in the international market due to its unique quality, color, flavor and aroma.

### **Input supply**

The main support activities at this part of the value chain were: input suppliers like fertilizer and other agro-chemical dealers, plant nurseries, and other farm equipment and machinery suppliers; and extension services which are provided by DEA; field demonstrations, training, advisory and fertilizer and plant subsidies. Growers purchase planting material from the Gampaha District Office of the Department of Export Agriculture and from private nurseries. They use both organic and chemical fertilizers to increase productivity. Most of the growers interviewed prefer to use organic fertilizers.

### **Production**

Ceylon cinnamon supply chain comprises the producer base: full time growers; small, medium or large scale, part time growers, plantation companies, producer societies and broad tree processing factories. Cinnamon peelers involved in the primary activities. According to the collected data, the majority of the producers, about 70%, were small holders and did not cultivate cinnamon as full-time engagement. The products are cinnamon quills and quill featherings.

(UNIDO (2016))states that most of the cinnamon growers are part-timers, engaged in other professions as their main livelihood. The producer associations were identified as the main horizontal linkage in this part of the supply chain.

In Gampaha district, the local trader/buyer is another important link operating mostly in a small shop in the village. There are small wholesale traders in the main area of production and big wholesale buyers in the main towns. They bulk produce and dispatch to traders in Gampaha district. Commission agents only mediate between buyers and sellers. They charge their clients for their services.

### **Collecting**

Collectors/dealers, balers represent the local segment of the downstream while, off-shore buyers, supermarkets and retailers. The collectors were revealed to engage in the collection and distribution of raw material supplies (cinnamon quills) across the chain and the balers attend to the sorting, grading, and fumigating with sulfate of the cinnamon supplies. Collectors buy cinnamon from the growers who properly cultivate and peel the cinnamon.

Collection of cinnamon is the main activity that collectors perform. Once the producer is ready to sell the cinnamon bales, they inform the collectors. Producers know who the collectors are and they contact them mainly via telephones. The collectors come to the producers where they have finished harvesting and peeling of cinnamon and buy mainly cinnamon quills and transport them to the town level collecting centers or directly to the processor / exporter. Collector's main issues are the high cost in transporting cinnamon and assuring the quality of their products.

### **Exporting**

The exporter is the final link in the domestic marketing structure. Most exporters sell through a broker or a commission agent in the importing country in Sri Lanka. The exporters act as the final link in the domestic market structure and they can be categorized into two categories; quills exporters and value-added product exporters. Both semi-processed and ultra-processed products were observed in the basket of value-added product exporters.

The importer then sells to a grinder or processors who again sell the cinnamon to cosmetics and perfumes, hotels and bakery, pharmaceuticals and lifestyle products companies. In addition, there are companies involved in cinnamon processing brokers and institutions offering other services such as academic research, verification, certification and training. There are around 34 private companies, which export value-added products such as cinnamon oils and cinnamon

flavored tea bags. However, the value-added cinnamon production industry is not yet well developed compared to those in the overseas market. Some exporters and processors deal directly with farmers when purchasing cinnamon, whereas most of the exporters source their supply through collectors.

Exporting value-added products are Cinnamon oil, Cinnamon powder & tablets are also used in bakery products, Asian foods, flavored tea for its distinctive aroma and flavor and also in the preservation of certain foods, in the pharmaceutical preparations & in the cosmetics industry worldwide. Volatile oil of Cinnamon is widely used in perfumes, cosmetics and scented exotic gifts.

### **Consumption**

Sri Lankan cinnamon consumption channels are consumed both domestically and internationally. Cinnamon is generally purchased in village level markets and consumed in retail stores such as supermarkets, as well as hotels and boutiques. In the international market, bulk cinnamon is sold in various markets mainly in its packaged form. Modern retail markets are mostly the end channels of the packaged products. While a large portion of the products is consumed in its primary form, they are also converted into value-added products or used in the cosmetics industry as well.

Finally, government supportive services extended by ensuring the effective functioning of the cinnamon supply chain. The Department of Export Agriculture, Export Development Board, Agriculture Research Institute, Cinnamon Research Institute, Cinnamon Training Academy, Ceylon Cinnamon Association, Ministry of Primary Industries and Banks provide multiple services extending support for the effective functioning of the CSC.

### 4.3 Ginger Supply Chain Model

The study used primary data which was obtained with the aid of the questionnaire and personal interviews. The respondents were assured of confidentiality. This was to enhance their willingness to volunteer information. The local language was used for clarification where necessary, while questions were limited to the last farming season.

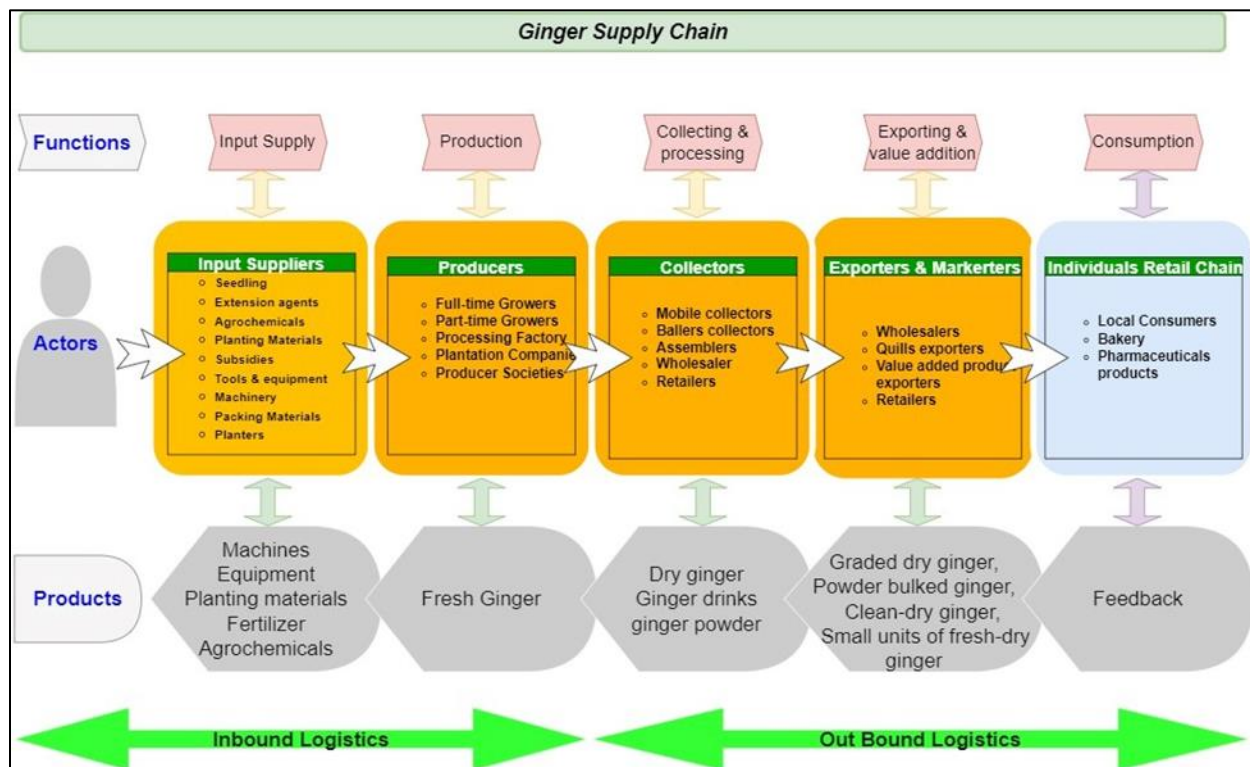


Figure 5: Ginger SCM

The study of the ginger supply chain mapping module in the study area is shown above. The result shows that the key functions in the supply chain include Input supply, Production, Collecting and Processing, Exporting and value addition, Consumption. The respective actors or players are input suppliers, Producers, Collectors, Exporters and Marketers, Individuals Retail chain.

The ginger supply chain module facilitates a clear understanding of the sequence of activities, the key actors and relationship involved in the supply chain.

The study of actors in the ginger supply chain, their characterization and functions are shown in the following table. The results show five key actors along the ginger supply chain: the producer (farmer), assemblers/aggregators/off-takers, wholesalers, retailers, and consumers. The ginger supply chain identified include fresh ginger, dry ginger, ginger powder, and ginger drink.

### **Input supplies**

Input suppliers form the beginning of an agricultural supply chain. This group of actors provides various inputs (e.g., training, fertilizers, pesticides, herbicides, seedlings, and farm tools or equipment) to farmers. They also guide the farmers on the application of the respective inputs provided. In many cases, input suppliers provide inputs across various agricultural commodities and are not vertically integrated. For instance, a fertilizer dealer supplies to every farmer who wishes to buy notwithstanding the crop being produced. The seedlings used by the ginger producers are usually reserved from the preceding harvest season. Other inputs like farm implements and agrochemicals are sourced from neighboring towns. However, occasionally, seedlings are sourced directly from fellow ginger producers. The inputs utilized by ginger producers include basic farm tools (cutlasses, bowls, hoes, and sprayers) and agrochemicals (fertilizers, herbicides, and pesticides). Many producers apply cow dung in place of inorganic fertilizers. The cow dung is sourced from herdsmen in their neighborhoods.

### **Producers**

Next on the supply chain are the producers. These are the ginger farmers. Most farmers live in rural areas where the farms are located. They are mostly smallholder farmers and often cultivate a range of crops to provide food for their families. The key functions of ginger producers are to establish and manage ginger farms. Every ginger producer in the study area cultivates with marketing in mind. Therefore, ginger is a 100% cash crop. Producers have direct links with input suppliers and form the actual beginning of ginger marketing. They also engage in simple processing activities. These include cleaning, slicing, drying and sorting.

### **Collectors**

The mobile collectors, ballers collectors, wholesalers, retailers are the collectors in ginger supply chain. The wholesalers also fall into two categories, namely in-situ wholesalers and transit wholesalers.

Assemblers collect and bulk fresh or dry ginger for sale to wholesalers. There are two categories of assemblers in the ginger marketing system, namely farm-gate assemblers and market-arena assemblers. The farm-gate assemblers collect and bulk ginger from individual farmers at the farm gate while the market-arena assemblers collect and bulk ginger at the market and sell to wholesalers usually in the same market.

The in-situ wholesalers resell their collection of ginger produce right in the market while the transit wholesalers transport their ginger produce to cities or areas where they hope to attain a higher margin.

### **Processors**

There was very low sophistication in ginger processing. The major processing activities in the study area were cleaning, slicing, drying and sorting. The majority (>80 %) of ginger trade was in dry ginger. Ginger was also processed into powder and local ginger drinks on a small scale. Ginger processors either buy their produce (raw material) from assemblers or directly from producers. They operate mainly on a small-scale basis and make use of rudimentary implements for their processing activities. Processed ginger products, especially ginger powder and ginger drink were widely sold and accepted in the study area but were only sold locally. All (100 %) of the ginger handled by wholesalers were in dry form. This is because fresh ginger has a short shelf life and is highly susceptible to pests and disease.

### **Exporters and Marketers**

This group of actors includes Wholesalers, Quills exporters, Value added product exporters, Retailers. Wholesalers were fewer in the market compared to other intermediaries. This is because of the huge capital required to run a wholesale ginger business. Some wholesalers enter into contractual arrangements with farmers. The wholesalers sell to retailers as well as exporters. The wholesalers sell to retailers as well as exporters. The retailers are the link between the marketers and the final ginger consumers or end users. They sell in small units to individual

consumers. They also obtain information on the quality and quantity of ginger desired by consumers and give feedback to the wholesalers. Many marketers also carry out processing activities like cleaning, sorting/grading, and bagging. Exporters buy ginger from collectors and processors. Then exporters sell ginger to the individual retailers and companies involved in ginger processing brokers and institutions.

### **Individual retail chain**

This group of actors includes Local Consumers, Bakery, Pharmaceuticals products, etc. Consumers are the final users of ginger and ginger products. About 15% of the total ginger produced is consumed in the country. The remaining 85% is exported. Ginger is used as a spice for food and confectionaries. It is sought after for its pungency and aroma. It is also consumed as drinks or as additives to spice local drinks. Some of the consumers interviewed believe that ginger has medicinal values for both man and animals. Ginger powder is added to food and animal feed as a supplement and consumed. There is increasing acceptance and demand for ginger and ginger products in the country due to rising health awareness.

### **Inbound and Outbound Logistics**

Inbound and outbound logistics both focus on the transportation of goods from one distribution network to another. Knowing how each process works is crucial to optimizing the supply chain, reducing logistics costs, and better managing customer expectations of the Ginger crop.

## **Chapter 5: Future Directions/Plans**

We have to build ontologies by considering the factors of built models. An ontology is a way of showing the properties such as formal naming, properties, definition, relation between the concepts, entities and etc. of a subject area and how they are related, by defining a set of concepts and categories that represent the subject.

Here we are going to use Agile Development Methodology for Ontology Development, because a novel agile development methodology for the development of ontologies by means of small



steps of an iterative workflow that focuses on creating well-developed and documented models starting from exemplar domain descriptions.

We are going to use a protege tool for the development of ontologies. Protégé is a free, open source ontology editor and a knowledge management system for creating, sharing, and visualizing web ontologies and taxonomies. So, we suppose to use the most popular ontology language called Web Ontology Language (OWL). Because one of the primary goals for generating web ontologies is to make data more shareable and accessible, visualization can be an essential component of the process. As part of its features, Protégé offers tools for transforming our ontologies into dynamic visualizations for sharing data structures and taxonomic features. These visualizations can also allow interactive navigation of the data, creating an intuitive way for collaborators to understand data structures and relationships.

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## Appendix

### Appendix A- Divulapitiya Organic Export Crops Growers

X farmer list updated 2021.09.08.xlsx					
Open with ▼					
A	B	C	D	E	F
Divulapitiya Organic Export Crops Growers Society					
	Neme of Growers	Address	Contact No	Total Extent (Ha)	Crop
1	A.H Kulasingha	Akkara 52,Batagama waththa,J-ela	770520503	20.8	Cinnamon
2	I. Basnayake	88,Bollatha, Ganemulla	714716340	2.8	Pepper
3	J.A.Harry Lionel Jayasuriya	303,"Jayaniwasa",Parakadeniya,Ibulgoda	715542825	1.6	Pepper
4	H.A.Dayawansa	Dunagaha Florist,Godigamuwa RD,Dunagaha	777290903	0.4	Pepper
5	E.A.G.Apasingha	Hapugahagama,Divulapitiya	313313234	1	Pepper
6	H.A.Margaritha	Godigamuwa,Palliyapitiya.Dunagaha	778182856	0.5	Pepper
7	W.A.A.I.I.M.N.Perera	278/c,Batepola,Dunagaha	777187793	0.8	Pepper
8	Sunil Athapaththu	Diya gampola,Kotadeniya wa.	777578762	4.2	Cinnamon/Pepper
9	S.D Kulakulasuriya	julis waththa,Ullalapolu,Divulapitiya	719452820	0.2	Pepper
10	A.A.S.G.Wicramasinghe	Varadala, Kotadeniyawa	719444137	0.4	Vanilla
11	M.P.Nimali Dilrukshi	154,Thammita waththa,Thammita,Hunumulla	773314925	0.4	Pepper
12	M.A.W.Kariyakarawana	Maddathanna waththa,Kandy RD,Wewaldeniya	777265686	16.8	Pepper/cinna.
13	J.S.T.Sadanayake	69,Kandewatha, Bothale Madagama, Meerigama	773204888	3.8	Pepper
14	G.A.N.M.Abesinghe	121,Giriulla Rd,Illana, Meerigama	777662433	2	Cinnamon
15	Priyan Herath	Vagollawatha,Loluwigoda, Meerigama	777756664	7	Pepper/cinn
16	H.P.L.M.Nimalasiri	178A,Dherananda Mawatha,Mugurugampala,Meerigama	779767662	6	Pepper/cinn
17	I.G.Jayalath Kumara	44,Hakurukumbura,Meerigama	716259096	2.8	Pepper/cinn
18	K.P.Ajith Nandasiri	61,Thalgahalandu waththa,Wewaldeniya	728030335	8	Cinnamon/pepper
19	E.M.Ginadasa	21/49H, Dadagamuwa, Veyangoda	717064179	0.8	Pepper
20	N.Hewapathirana	552/1,Pahalagama,Thihariya, Kalagedihena	712757442	0.2	Pepper
21	S.K.Ranathunga	Thriwanegama,Kalagedihena	777527998	0.4	Pepper
22	R.K.Kumarasinghe	308A,Waduramulla,Aththanagalle	718079410	0.4	Pepper
23	H.A.D.Jayantha Chandrasiri	296/1,Kaduboda,Deigoda	112403807	2.4	Pepper
24	D.A.Nandana Kusumsiri Ranathunga	323/1,Yongammulla,Yakkala	717316878	0.8	Cinnamon
25	K.A.H.Mangala Kariyapperuma	294,Dikwella Rd,Siyambalape	716512403	0.6	Pepper
26	K.A.S.C.Kuruppu	24,Marapola,Veyangoda	332289112	4	Pepper
27	S.A.M.A.P.P.Senanayaka	29,Marapola.Veyangoda	773440083	4	Pepper
28	R.A.Sarath Jayasiri Rajapaksha	39,Vigoda,Bemmulla	332287711	0.9	Pepper
29	Ranjan Wijayasingha	"Shanthasri",Vigoda,Bemmulla	716098247	0.6	Cinnamon

## Appendix B- Collectors details in Gampaha District

ගම්පහ දිස්ත්‍රික්කයේ දැනට ස්ථාපිත කම්රාන්ත පිළිබඳ තොරතුරු		
අනු අංකය	කම්රාන්තයේ නම, ලිපිනය, දුරකථන අංකය	මිලදී ගන්නා අමුද්‍රව්‍ය
01	The Urban Spice Shop පුද්ගලික සමාගම, 10, නුවර පාර වෙදමුල්ල, කැලණිය. දු. අ. 0112724491	ගම්මිරිස්, කුරුඳු
02	වින්දනාලේප, ආයතනය දුමමලගොඩුල්ල බංගලාවත්ත, පනාවල දු. අ. 033-2289203	කහ, ඉඟුරු, කුරුඳු, ගම්මිරිස්, ජේර, පැහිරි, කරාඬ
03	වෙන්වෙල් , පුද්ගලික සමාගම වෙවුල්දෙණිය, මිරිගම දු. අ. 033-2285575	කහ, ඉඟුරු, කුරුඳු, ගම්මිරිස්
04	සැනෝදා පුද්ගලික සමාගම වෙවුල්දෙණිය, මිරිගම දු. අ. 033-2269555	කහ, ඉඟුරු, කුරුඳු
05	Lakmali Food Products පුද්ගලික සමාගම. මිරිගම දු. අ. 077-97676662	කහ, කුරුඳු, ගම්මිරිස්, කරාඬ
06	Rainbow marketing පුද්ගලික සමාගම දියගම්පල, කොටදෙණියාව දු. අ. 077-7978762	ගම්මිරිස්, කුරුඳු
08	N S Traders පල්ලෙවෙල පාර, කල්පිටිය දු. අ. 033-2270324	ගම්මිරිස්, කුරුඳු, පුවක්, කහ, ඉඟුරු, කරාඬ, කෝපි
09	"SANMIC" පුද්ගලික සමාගම මැදගම්පිටිය දු. අ. 033-2298960	ගම්මිරිස්, කුරුඳු, පොල්, පොලොස්, අන්නාසි, අඹ
10	රසෝපා පුද්ගලික සමාගම එල්ලක්කල, චතුපිට්ටිවෙල දු. අ. 077-2547905	ගම්මිරිස්, කහ, කුරුඳු

11	නාමල් අධිකාරි 133 A , වර්නාපහ දු. අ. 077-7657904	කහ,ඉඟුරු
12	රසිකා පියංගනී අනුකෝරල 111 C, බෝටියාවත්ත, මිනුවන්ගොඩ දු. අ. 0112-280133	ගම්මිරිස්,කුරුඳු,කහ
14	PODDIE පුද්ගලික සමාගම 33/3, වෙස්ටර් සිමන් වත්ත, උතුරු කදිරාන, දෙමත් හංදිය දු. අ. 031-2233773-5	ගම්මිරිස්,කුරුඳු,කහ,ඉඟුරු
15	Orient Trading පුද්ගලික සමාගම උඩුපිල , දෙල්ගොඩ දු. අ. 0112-403088	ගම්මිරිස්,කුරුඳු,සාදික්කා,කරාඬු, වසාවාසි
16	Prime Lanka Exporters 17/1B , හින්සන් ඒල, වැලිවේරිය දු. අ. 077-3666910	කුරුඳු,ගම්මිරිස්
20	New Central Traders කල්එලිය දු. අ. 033-2270309	ගම්මිරිස්,කුරුඳු,පුවක්,කහ,ඉඟුරු,කරාඬු,කෝපි
21	Munnas Traders මිරිගම දු. අ. 077-6523086	ගම්මිරිස්,කුරුඳු,පුවක්,කහ,ඉඟුරු,කරාඬු,කෝපි
23	M.I.M. ඉක්කල් ලංකා වැනිලා හා ඉඟුරු සැකසීමේ මධ්‍යස්ථානය කහවෝට්ට, වේයන්ගොඩ. දු.අ. 076-5457381	වැනිලා, ඉඟුරු



## Appendix C- New planting Register Data

Postal Address Line 3	GN Division of the Land	Applicant's ID Number	Applicant's Phone Number (Optional)	Requested Crop	Requesting Area (Ha)
Meerigama	Henepola	1 97307004399	773782525	Cinnamon	0.4
Ambepussa	Andagala kanda	751041420		Cinnamon	0.1
Ambepussa	Andagala kanda	572824926		Cinnamon	0.2
Loluwigoda	Loluwigoda	721603695	702633249	Cinnamon	0.2
Yakkala	Wewaldeniya	897141272	717133128	Cinnamon	0.8
Ragama	Nalla	1 99853403080	771367293	Cinnamon	0.4
Meerigama	Palmada	837780560	778944454	Cinnamon	0.235
Loluwigoda	Giriullagama	660284494	779377124	Cinnamon	0.25
Pamunuwatththa	Pamunuwatththa	625744318	770035284	Cinnamon	0.6
Danowita	Siyabalagoda	802110049	776102195	Cinnamon	0.3
Danowita	Ihalagama Madabawita	770352878	774684812	Cinnamon	0.2
Nittambuwa	Panawala	620300314	777929977	Cinnamon	0.4
Danowita	Kotadeniya	1 96975001037	774305943	Cinnamon	
Danowita	Weragoda	761920316	776189707	Cinnamon	0.13
Wewaldeniya	Wewaldeniya	701792440	777550594	Cinnamon	0.4

Requested Crop	Requesting Area (Ha)	EO/DO Name	Preliminary Inspection Year	Preliminary Inspection Month	Preliminary Inspection Date
Cinnamon	0.4	R.M.K.S.Rathnayaka	2021	February	6
Cinnamon	0.1	R.M.K.S.Rathnayaka			
Cinnamon	0.2	R.M.K.S.Rathnayaka		February	17
Cinnamon	0.2	R.M.K.S.Rathnayaka	2021	February	3
Cinnamon	0.8	R.M.K.S.Rathnayaka	2020	March	26
Cinnamon	0.4	R.M.K.S.Rathnayaka	2021	May	6
Cinnamon	0.235	R.M.K.S.Rathnayaka	2021	September	11
Cinnamon	0.25	R.M.K.S.Rathnayaka			
Cinnamon	0.6	R.M.K.S.Rathnayaka	2021	March	5
Cinnamon	0.3	R.M.K.S.Rathnayaka	2021	September	18
Cinnamon	0.2	R.M.K.S.Rathnayaka			
Cinnamon	0.4	R.M.K.S.Rathnayaka	2021	February	27
Cinnamon		R.M.K.S.Rathnayaka			
Cinnamon	0.13	R.M.K.S.Rathnayaka			
Cinnamon	0.4	R.M.K.S.Rathnayaka			
Cinnamon	0.1	R.M.K.S.Rathnayaka			
Cinnamon	0.2	R.M.K.S.Rathnayaka	2020	February	15
Cinnamon	0.4	R.M.K.S.Rathnayaka			
Cinnamon	0.1	R.M.K.S.Rathnayaka			
Cinnamon	0.2	R.M.K.S.Rathnayaka	2020	February	17

## Appendix D- Ginger/Turmeric cultivation survey

GigerTurmeric - final 2020.09.14 -.xlsx												Open with
A	B	C	D	E	F	G	H	I	J	K	L	
Turmeric/Ginger Cultivation Survey - 2020												
Department of Export Agriculture												
District- Gampaha												
NO	EOs Division	GN Division	DS Division	Name of the Farmer	Address	N.I.C.No.	Tel.No.	Cultivated Extent (Kg)	Cultivated Extent (Kg)	Cultivated Extent (Ha)		
								Turmeric	Ginger	Turmeric	Ginger	
1	Dompe	Maddegama South	Dompe	D.P.A.P. Jayalath	20/A.Maddegama,Kiridivela	601880237 v	033-2247663		32	0	0.0256	
2	Dompe	Maddegama	Dompe	R.A.Chamida sampath	167 , Maddegama, North ,Kiridivela	198319000415	071-1729149	10	25	0.006666666	0.02	
3	Dompe	Maddegama North	Dompe	H.W.D.Wasantha jayanandura	22/2 ,Maddegama/a,Kiridivela	730430680 v	033-2267797	10		0.006666666	0	
4	Dompe	Maddegama	Dompe	J.A.D.G.jayakodi	100/3 ,Maddegama,Kiridivela	772931638 v	071-0712289	10		0.006666666	0	
5	Dompe	Maddegama South	Dompe	R.A.Renuka D. Rupasinhe	54/a ,Maddegama,Kiridivela	668601049 v	071-3589527	10		0.006666666	0	
6	Dompe	pananwala	Dompe	S.D.Chandrasiri	Wedewaththa,Halammahara,Dekatana	672930472 v	011-2403829	10		0.006666666	0	
7	Dompe	pananwala	Dompe	E.A.A.D.M.P. Wijesinghe	22, Pananwala, Delgoda	731691100V	011-2402047	55		0.036666666	0	
8	Dompe	pananwala	Dompe	R.A. Chandra	3/A, Wanniyawaththa , Delgoda	541401660V	011-2402782	50		0.033333333	0	
9	Dompe	halumamahara	Dompe	M.M.A.D.C. Hemalatha	103/2, Halumamahara, Dekatana	537732334V	011-2402562	15		0.01	0	
10	Dompe	halumamahara	Dompe	M.A.A.S. Abhayawickrama	107/1, Halumamahara, Dekatana	451850628V	011-2403226	10		0.006666666	0	
11	Dompe	halumamahara	Dompe	T.A.Kamal Premalal	76/1, Halumamahara,dekatana	610952224V	072-6220821	15		0.01	0	
12	Dompe	Radawana /S	Dompe	M.A.A. U.P. Amarasekara	466/A, Epitawaththa, Radawana	197805602285	071-6775052		150	0	0.12	
13	Dompe	Radawana / S	Dompe	M.Shanika Priyangani	461/Hospital Road, Radawana	887682151V	033-2268198		125	0	0.1	
14	Dompe	Diyyewala	Dompe	W.P. C. Samaranyaka	2, Diyyewala, Kirindivela	610950485V	071-1044424		300	0	0.24	