Supply chain of fruits and vegetables and correlated impact of managing the quality

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Abstract—Fruits and vegetables processing, trading and marketing require some vital support of integrated supply chain management system. Due to its perishable nature and more consistent application of quality standards, the organizations involved in business of these horticultural commodities have to face colossal quality problems. Therefore, one of the purposes of this research study was to collect information regarding current processing practices and quality attributes applied. For this purpose, an exploratory and qualitative research study was carried out by using the pre-tested questionnaire and to collect information from various organizations dealing in supply chain of these horticultural commodities.

I. INTRODUCTION

FRUITS and vegetables are perishable in nature and cannot be stored for longer periods, which result in very sensitive and complicated trading of these horticultural commodities and exposing big challenges to suppliers, processors and traders. In addition, the inconsistent availability of healthy fruits and vegetables from farm-gate to the consumers, continuous quality assurance push by the traders and supermarkets, competitive global environment, increasing trend of better supply by companies of other competitive countries and also more and more implications of quality standards (FruitVeB., 2008) are also other parallel competitive elements making this business more vulnerable and complex. Fruits and vegetables require certain effective post harvest management practices for better quality and ultimate price. Therefore, to cope with these challenges, the only integrated way to be applied from farm gate collection through washing, grading, packaging, storage and marketing to ultimate consumers is to establish the consistent and sustainable supply system of “Farm-To-Fork Approach”, currently transformed as Supply Chain Management (SCM).

Globally, the demand of fruits and vegetables is increasing like anything due to dietetic potentiality, which thereby, augmented the annual production and also enhanced the exports and imports of these horticultural commodities around the globe. According to Statistical Yearbook of FAO (2009), the world production of fruits and vegetables in 1996 was 98.0 million tons which increased to 146.0 million tons in 2007. Similarly, in 1996, the total exports were 20.0 billion US$ which then increased to 44.0 billion US$ in 2007, whereas, imports of these fruits and vegetables were 25.0 and 49.0 billion US$ in the same years, respectively.

In case of food sector, supply chain starts from farm-gate collection of raw materials, then processed and prepared and the finished goods continue downstream to regional and global distribution centers and finally enter retail stores, where they come in contact with the customers for consumption. In general, SCM is one entity, which helps foster to manage and meet customer needs by improving every element of the supply chain, whereas, the role of food safety, quality requirements and their evaluation in international trade is also receiving more and more attention. Among the components of consumer behaviour, motives related to safety are getting stronger and as a result, an increasing attention is given to the interrelations of food safety, quality, supply chain and ethical issues (Joszef et al., 2009).

Presently, food markets are becoming globalised and food trade more and more concentrated and internationalized, but at the same time, quality assurance and traceability requirements against suppliers have also increased significantly (Spriggs, 1999). Increased food safety requirements are now expected to exercise more strongly on fresh products (Unneverh, 2000) due to the fact that food safety and quality components have an outstanding role with respect to fresh products supplied through marketing channels. Similarly, more safe food demands, traceability and inspection in the developed countries are higher than in countries of medium level and developing one. Risk and uncertainty have been the hallmark of these horticultural products and food business. A long gestation period, seasonal production, significant transportation and logistical costs, the low value/weight ratio, poor infrastructure and the lack of any effective legal system to enforce fair trading, accentuates risk and uncertainty along the supply chain (Trienkens and Van der Vorst, 2007).

The new age consumers are becoming more health conscious in terms of hygiene, source of the food, ingredients of processed food and caloric content. Food safety and quality requirements have an increasing importance around the globe (Kalei, 2008). Dissemination and introduction of the quality assurance systems such as GLOBALGAP, International Food Standards (IFS), Hazard Analysis Critical Control Point (HACCP) etc., as an urgent task, have become integral parts for both production and trade (Biacs, 1999). Without the realization of these systems, efficient marketing can be performed neither on the domestic nor on the international market (Tomcsanyi, 1999).
A. Problem of the Study

The thematic approach of SCM in this business is to provide wholesome quality fruits and vegetables to even distant consumers without distorting taste, texture, color also the size of these horticultural commodities. Whereas, an effective application of quality management systems and the flow of efficient and accurate information both upstream and downstream and also an efficient application of SCM system of fruits and vegetables has not been designed to its heart due to the lack of detailed study and development and standardization of particular business process involved in the quality management throughout the whole chain from harvesting to consumer's end.

B. Scope of the Study

Keeping in view the appropriate scope and objectivity and thereby prospective applicability, instill quality and sustainability in supply chain, a research study entitled “Supply chain of fruits and vegetables and correlated impact of managing the quality” was carried out. The main purpose of this study was to chalk out the flaws which are being faced by the various organizations in managing the quality of these perishable horticultural commodities in the supply chain from Farm-To-Fork and also to bring the wholesome fruits and vegetables to the consumers door step in order to satisfy them.

C. Objective of the Study

The objective of this study was: To chalk out the quality-oriented gaps present in the current supply chain of fruits and vegetables in the form of AS-IS and TO-BE Approaches and also to re-design and propose new business processes to develop an impeccable supply chain system.

II. REVIEW OF LITERATURE

Fruits and vegetables are critical source of nutrients and other substances that help protect against chronic diseases, including heart diseases and cancer, stroke and other chronic diseases (Prior and Cao, 2000; Produce for Better Health Foundation, 1999; Quebedeaux and Elisa, 1990; Southon, 2000; Tomas-Barberan and Robins, 1997). Fruits, and vegetables play a significant role in human nutrition, especially as sources of vitamins (C, A, B6, thiamine, niacin, E), minerals, and dietary fiber (Quebedeaux and Bliss, 1988). Their contribution as a group is estimated at 91% of vitamin C, 48% of vitamin A, 30% of folacin, 27% of vitamin B6, 17% of thiamine, and 15% of niacin in the U.S. diet. Fruits and vegetables also supply 16% of magnesium, 19% of iron, and 9% of the calories. Other important nutrients supplied by fruits and vegetables include folacin, riboflavin, zinc, calcium, potassium, and phosphorus. Some components of fruits and vegetables are strong antioxidants and function to modify the metabolic activation and detoxification disposition of carcinogens, or even influence processes that alter the course of the tumor cell (Wargovich, 2000).

Due to their potential goodness for health, the demand of these horticultural commodities is extensively increasing as the consumers are becoming more aware of health risks and health related issues. Food business is the largest business of the world and with the marvelous growth of cash and carries and super markets, as a componential part of this business, the trading of fresh fruits and vegetables is also becoming an essential entity for these business giants due to the rise in customer expectations and time arrests. Fruits and vegetables require impeccable post harvest management practices to manage life and ultimate quality. In this regard, number of techniques are being used through-out the world which include storage at low temperatures, cold and hot water treatments, vapour heat treatment, controlled atmosphere storage, modified atmosphere packaging etc. and due to the stringent quality parameters being applied by most of the countries, the need for cold chain trend is also becoming more intensive.

Hicks (2002) found that modern food packaging technology brings traditional foods into a global arena which increasingly emphasizes their commercial and economic aspects. This means that food and packaging technologists become involved in the entire food supply system. This system ranges from the sea, village farm, plantation, to the markets and consumers in towns and cities, not only in their own country, but also in distant overseas markets. The surplus foods grown in the village have a need to be more carefully harvested, protected from spoilage and damage, packaged, and transported by various means to these markets.

Climatic conditions, especially temperature and light intensity, have a strong effect on the nutritional quality of fruits and vegetables. Soil type, the rootstock used for fruit trees, mulching, irrigation, fertilization, and other cultural practices influence the water and nutrient supply to the plant, which can affect the composition and quality attributes (appearance, texture, taste and aroma) of the harvested plant parts (Goldman et al., 1999). Maturity at harvest and harvesting method influence the commodity’s quality and extent of physical injuries. Delays between harvest and consumption or processing can result in losses of flavor and nutritional quality. The magnitude of these losses increases with exposure to temperatures, relative humidity, and/or concentrations of oxygen, carbon dioxide, and ethylene outside the ranges that are optimum for each commodity during the entire postharvest handling system (Lee and Kader, 2000).

Management intensive application helps to add more value in the supply chain in the form of quality, timeliness, food safety and labour. This has technological, organizational and managerial implications that resound along the chain all the way to upstream and downstream. Value creation potential of an individual firm can be enhanced, in some cases, through a more collaborative relationship with its suppliers and customers, provided that trust and commitment is developed. Herlambang et al. (2009) studied the effectiveness in the supply chain and its relation to the satisfaction level of ultimate customers. Sub-effectiveness could occur if each actor in a supply chain attempts to optimize its own results.
rather than to integrate its goals and activities with other actors to optimize the results of the entire chain. In this case study on Manalagi mango fruit supply chain in Indonesia, the researcher used price-margin analysis, gap analysis and relationship analysis to explore the effectiveness of the chain. He found that a high level of certain activity cost in the supply chain could indicate the inefficiency built into that activity. The perishable nature of fresh fruit made particular actors in the supply chain can damage all the efforts taken in another stage to deliver more value to customers. Thus, effectiveness is derived from the sum of the contributions of all participants along the chains.

Most of the food we eat derives from crops and livestock (Knight et al., 2002) that are formed specifically for that purpose. With the exception of fish, game and some wild nuts, berries and fruit almost everything else comes initially from crops and livestock. From a wide range of process and production systems, some of which are highly complex and requiring considerable technical input come a vast array of products which are now food on the modern food retailers’ shelves. The term “Food Chain” is usually reserved for an understanding of the total supply process from agricultural production, harvest/slaughter, through primary production and/or manufacturing, to storage and distribution to retail sale or use in catering and consumer practice. Many sectors in the food chain now recognize advantages in working partnerships to realize the maximum benefits of a safe, wholesome and efficient food supply business (Adebanjo, 2004).

In today’s environment there are a number of reasons why a total integrated food chain approach is necessary including establishing specifications, food safety systems and traceability. It is important that for those in the manufacturing part of the chain, clear specifications are established for raw materials and ingredients such that they meet the requirements for further processing. This relates to both quality attributes and food safety. It is also most important to ensure consistency in developing final products, in terms of keeping and eating quality and traceability (Barrett, 2004). Wysocki (2005) delineated that these are both evolving and challenging times for food distribution and retailing and now the same consumers are behaving in so many different ways due to more shopping experience, awareness, number of varieties and more expectations and quick response from the organizations for marketing.

Hughes and Merton (1996) pointed out that consumers are turning increasingly away from specialist retailers towards supermarkets for their fresh produce requirements, and looks at how supermarket chains are responding. Grimsdell (1996) examined the supply chain of various horticultural commodities which was developed efficiently by British Field Products Ltd, over the year. He outlined the six fundamental requirements for an efficient supply which were scale of operation; strategic alliances, production, flexibility, continuity of supply, quality control and communications and concluded that mutual awareness by all the stakeholders was one of the best ways forward for sustainability. SCM is not a thinking but is a paradigm, characterised by operational effectiveness and efficiency and based on concept of power, value appropriation and robust way of understanding (Cox, 1999).

Fresh-produce consumption has been favorably affected by demographic trends including declining household size, rising income levels, the consumption habits of baby boomers, and growth in the number of consumers. Better quality, increased variety, and year-round availability also have helped boost consumption. Packaging technology adds convenience in the form of precut, ready-to-eat products. In today’s system, large retailers have increased their market shares by establishing competitive advantage in areas such as logistics (Hinson, 2005). SCM is a collection of management activities exercised between vertically related firms to improve efficiency, vertical coordination, and overall performance and competitiveness of the participating firms within an industry. Therefore, the research focused on structural change and its impacts in the fruits and vegetables industry has targeted the larger players in the industry, with less attention paid to the impacts of change on mid- and smaller-sized companies or their actions to effectively manage in this environment (Ricks et al., 1999).

Sustainable and wholesome supply of food and food products, availability and fulfilling the implied needs of customers are actually the areas to be focused rationally in global trading. Quality and food safety are the most integrated activities, embedded with each other. For agri-food products, quality may be regarded as a complex characteristic of foods that determines its value and acceptability by consumers. Quality is the ongoing process and in case of horticultural commodities, quality cannot be improved after harvest, only maintained; therefore it is important to harvest fruits and vegetables at the proper stage and size and at peak quality. Hygiene and safety and nutritional and organoleptic sustainability accompanied by convenience to use and satisfaction and pleasure are the prime important parameters to be maintained. Supply chain management is the only paramount outlet, help managing the uniform quality and regular availability of safe food everywhere (Sackey et al., 2001).

Different scientists have done good contribution in this regard. For example, Talamini et al. (2005) studied about the growing concern about food safety and indicated that supply chains play predominant role in the productive process. SCM may contribute substantially toward a more uniform process throughout the chain, facilitating the sharing of information and productive practices. Stringer and Hall (2006) studied the generic model of the integrated food supply chain to aid the investigation of food safety breakdowns. He found that increasingly it is becoming important to study and manage various aspects of food production in relation to the total food chain implications and not one stage in isolation. Food safety management systems (CCFRA, 2003) are now built on a detailed understanding of all input variables to the manufacturing process. The internationally recognized approach for assuring food safety is HACCP (Hazard
Analysis Critical Control Point), requires an intimate understanding of the interaction between process and product and the identification of critical control points in the manufacturing process, through distribution and storage and including consumer practices.

The progressive liberalization of world trade has created opportunities for Pakistan (Mustafa, 2008) to become integrated into the global trading system and to exploit its national and regional comparative advantages. Pakistan has a potential comparative advantage over developed countries in the production of many agricultural products, such as cotton, rice, fruits, vegetables, flowers etc. However, to maintain or expand its world market share and ability to meet the demands of the world trading system, quality of exportable products and their safety standards and Sanitary and Phytosanitary (SPS) measure (Sheik et al., 2005).

Warriner (2009) found that food borne illness outbreaks linked to fresh produce are becoming more frequent and widespread. High impact outbreaks, such as that associated with spinach contaminated with Escherichia coli O157:H7 resulted in almost 200 cases of food borne illness across North America. Minami et al. (2009) conducted a study in Thailand (Bangkok and Pathum Thani provinces), from June 2006 to July 2007, in order to assess the prevalence of Listeria monocytogenes, Escherichia coli O157, Salmonella, Shigella and Vibrio parahaemolyticus in foods. Retail raw meats and seafood, including chicken (n = 109), pork (n = 80), beef (n = 108), shrimp (n = 43) and oysters (n = 48), from open markets and supermarkets were analyzed. Salmonella was found in 22 of 61 (36%) open market samples (48% of chicken, none of pork and beef, and 53% of shrimp) and in 12 of 75 (16%) samples from supermarkets (57%, 12%, 24%, 0% respectively). However, a small number of Listeria monocytogenes were isolated, where 6 of 217 (3%) were samples from open markets (6% of chicken and 3% of pork) and 17 of 171 (10%) were from supermarkets (3% of beef, 4% of chicken, and 32% of pork). In both markets, L. monocytogenes was not detected from shrimps, neither from oysters. E. coli O157, Shigella and the-positive V. parahaemolyticus were not isolated in this collection. Several Salmonella and L. monocytogenes isolates were multidrug-resistant (Boer, 1998).

Mergenthaler (2009) studied the implementation of different quality assurance programs (QAPs) and their impacts on international market for horticultural processing firms in developing countries. A representative survey of 50 registered firms processing horticultural produce in Vietnam was conducted. Logistic regression models were used to analyze the effects of QAPs and other firm level factors on participation in different export supply chains. It was found that QAPs influence firms’ participation in export supply chains significantly. While the implementation of internationally recognized QAPs improves access to OECD markets, national QAPs are more important for exports to non-OECD countries. Similarly, Murphy et al., (2004) concluded that horticultural processing firms in developing countries can improve their access to export markets when they implement formal QAPs.

In a case of two supply-chain development projects in Thailand: TOPS Thailand and Fresh Partners: related to Introduction of food safety standards for the domestic market and Development of an integrated quality chain for the export market, respectively, Buurma and Saranark (2007) analyzed 50 supermarkets in Bangkok and Chiangmai. The management decided to introduce a certification system for food safety in order to improve their competitive position and to consolidate their image of a quality supermarket. The introduction resulted in a system of preferred suppliers that had to obtain a certificate for good agricultural practices from the Department of Agriculture. The number of suppliers sharply dropped in the course of the project period. Fresh Partners Thailand is an export company shipping exotic vegetables from Thailand to The Netherlands and surrounding countries in Europe. The management decided to develop an integrated quality chain in order to comply with the increasing food safety requirements in the European Union and Japan. The investments in quality systems coincide with a growing demand for exotic vegetables in northwestern Europe. Consequently export volumes and numbers of smallholders and laborers are rapidly growing.

III. METHODOLOGY

This research study was carried out in the Department of Information Systems, Corvinus University of Budapest. The main purpose of this study was to examine the current practices of quality assurance being applied in SCM of fruits and vegetables in Hungary and to chalk out the gaps and exploring and recommending the prospective quality-oriented business processes required for an integrated system from farm-gate to consumers end. The Figure 1 depicts the generic elements/activities of SCM of fruits and vegetables.

In order to conduct this research work and to collect the primary data, this field study was carried out by visiting the organizations mentioned below, which are involved in the current system of supply chain of various fruits and vegetables in this country.

- Hungarian Interprofessional Organization (FruitVeB, Hungary) for Fruit and Vegetables, Budapest, Hungary.

For the purpose to collect information, a questionnaire technique was applied by using pre-tested questionnaire and
taking interviews from the management of these organizations and exploring the flaws available in current SC of fruits and vegetables. This technique also helped to explore and chart out the intra and inter business processes gaps throughout the whole chain of these perishables and to measure the differences between AS-IS and TO-BE approaches, of each process involved.

ADONIS Tool is one of the best techniques used to design, develop, link and translate all the old and new processes, activities and sub-activities of SCM into integrated models. It helps to streamline these processes and to restructure the co-operation and supports effort and help reducing the cost. Through its intuitive user interface and as a powerful analyzing mechanism (such as simulation, personnel resource planning, activity-based costing), it emerges as an ideal corporate business process management tool (ADONIS, 2009).

As the pivotal tracking role of this part of study was to bridge the gaps present in the current quality assurance business process in the form of AS-IS (Field Study) and to devise and suggest the most appropriate and interacted link/model in the form of TO-BE Approach for improvement and more compatibility.

IV. RESULTS AND DISCUSSIONS

Presently, food markets and food trading are becoming globalised and more and more concentrated and internationalized, but at the same time, quality assurance and traceability requirements against suppliers have also increased significantly. Increased food safety requirements are now expected to exercise more strongly on fresh products due to the fact that food safety and quality components have an outstanding role with respect to fresh products supplied through marketing channels. Similarly, more safe food demands, traceability and inspection in the developed countries are higher than in countries of medium level and developing countries.

Food safety and quality requirements have an increasing importance in international trade. Dissemination and introduction of the quality assurance systems such as GLOBALGAP, International Food Standard (IFS), Hazard Analysis Critical Control Point (HACCP) etc., as an urgent task, have become integral parts for both production and trade. Without the realization of these systems, efficient marketing can be performed neither on the domestic nor on the international market (Tomcsanyi, 1999).

The new age consumers are becoming more health conscious in terms of hygiene, source of the food, ingredients of processed food and caloric content (Loader and Hobbs, 1999). Food safety has become a primary concern across the world (Crespi and Marette, 2001). The food industry has become vast and diversified, categorized by different segments such as fresh food industry, organic food industry, processed food industry, livestock food industry, etc. All these segments are unique in nature and are interlinked with each other. Each segment needs different supply chain solutions such as procurement and sourcing, inventory management, warehouse management, packaging and labeling system, distribution management etc. (Kalei, 2008).

Therefore, the relation of quality assurance with supply chain management is vital important to develop a food system and sustainable marketing. In this study, application of both physico-chemical analysis (colour, flavor, size or volume or weight, peel thickness, taste, internal pressure of fruits, percent acidity and juice yield of fruits and damage occurred during transportation, presence/absence of fruit fly eggs etc.) and microbiological quality control for prevalent microorganisms such as Total Plate Count (TPC) for bacteria, Escherichia coli, Salmonella, Listeria monocytogenes, fungi etc. and quality assurance standards such as Hazard Analysis Critical Control Point (HACCP), International Food Standards (IFS) and GLOBALGAP, which are prime important to develop integrated system of supply. Similarly, the information regarding physical treatments of various fruits and vegetables such as Vapour Treatment (VHT), hot water treatment including time and temperature, freezing treatment of citrus fruits for particular time and temperature and quarantine certificate required for export are those phrases or information which would help generating and transforming different questions related to quality and sustainability of this system (EC, 2002).

Quality assurance (QA) is a process to add reliability in the products or services. The Institute of Food Science and Technology (IFST, 1998) defines QA as a process to design and plan, as relevant, raw material specifications, ingredients formulation, processing equipment and environment, processing methods and conditions, intermediate specifications, appropriate packaging and labeling specifications, specifications for quantity.

QA can be a tool to demonstrate regulatory compliance; business efficiency tool to ensure product quality and minimise hygienic risks and communication tool to customers and consumers, globally (Baines and Ryan, 2002) and characterized as the assurance wholesome of a product by means of a system which will manage quality and the product or the prevention of quality problems through planned and
systematic activities. Therefore, Manning (2006) delineated that quality Assurance standards are considered to be a proven mechanism for delivering quality of product and service. He analysed critically how effectively this mechanism has been implemented in the integrated food supply chain and concluded that compliance with a set of extrinsic quality standards are pre-requisites in determining the mechanism of supply with particular emphasis on poultry meat.

Quality and health risks are inversely proportional to each other. Stricter the quality, the lesser will be the risks. Owing to perishability, the fruits and vegetables are also inflicted with many microorganisms, if post harvest management practices starting from harvesting or picking, keeping, cooling, loading, transportation, receiving, washing, packaging, storage etc. are not applied appropriately. Mishandling, bruising and poor transport and cold store facilities etc., invite the various pathogenic microorganisms to attack which trigger the conditions for health risk to create in the supply chain and ultimate decline in business.

Food system (Figure 3) is an integrated approach which helps to provide food to the consumers table by involving all the stakeholders such as suppliers, research institutions, processors, traders, government agencies and regulations, importers, exporters, wholesalers and customers. When this system is packed up and bounded with quality assurance standards (Due Diligence Defence or 3D) and integrated business processes, then it is named as safe food system or supply chain management (Figure 4). Safety and reliability in supply chain and afterward in the product while purchasing and using, can only be possible by applying the shield of Due Diligence Defence. This 3D approach also helps to develop a brand image of an organization, marketing and ultimate customer satisfaction and good profit.

Quality assurance systems in the food industry have developed from generic standards, such as ISO 9000 and HACCP, to systems specific to the food industry and its subsectors. New national and international rules require increased vigilance on the traceability and quality of inputs processed. Examples are the Dutch QC standard (Quality Control of Feed Ingredients for Animal Feed), the British Retail Consortium (BRC) technical standard for companies supplying retailer branded food products, the Global Food Safety Initiative (GFSI), and the German Quality and Safety (Qualität und Sicherheit GmbH, QS) standard.

These systems build on quality management principles such as the ISO 9000 system and the HACCP concept. They involve quality management principles in processing and distribution and good practices for agriculture. In parallel to the BRC standard, the German retail sector is currently developing an international standard for auditing of private labels products. By outsourcing the auditing according to this standard by third-party certifiers, the German retail industry hopes to reduce the need for and the costs involved in individual audits of private label manufacturers.

In order to restore consumer confidence in meat products, the German meat sector has created the QS label. This label involves firms starting from farm suppliers over individual farms, slaughterhouses, and meat processors up to retailers. Launched after the BSE crisis in 2000/01, the QS system introduces a system of process control and traceability for meat and meat products. The QS system requires documentation and consists of three layers of control: self-auditing, firm audits by independent auditors, and accreditation of auditors. As of March 2003, 869 companies have enrolled in the QS system (QS GmbH, 2003).

However, Critics claim that standards fixed within the QS system do not go far enough beyond legal requirements. The system as such does not lead to a differentiated, high-quality product. The recent case of dioxin contaminated feed in eastern Germany has shown that the QS system leaves gaps in the supply-chain management of quality. While the identified feed producer in Thuringia was not certified under the QS system, he delivered feed ingredients to feed mills participating in QS. Those participating feed mills only rely on self audits and few regulatory controls (Handelsblatt, 2003). Additional problems relate to the fact that the system tries to cover all actors of the meat production chain. As a result, vigilance may not be at its best and moral-hazard problems may reduce care-taking actions of participating firms. Due to its wide scope, the differentiation of products does not seem possible and because of free-rider problems, the investment in reputation may be at risk.

Garetn Ltd, being a quality conscious pack house also uses to put continuous efforts to practice and maintain the spirit of all the related quality assurance systems in their four accredited cold stores in order to develop competitive strength and deterrence. For example, Garten Cold Store, Tiszakecsketiszabog has been accredited for International Food Standards (IFS) and GLOBALGAP certificates in 2007, Garten Cold Store, Nyirtelek-Gyulatanya for HACCP and GLOBALGAP certificates in the same year and Taszsagi-Mesz Cold Store and Szentesi-Zoldker Cold Store for GLOBALGAP certificates both in 2009. Figure 5 shows the details of all the unit operations involved in quality assurance and quality control during processing and packing of fresh fruits and vegetables. As, quality control is the part of quality assurance, which helps to add excellence in product by analyzing both physic-chemical and microbiological quality during processing. So Garten Ltd. needs to establish these
laboratories within their units instead of getting samples analysed from out-side laboratories to get consistent analysis, in all its cold stores as a part of TO-BE unit operation in quality assurance business process.

V. DISCUSSION

Fruits and vegetables processing, trading and marketing require some vital support of integrated supply chain management system. Due to its perishable nature and more consistent application of quality standards, the organizations involved in business of these horticultural commodities have to face colossal quality problems. Therefore, one of the purposes of this research study was to collect information regarding current processing practices and quality attributes applied. For this purpose, an exploratory and qualitative research study was carried out by using the pre-tested questionnaire and to collect information from various organizations dealing in supply chain of these horticultural commodities. On the bases of this study the current situation of supply chain was analyzed which helped to chalk out the gaps present in current (and the and also helped to analyze and measure the gaps between AS-IS and TO-BE approaches).

It was concluded from this study that some of the unit operations of quality assurance in SCM were not applied and practiced completely which result in quality gaps throughout the whole chain. Therefore, in order to develop closely integrated system of supply chain of fruits and vegetables and subsequently, bridging the gaps between current AS-IS and TO-BE approaches of SCM, there is a dire need to implement the quality management system from harvesting through consumer’s end in order to develop safe food management system.

VI. RECOMMENDATIONS

Owing to perish ability, increasing trend and global demands of fruits and vegetables, the integrated approach of supply chain from farm-to-fork is the only way out to fulfill the implied needs and expectations of customers. In this study, a new method was developed by using mind mapping technique, in order to collect information, a field study was carried out by using this methodology and then ADONIS tool was applied to chalk out the gaps and also to develop the prospective business processes which were required to help in developing the holistic approach of supply chain management of fruits and vegetables. After completing, the following recommendations based on the findings of this study were made, which are discussed below:

A. Policies for strategic competitiveness

The growers of fruit and vegetables must be restricted strongly to purchase plant nursery of fruits and seeds of vegetables from the certified nurseries and suppliers. Effective participation by the government authorities in international standard setting (e.g., participation in international, regional and national codex committees) is a must to develop a base and establish a platform of SCM of fruits and vegetables in Hungary.

A regional level database of cases/ experiences of health risks due to food borne diseases must be maintained by the agricultural statistics department for information which could be used in risk assessment and standard setting process both by concerned government agencies and pack houses.

In order to have an effective SCM, capacity building for compliance of GLOBALGAP, IFS and HACCP is highly important to translate the specifications to last level of an organization. In this regard, Government of Hungary must strengthen the related national and regional institutions, in order to provide training of various standards and bar coding, help to conduct risk analysis and testing and monitoring and enforcement of standards and also to carry out certification.

As an effective SCM triggers with planning from planting-to-produce, best pre-harvest practices such as application of GLOBALGAP must be made mandatory for each grower, for ultimate produce traceability. Otherwise, fresh produce pack houses of competitive countries of EU like Spain, Holland, Italy etc., are intruding more in national market, creating problems for local growers and sweeping out their market benefits due to better pre and post harvest management practices and supply chain system.

B. 2. Harvest management practices

The essence of supply chain management is to reduce the lead time to appropriate level from harvesting/ picking through packing and marketing of these horticultural commodities. Whereas, delayed harvesting, transportation and arrival at various cold stores or pack houses for further processing, affect adversely on the quality of fruits and vegetables due to the presence of field heat for a longer period. So refrigeration transport or efficient field heat removal technique must be applied immediately by pack houses or large growers at farm level after harvest, to prevent any damage to crop.

C. 3. Sustainable availability of risk free produce

Continuous quality control-push by the traders and supermarkets and more implications of quality standards, making this business more vulnerable and complex. So in order to establish deterrence and sustainable supply chain system, the pack houses must be more committed towards application of all required quality standards and instilled quality control laboratories in their premises, for routine physico-chemical analyses including pesticide residues and sensory evaluation, true to spirit, as a part of TO-BE approach in SCM. As an integral component of SCM, this vital activity will also help tracing back any health risk if it could occur in whole supply chain.

Integrated SCM also demands for all the business partners such as suppliers, processors and customers to sit together and join heads twice in a year, to cooperate and make future developments in order to target market needs and promotion of their products and branding.
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Fig. 1. Elements of Fruit and Vegetables SCM (Buy: Purchasing of fresh fruits and vegetables; Make: Processing as finished products or packed as required; Fulfill: Ensuring that customers receive these produce)
Fig. 2. Flow chart – Business processes of SCM of Fruits and vegetables
Fig. 3. Concept of Food System in SCM