New Agriculture for a New Generation: Recharging Greek Youth to Revitalize the Agriculture and Food Sector of the Greek Economy

Task 1 Deliverable: A report comprising a thorough review and critical analysis of the state of the art and practice

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NEW AGRICULTURE FOR A NEW GENERATION

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Abbreviations

A.I.	Artificial Intelligence
DLO	Dienst Landbouwkundig Onderzoek
IoT	Internet of Things
NGO	Non-Governmental Organization
RFID	Radio-frequency Identification
SC	Supply Chain
SCM	Supply Chain Management

Summary

Global changes regarding consumer expectations, market needs and fierce competition among business enterprises in agricultural products' trade, work as a driving force for higher standards in multiple levels of agri-business procedures. Safe and nutritional food, excellent quality and just-in-time delivery of fresh fruits, vegetables etc. create the necessity for the counties to have the best knowledge of state-of-the-art and stat-of-practice of emerging technologies, efficient infrastructure and current trends on the contemporary agri-food supply chain. Effective management of agri-food supply chain in a highly competitive market - especially for cross-border trade, seems to be a major challenge, which, however, could possibly be tackled through the collaboration between trade actors. Combining experiences from various countries regarding the necessary measures for effective management of supply chains, it seems that numerous advantages can be obtained, through reduction of product losses and transaction costs, better control of product quality and safety as well as higher added value for the products. Case studies from the Netherlands, India and Thailand highlight different aspects of the agri-business sector and specifically the key success factors, bottlenecks and initiatives to tackle them.

1. Introduction

1.1 Major components of the Agri-Business sector

Population growth combined with the changing lifestyle and increasing consumer needs has led to significant changes in the agriculture sector, including the use of new products and new technologies. The agricultural commodities and processed food products seem to be of high importance to consumers [1],[2]. Modern farming is facing several challenges in production, management, financing, labour sourcing and marketing which indicates that it becomes part of an industrialized production system with different aspects of primary, secondary and tertiary sector. Besides agricultural production, important elements of the agribusiness sector include packaging, marketing, consolidation and distribution services [1].

Consumer demand for variety, quality, and year-round availability of preferred products feeds into the need for the development and management of integrated supply chains from farm gate to retail level, in a way that also achieves improved quality, cost-effective transport and timely delivery. In order to overcome these challenges, it is important to understand the changes required in the system for responding efficiently to contemporary consumer needs and coordinating the overall supply chain system [3]. Supply chains acquire new aspects and characteristics as they not only extend across regions, but very often across borders connected to supply chains from other continents. Considering these trends it is well understood that new business strategies arise along with the new supply chain relationships and supply chain management practices in the fields of operational and materials management, logistics, inventory control, planning and scheduling, industrial and retail marketing, handling and storage in different stages of a supply chain [3],[4]. The key elements of the agricultural sector value chain are shown in *Figure 1*.

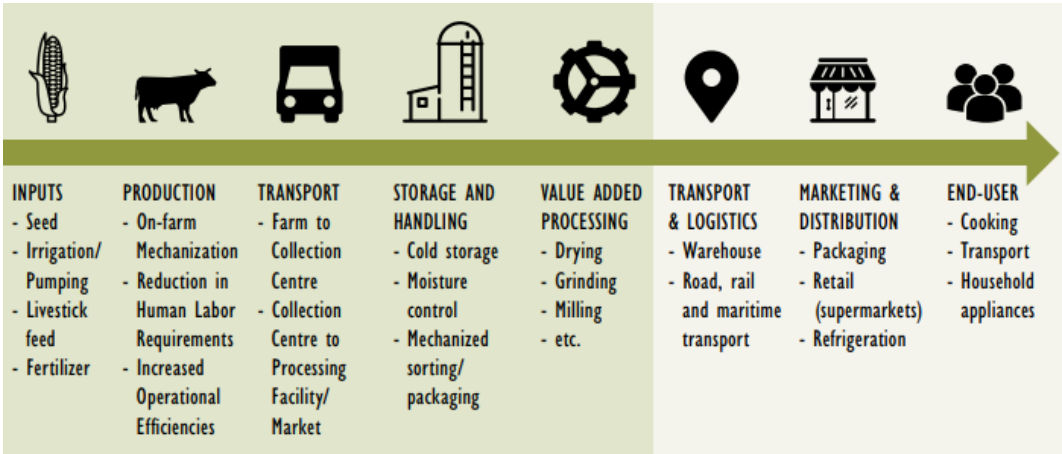


Figure 1. Agricultural Value Chain (Source: [5])

Logistics of the agro-food supply chain (agrologistics), is the sub-discipline of logistics which manages a variety of product types such as commodities[1] to be used as raw materials for industrial production of processed food products. Agrologistics also deals with highly perishable agricultural products[2] and high-value, processed and customized products[3] and includes all the activities in the agri-food supply chain to properly get the right agro-product, in the right place and time according to the appropriate specifications of quality and sustainability requirements [6].

1.2 Role and significance of agrologistics in Supply Chain Management

Aiming at meeting customer needs, which is one of the major goals for the agri-food industry, managers try to ensure the seamless flow of goods and services along the supply chain while at the same time lowering costs [3].

Performance measurement of the individual supply chain elements and the supply chain as a whole, began to concern recently researchers and practitioners after decades of focusing unilaterally in the operation of individual firms. Thus, dimensions such as transaction cost, efficiency, sustainability, risk and investment analysis initiated a massive research activity on production chains and networks [7]. In fact, it could be said that one of the most critical bottlenecks in the agri-business sector is the complexity of transactions and cost-efficiency of the logistics operations at any level of the supply chain. Multilevel supply chain management in the agri-food networks as well as vertical and horizontal integration among its segments, seems to be crucial for the seamless flow of agriculture goods and information [2].

When it comes to energy consumption, all activities taking place in the agri-food sector have a share. Fuel consumption in transportation of goods, vehicle idling and long-term storage significantly contribute to the energy use. Subsequently, sustainability is a key issue to consider when designing and operating supply chain networks in which efficiency and environmental impact should be balanced [2],[8].

According to the DEFRA (Department for Environment Food and Rural Affairs) Food Statistics Pocket Book 2013, “The agrifood sector in the UK contributed £97.1 billion or 7.4% to national Gross Value Added in 2012 and £3.6 million or 13% of national employment in Q3 2013”. These statistics, similar to those of other countries, show the importance of an efficient supply chain and logistics system and how vital this industry is at a global level, not only in terms of prosperity increase but also in terms of employment possibilities generated [9].

The flows of key commodities, such as grains, have been extremely augmented, predominantly owing to the influences of elements such as the concentration of

[1] Products such as cacao, grain, soy, sugar, coffee
[2] Products like fresh vegetables, flowers, fruit, fish, potatoes
[3] Products like processed dairy or meat products

production systems and the globalisation of marketing. Transportation of goods classified as agricultural, plays an important role within the system and must therefore be appreciated and thoroughly investigated to achieve the best results [10]. Adopting the aforementioned approaches is important in matching competitors and gaining access to markets. However, to remain competitive, a supply chain must aim to introduce innovations in product and service design that are hard for competitors to match [3].

The way that agri-food products are priced including the transmission cost[4] affecting different stages of supply chains, create a significant requirement for effective management of the processes in an agri-food supply chain. Price levels and profit margins of firms should be sufficient and at the same time high enough for the firms to produce, invest and innovate. Changes in supplier prices could potentially cause imbalances in the overall value of products, increasing the final price. Aspects like product specifications can be demonstrated as an example of non-price aspects which, however, have a financial importance [7].

Another important element that needs to be considered in assessing the role and significance of agrologistics in supply chain management concerns the key performance indicators that can be used for different kinds of products, to assess the performance of supply chain processes. Figure 2 presents a conceptual framework of agri-food supply chain performance.

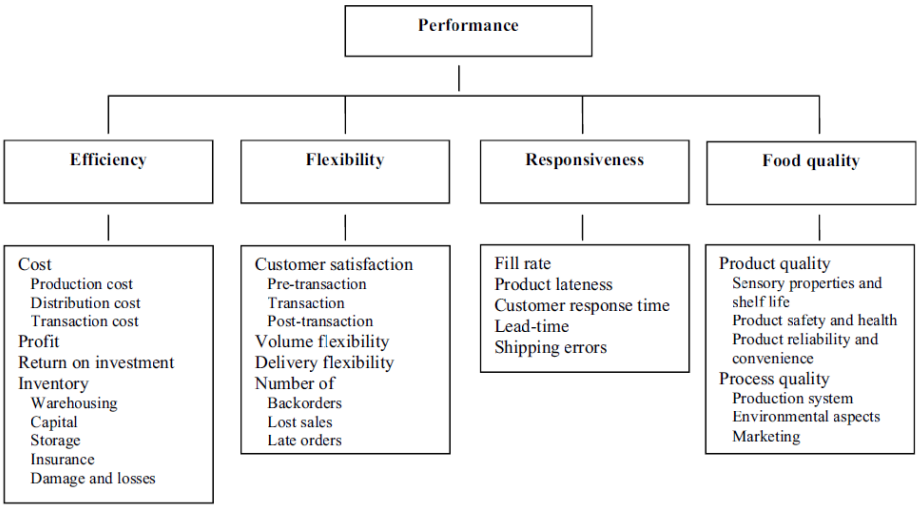


Figure 2. Conceptual framework of agri-food supply chain performance (Source: [7])

For supply chains of agricultural products the main processes are typically producing, storing, packing, labelling, transportation and trading of goods [7]. Performance of these processes is assessed in terms of efficiency, flexibility, responsiveness and quality.

[4] Price transmission refers to the way prices at one level in the product chain react to changes at another level [7]

2. Conceptual approach and methods

The approach followed in the present report follows the requirements of the tasks of the Sectoral Study on the potential of Agrologistics in Greece. The aim of this report is to summarize findings of activities in tasks 1.1: *State of the art* and 1.2: *State-of-practice*. It is part of an ongoing work process where reports from different tasks will link into the Sectoral Study.

2.1 Key Definitions

Before proceeding with the review of the state of the art and the state of practice it is important to present some key definitions and terms that are commonly used.
Additional definitions derived from pertinent literature are shown in Annex I.

Agri-Food Supply Chain is comprised by a set of sequential operations such as the input supply, production, postharvest, storage, processing, marketing distribution, food services, and consumption following a sequence of operations from 'farm-to-the-fork' [11].

Agricultural products logistics (Agrologistics) is a branch of the logistics industry, which refers to physical flows of physical entities and related information from producer to consumer that satisfy consumer demand, including agricultural production, acquisition, transportation, storage, loading and unloading, handling, packaging, distribution processing, and information activities. Development objectives of agricultural products logistics is to increase value-added of agricultural products, reduce distribution costs, improve circulation efficiency, reduce unnecessary losses, and avoid market risks [12].

Agribusiness sector is composed of agriculture production, processing, packaging and distribution in an attempt to cover activities and disciplines encompassed by modern food production, integrating services of the secondary and tertiary sector of the production process [1].

2.2 Method and material used

For the purpose of this report, an extensive web-based research has been conducted. Web sites, platforms and databases have been reviewed, along with recently published reports and books, to gather information available on the state of the art and practice in agrologistics worldwide, as well as on trends and prospects including policy-making, emerging technologies, best practices and practices providing useful insights.

3. State of the art

The development of the agri-business sector has evolved in recent years, with the whole industry and stakeholders in every level of the supply chain aiming for innovative solutions in equipment, vehicles, software and processes for better and more efficient management of the agri-food flow [13]. This chapter presents a state of the art review on the emerging technologies in the agri-food sector, but also on innovative policies and guidelines arising in the industry or imposed by the states across the world. Furthermore, an overview of research projects focusing on agrologistics applications is presented.

3.1 Emerging technologies in agrologistics

Transportation of agricultural products is considered as one of the main activities in the agrologistics sector, presenting challenges related to transporting products over long distances and reducing costs, air pollution and energy consumption. From the consumers' perspective the emerging need for innovative technological solutions mainly concerns the availability and safety of the agri-food products consumed. Seamless, efficient and continuous supply of goods is equally important to the fast transportation of perishable agricultural products, and the availability of the necessary infrastructure and vehicles [14]. Inefficiencies in handling, storage or transportation could possibly lead to extensive financial losses to the responsible firm. As such, standards and regulations regarding hygiene and health conditions, temperature and humidity conditions, sensitivity to foreign odors, loading and unloading procedures etc., should be followed consistently. To address these challenges, "cleaner" and more sustainable technologies, as those listed below[5] are being implemented.

3.1.1 Systems Applications and Products (SAP) - Agribusiness software

Many software solutions in the data processing domain offer a variety of possibilities on all stages of a supply chain. Warehouse management, collaborative transportation management, order fulfillment and processing, yard management, logistics network management and track and trace are only some of the digitalized services offered using intelligent technologies. Fleet operations, delivery and storage may be optimized by providing visibility, which is required for efficient logistics decision-making [15].

3.1.2 Internet of Things (IoT)

Many agri-food supply chain processes, such as inventory, transportation, information and procurement can be optimized through the application of IoT.

A schematic representation of IoT potential application and support to an agricultural logistics network is shown in Figure 3.

[5] Most of the technologies mentioned in this chapter are applicable in other sectors as well, besides agrologistics

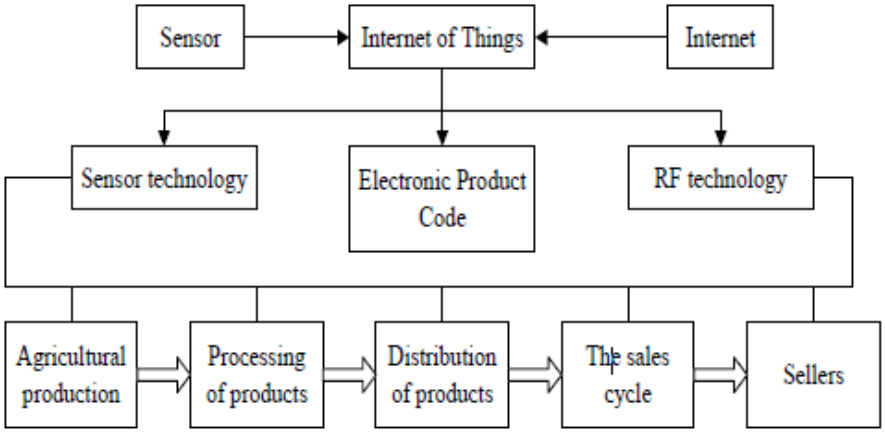


Figure 3. Logistics Network Application in Agricultural Logistics (Source: [13])

IoT can offer improvements in different stages of the agri-food logistics, including the process of transportation. By providing visibility along the transport chain, transport vehicles may be scheduled in a timely manner avoiding inefficient transport movements, while at the same time cold storage inventory and in-traffic conditions information may be acquired in real time, for an effective cold chain logistics management. In combination with RFID tags and other technology components, product information may be available automatically, to monitor the quality of goods and deal with expired/damaged products in a timely manner. Information transferred throughout the supply chain can provide all stakeholders with the whole picture about raw materials, processing conditions, information on storage of products in warehouses and storage environment conditions [13]. With the IoT technologies stepping in into the agri-food sector, farmers are now able to check the status of their fields and stock on their smartphone; while consumers can access information about the origin of their food and its producer, among other things [16].

3.1.3 Digital logistics platforms

Sharing of information about product movements along the supply chain is an essential part of a collaborative process [17]. As the main characteristics of agricultural products and processes are local and global sourcing,; short cycle time, which requires quick transportation of the product to allow it to be consumed fresh; seasonality of some products and variation in flow, it is well understood that it is of critical importance to share information in every stage of a supply chain. Exchanging of logistics data in a secure environment enhances cooperation among various stakeholders. As such, a secure data exchange platform may assist in effectively and quickly responding to contingent problems in logistics processes [18]. In addition, orders from the participating companies may be gathered and the best routes for the transportation of goods and loading/unloading combinations may be determined [19].

Benefits that may be derived from the use of a digital logistics platform include financial benefits through economies of scale, improved sustainability profile for the involved companies and the logistics process in general and security in the exchange of logistics data. Such a platform has been recently tested successfully in the Port of Rotterdam with an increasing number of stakeholders expressing an interest to join the platform [19].

3.1.4 Track and Trace systems

Modern truck and trace systems have overcome the inefficiencies of past practices, which relied on manually collecting information from websites, a time consuming and often unreliable process. Today's technology and digital applications allow shippers and freight forwarders to locate products in real time. As an example, relevant easy to use applications are implemented in maritime container transport chains (Figure 4) to improve reliability in tracking and tracing of goods both at sea and on land.

Figure 4Track and Trace system in maritime trade (Source: [18])

Such a system has been tested recently in the port of Rotterdam [18]. Up-to-date information on the condition of the products, on their exact location and on possible delays can be derived from the system, which works by combining and crosschecking container events data from multiple sources. These include data from vessels, deep sea terminals and inland terminals. The user can log in the application and retrieve detailed information on every stage of the journey of the container [20].

3.1.5 Smart reefer containers

When it comes to perishable agricultural products and commodities that should be transported over long distances through maritime transport, it is essential to have real time control on aspects such as temperature and humidity as well as overall energy

management and quality control. The new generation of reefer containers (Figure 5) have the capability to provide such services.

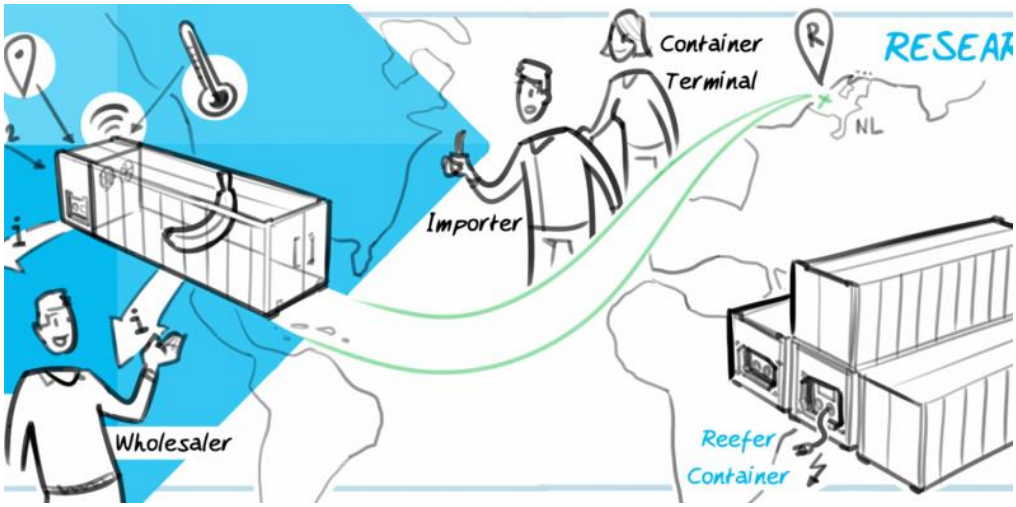


Figure 5. Smart reefer container operation (Source: [18])

Apart from the ability of sending real-time information on the location and internal conditions, a smart refrigerated container allows the operator to correct any problems in real-time and provides precise information on maintenance requirements. Research efforts focus on providing these containers the capability to operate autonomously and make their own decisions following the guidelines of their operators [18].

3.1.6 Blockchain technology

Usage of blockchain technology in the agribusiness sector may allow producers and consumers to share data and make decisions without the need of intermediaries, through a secure data environment. Blockchain technology induces added value by digitally linking data, connecting various platforms and sources of information. The necessary transparency about the origin of goods and route they follow, seems to be ensured through the use of this technology [18], [21].

A series of pilot studies indicate that blockchain technology enables food tracing from farm to grocery store in just a few seconds. Blockchain also helps to keep tabs on abundant commodities and reduce cases of illegal harvesting and shipping frauds. The United Nations reveals that food frauds cost the global economy around $40 billion per year because of illicit trades [22].

3.2 New policy imperatives

Policy making is adjusted to the changing priorities and critical factors that concern the key actors in the agrifood business. Until recently, high priority in supply chain design was given to parameters such as cost efficiency and on-shelf availability. Today, traffic

congestion in urban areas, energy consumption, CO2 emissions, permanent rise in transportation costs and food waste[6] on different stages of the process seem to be the emerging issues that need to be addressed in the contemporary agrifood business [17]. The following dimensions are examined within the context of emerging policy strategies and their adoption will assist in shaping future supply chains (Figure 6).

-***In-Store Logistics:*** includes in-store visibility, shelf-ready products and shopper interaction.
-***Collaborative Physical Logistics***: shared transport, shared warehouse, shared infrastructure
-***Reverse Logistics:*** product recycling, packaging recycling, returnable assets
-***Demand Fluctuation Management:*** joint planning, execution and monitoring
-***Identification and Labelling:*** *used as standardized identification and communication mechanisms*
-***Efficient Assets:*** alternative forms of energy, efficient/aerodynamic vehicles, switching modes, green buildings

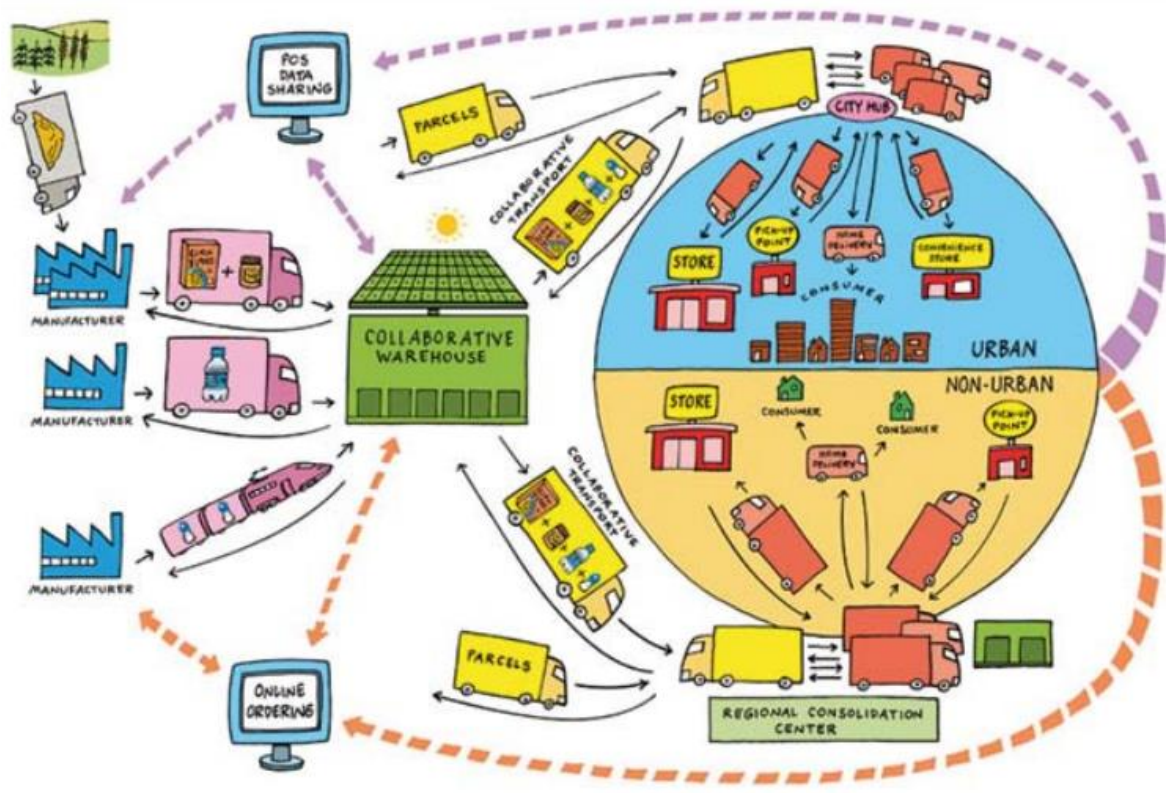


Figure 6. Future agri-food supply chain (Source: [17])

[6] Up to 30% of the produce is estimated that get lost due to inadequate post-harvest treatment, packing, storage and transportation [23]

Commitments undertaken and regulations applied by governments worldwide regarding the reduction of the supply chain ecological footprint due to climate vulnerability, are becoming more and more strict and necessary. In this direction, *reverse logistics* refer to the reprocessing of assets, materials, packaging, products or other components that can be recycled, reused or remanufactured, using solutions that include traditional backhauling, product recycling, packaging reuse and packaging recycling.

Identification and Labelling through the use of appropriate equipment like RFID tags gives the opportunity to all actors in a supply chain to use the same standardized mechanism to identify parties/locations, items and events, with clear rules about where, how, when and by whom these will be created, used and maintained. Labels currently remain one of the most widely used means to communicate relevant security aspects of a certain product, between consumers and trading partners.

Efficient assets solutions include the modification of existing infrastructure such as buildings and equipment with more efficient alternative energy solutions, or even their redesign in order to comply with reduced environmental impact requirements and enhance their productivity. The target may be an up to 30% reduction of energy consumption compared to conventional buildings. Solutions like the use of multiple modes of transport in combination to switching to alternative modes of transport (e.g. jumbo vehicles, efficient/aerodynamic vehicles etc.) can lead to further reduction of green gas emissions.

Sharing of warehouse storage, transportation vehicles, load planning and truck capacity for consolidating flows of goods to improve service and asset utilization, shapes a strong collaborative relationship among the manufacturers and retailers and possibly 3PL providers. These kinds of collaboration can take place in every stage of a supply chain, among different types of stakeholders, and may concern existing infrastructure or new-builds. Following such practices, stakeholders may achieve economies of scale through collaboration [17].

3.3 Research projects/Pilots

Several research projects aim to tackle major challenges in the agri-business sector and propose solutions for different stages of the supply chain. The projects highlighted below emphasize on agrologistics applications. Information on these projects is retrieved from the CORDIS platform [24] as well as from other agrologistics related sites.

1. *GREEN-AgriChains - Innovation Capacity Building by Strengthening Expertise and Research in the Design, Planning and Operations of Green Agrifood Supply Chains [25]*

GREEN-AgriChains aims to improve the research capacity of the Aristotle University of Thessaloniki (A.U.Th), Greece in order to establish the University as a prominent stakeholder of innovation in the areas of green Supply Chain Management (SCM) and Logistics, focused on the Agrifood sector. The perspectives of supply chain design and planning that support green image are examined, including sustainable farming, reverse logistics, green procurement and sourcing, waste management and packaging reuse, transportation, energy consumption efficiency, green marketing, green accounting, and corporate social responsibility. The strategic partnership comprises seven well-established research institutions, four industry stakeholders and policy-makers. In addition, synergies between leading SCM and Logistics practices and the Agrifood sector are expected to act catalytically in unleashing innovation and opportunities for added-value products and services in the sector. The project aims to promote Green Development for the regional economy.

2. *ANTARES - Centre of Excellence for Advanced Technologies in Sustainable Agriculture and Food Security [26]*

The scope of ANTARES is to develop a BioSciense Centre at the University of Novi Sad, into a European Centre of Excellence (CoE) for advanced technologies in sustainable agriculture and food safety. The vision of the BioSciense Center is shown in Figure 7.

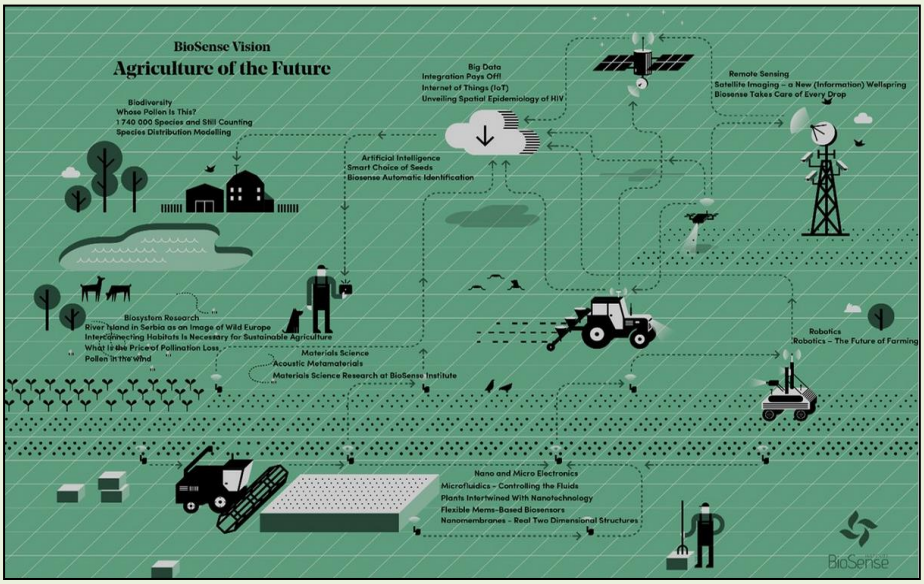


Figure 7. BioScience vision and advanced technologies used (Source: [26])

ANTARES is based on the continuity (by capitalizing on the achievements of BioSense), the growth (by identifying the gaps and implementing actions to address them), and consensus (by incorporating the needs and expectations of stakeholders in the vision and strategy of the new CoE), in order to engage the region in a path of innovative growth. This project is completely aligned with the regional innovation priorities as presented in the Smart Specialization Strategy of Vojvodina. Its impact in innovation,

economic development, and sustainability is going to extend at a much broader national and European level.

3. *FOrLedger - A Blockchain-based Middleware Platform for Food Tracking Ledger Builder [27]*

FOrLedger, is an innovative low-code development platform. It allows software companies oriented to agrifood supply chain businesses to make a blockchain-based software quickly and with minimal coding. The goal is to support growers in the traceability and the certification of food products by using the Blockchain technology and Smart Contracts. The benefit will be to build transparency beyond the "one step down, one step up" traceability principle. Additionally, the project develops the integrity of product data and drives efficiencies for stakeholders. FOrLedger's novelty lies in blockchain technology which is provided "as-a-service" facilitating its integration in any software method within a supply chain environment. The blockchain technology allows to make secure and automatic transactions along the supply chain. It increases the high-quality production (especially of organic products), improves the environmental sustainability and guarantees transparency and security to the final customer. The blockchain was created as a decentralized ledger which records transactions and stores this information on a global network in a way which prevents future changes. While it was initially adopted for its financial implications, the blockchain decentralized system has a big potential and applicability to the traceability of supply chains. The blockchain gives a neutral open platform, in which there is no need for a third party to authorize transactions. Rather, a set of rules is set for all participants, both users and operators of the system. The blockchain technology is used as a construct of proof: proof of existence, proof of ownership, proof of transaction, proof of exchange and proof of cost. The blockchain has the ability to take the power of information from Big Food and give it into the hands of the direct consumer.

4. *Dairy Park [28]*

The DOC Cheese Cooperative, placed in the northeast of the Netherlands, is a medium-sized business that processes 600 million litres of milk annually to produce cheese, milk powder and whey. The company produces crustless cheese, which is further processed and placed into pre-packed slices. DOC Cheese also produces naturally ripened cheeses.

Until 2003 the process of cheese ripening was carried out at various locations around the town of Hoogeveen. This was far from ideal and also restricted any growth opportunities, from a logistical perspective. As a result, DOC Cheese decided to consolidate its activities to an area adjacent to a motorway, enlarging in this way the accessibility to its customer base, including Germany.

In the construction of the new premises, improvements in logistics, water and energy use processes were considered. Further ideas included improved efficiency through attracting related businesses, like a slicing and packing company, to the site for the purpose of reducing transport needs and consolidating and shortening the various links in the cheese production chain. The new construction offers environmental benefits as well. For instance, the water used in the cheese production is obtained as a by-product of the whey production process, by membrane separation. Furthermore, energy use is optimized through the use of a heat-power generator, which allows heat released during the production process to be re-used.

5. Agriport A7 [29]

In the Netherlands to the northwest the ground exhibiting the straight-line symmetry of green and white cabbages alternating with the more frivolous curly kale and broccoli.

The Agriport A7 cluster was established to enable the firms involved to collectively sort and package the vegetables grown in the fields and in neighbouring greenhouses (mainly green and white cabbage, curly kale and broccoli) and transport them 'just in time' to suppliers.

Because the actions of the companies involved are spread out over various locations, empty boxes, crates and other packing materials need to be transported. The companies hope to reduce this unnecessary burden to the environment by bundling their activities and creating an Agripark – a business park where related businesses could also find a home. This, at the same time will improve their own efficiency and reduce their costs.

Clustering activities scale down transport by an estimated 20 percent. Apart from the environmental and economic advantages, this also results in a significant reduction in the number of trucks that thunder through the small villages in the area. Connecting the various product flows will also decrease the order-to-delivery time for supermarkets. Furthermore, the combination between different companies makes it possible to connect certain actions, such as washing crates or folding boxes, resulting in cost decrease for the producers.

6. Flora Holland [30]

The northeast of the Netherlands and the neighbouring areas in Germany are an emerging region for growing flowers, pot plants and trees. Although Germany and Scandinavia are important markets for these products, producers currently must travel to auction houses in the other parts of the Netherlands (western side) to sell their wares. This results in a large number of 'empty kilometres' on the road.

The auction organization, FloraHolland, together with producers, collectives, logistics

suppliers and regional governments, are looking for methods to make this transport between the two sides (north and west) more efficient. The average load of trucks at the moment stands at a modest 70% and sometimes even less. Shuttle services aiming to improve the transport stream need to be enhanced. Achieving this requires effective management. Central planning will initially lead to an improvement of logistics efficiency by around 15%. This could be further developed by collaboration with suppliers and customers dealing with a variety of agricultural products. The FloraHolland auction in Eelde forms a link in the chain of logistics suppliers for ornamental plants. In the near future it will also provide a place where the plants can be processed, inspected and packed.

7. Agrotrace - Integrated system for traceablility and agrologistics of fresh fruit and vegetable [31]

Industry segments are evolving on separate, yet parallel paths to define their own traceability guidelines and address the supply chain-related aspects of food safety in an effort to meet regulatory requirements and satisfy consumer expectations for safe fresh foods. To contribute to food safety, unique identification of products and standardized exchange of product data are required, while also establishing cost-efficient business processes for information linkages to all participants in the supply chain. Agrotrace creates an effective integrated traceability procedure and a standardized approach for fresh product identification while also remaining flexible for the different supply chain roles and duties within the ecosystem. The Agrotrace way creates a common language and procedures shared by all players through all levels of the supply chain. It combines interoperable hardware and software solutions to accommodate and improve food safety. New operational efficiencies are gained by all members of the supply chain. Reduced waste is achieved by implementing proper handling or rotation based on item-level traceability.

4. State of practice

This chapter aims to present a descriptive overview of best practices in the agrologistics sector, pointing out not only the key success factors for each paradigm but also challenges that need to be addressed. Factsheets of the three cases that are reviewed in the following sections, are presented in Annex II.

4.1 Reduction of post-harvest losses in the Netherlands

The second-largest exporter of agricultural products worldwide (after the US) and one of the most important hubs for international agri-food processing and trading is the Netherlands. Despite the small size of the country, exports totaled almost 100 billion in 2017 [32]. Vegetables, onions and potatoes are the biggest exports, followed by pork, poultry products, cheese, outdoor plants and herring. The country's major trade partner for exports of these products is China, while import products come mainly from South Africa, Brazil and Costa Rica [33].

Key element in the Dutch agribusiness sector is the port of Rotterdam which is an all-round port for import, export and transshipment of agricultural commodities. Rotterdam remains the first port in Europe for trading refrigerated and frozen products in reefer containers. A broad selection of services for the transshipment and storage of agricultural products, such as corn, grains, soybeans, oilseeds and rapeseed are located in Rotterdam. The region around the port includes various leading companies with expertise in agricultural commodities trading and processing, generating attractive economies of scale due to the large quantities of cargo [34]. More than €19 billion of the total Dutch exports of agri-food products (which was worth more than €80 billion in 2013) were re-exports via the port of Rotterdam and Schiphol. Over €58 billion concerned domestic produce and only €2.7 billion was transit cargo. Re-export means that the product is first imported and becomes the property of a Dutch company, undergoes minor processing and, possibly after being repackaged and regrouped, is exported to another country. This happens, for example, with tropical fruit in the port of Rotterdam, imported grains and oil-bearing seeds [35]. A key network for agribulk-related producers is located in close proximity to the port of Rotterdam, generating significant value-added services including processing of grains for food industry, production sites for vegetable oils and fats, laboratories and specialized logistics services offering optimum storage, distribution and related services, such as packaging, repackaging and labelling of products [36].

Fresh produce supply chains in developing countries are characterised by relatively high losses that take place in all the steps and processes between harvest and consumption. This remains one the most challenging factors that need to be tackled[7]. Stakeholders in

[7] In FAO's Food Loss Reduction Strategy it is stated that perishable crops losses, by their nature, are higher than those for cereals and vary highly by region and commodity type, suggesting losses over 50% [38]

the Netherlands, interviewed in January of 2013, indicated that food losses in the postharvest fruit and vegetable supply chain is a major issue they are working on [37]. The Netherlands have a technologically sophisticated and efficiently organised network for the production and distribution of vegetables and fruits. The government is supporting the consistent collaboration between government agencies and private investors. More specifically, the Ministry of Economic Affairs initiated a network encouraging the co-operation between the private and the public sector as well as research institutes (see Figure 8) in order to ensure food security and nutrition in the Netherlands [37].

Figure 8. The Duch Golden Triangle (Source: [37])

The project called 'Rotterdam Food Hub' (Figure 9) comprises a 60 hectare Business Park in the heart of the port of Rotterdam providing optimum facilities for businesses in the agri-food sector as well as transport, storage, access control and customs facilities, which can be shared efficiently [33].

*Figure 9. Rotterdam Food Hub (*Source: [39])

As the speed in processes of perishable products is crucial, the Rotterdam food hub exploits its close proximity to deep-sea container terminals, giving to the settled businesses access to multiple berths for vessels especially equipped for refrigerated cargo and to available warehouses located immediately adjacent to the quays **[39].**

4.2 Enhance primary processing of commodities in India

Traditionally, India was- and still is- one of the largest producers of several food grains, fruits and vegetables, dairy products, marine products, meat and poultry and one of the key food producers in the world, with the second largest arable land area (156.43 million hectares). Almost half of India's work force is still dependent on agriculture for its livelihood which indicates the magnitude of the domain for the country [40]. Despite being one of the largest producers of various food grains, fruits and vegetables, processed foods account for small proportion of the total food production. In order to achieve better terms in the trade of agricultural products in the international markets, it is vital to grow the food processing sector in an efficient way, which will work as a driver of economic growth of the country. In addition, proper food processing procedures including clean water and access to adequate equipment is crucial for the security of the food both for exports as well as for internal consumption. The advantages of efficient food processing include greater food consistency, longer shelf life, reduction of wastage, removal of toxins, reduction of food borne diseases and cheaper food [23].

One of the most significant bottlenecks that the Indian trade has to face is the high percentage of products loss. Around 30% is being lost due to inadequate infrastructure for postharvest treatment, packing, storage and transportation. Specifically, there is nearly 4.5 to 16% wastage in fruits and vegetables annually due to lack of modern harvesting technologies and cold chain infrastructure. At the same time, processing levels in fruits and vegetables stands at around 2% [40]. For that reason, major private investments have been made in the recent past from large food companies. These investors, recognized the huge potential that India has to offer for further growth in the food processing industry and took advantage of the strong government support given in the form of targeted incentives. The most significant initiatives include ambient temperature storage facilities, cold chain networks, and training to farmers in collaboration with universities.

Indian agriculture is characterized by fragmented farms, weak infrastructure and the strong involvement of intermediaries [23]. Efforts are emphasizing on the integration and collaboration among key stakeholders which is being driven by the manufacturers who are trying to make linkages between raw material producers (farmers) and logistics providers, which has led to new models. Specifically, an initiative called e-Choupal from a conglomerate in India, aims to link directly with rural farmers via the Internet for

procurement of agricultural products like soybeans, wheat, coffee, and prawns. Therefore, the programme installs computers with Internet access in rural areas of India to offer farmers up-to-date marketing and agricultural information resulting also to the reduction of wastage and decreasing of cost related to food processing.

Government, as the key stakeholder, invests in specialized infrastructures like agro-export zones and mega food parks with the primary objective of boosting agricultural exports from India. The major components of this comprehensive concept are:

- Cluster approach of identifying the potential products and geographical region in which these products are grown.
- Adopting an end-to-end approach of integrating the entire process, right from the stage of production till it reaches the consumption stage.
- Integration of the activities of various agencies [41].

Adding value in pre and post-harvest phases through enhancement of market linkages and also providing the agri-marketing systems with information and communication technologies seems to be a key element towards the success of the agri-business sector. Development of terminal market complexes is one such initiative taken by the government of India to strengthen the market infrastructure and encourage farmers' associations to potentially manage the collection centers [23].

4.3 Fresh fruit agrologistics in Thailand

Many kinds of tropical fresh fruit are produced in Thailand and exported to international markets (mainly through the Netherlands) where the demand is greater than in-country consumption[8]. On the other hand, many other fruit like apples, grapes and oranges are imported to Thailand from all around the world [42]. Although the country can produce a great variety of exotic fresh foods, it cannot leave a mark on the international trade since the export markets are regarded as an option during times of oversupply in domestic ones, which leads to lower product quality and poor brand recognition. This indicates the emerging need for addressing the inefficiencies in the logistics environment of the export sector, in order to move forward with a more market-oriented strategy.

Four types of bottlenecks exist in the agribusiness of tropical fruits in Thailand (Table 1). These are related to the certification, quality infrastructure and logistics, post-harvest technology and enabling environment as shown in the table below.

One of the major challenges in the early stages of fruit processing is the inefficient way in which farmers are handling the fruit, using inappropriate and unclean machineries,

[8] According to Office of Agricultural Economics (2011a), around 3%, 40% and 25% of longans, durians, and mangosteens, respectively, are consumed domestically [42]

inappropriate cultivating practices and prohibited chemical fertilizers. Therefore, when these products arrive in European laboratories they are often rejected causing enormous financial loses annually for Thailand [42].

Table 1. Bottlenecks in agrologistics of tropical fruit in Thailand (Source: [42])

Type of bottleneck	Bottleneck
Certification	Thailand does not have a consistent and well implemented policy on residue/chemical control.
	Food certification and standards assurance are not in line with leading requirements, requested by the private sector in the EU.
	Dual standards, which the exporters have to deal with, are increasing costs and do not contribute to increased competitiveness.
Quality infrastructure & logistics	High transportation costs because of the dependency on air freight shipment due to the limited shelf life of fruits
	High costs of distribution due to substantial distances.
	Limited number of airline services.
	Cargo space is fully occupied on the way to Europe but empty on the way back.
Post harvest technology	Farm based cooling systems (hydro cooling, force air cooling, vacuum pre-cooling) are not widespread and only selectively applied.
	Facilities at packing houses (pre wash, waxing, pre-cooling) are limited.
	Deficient logistics and quality infrastructure (cool chain refrigerated truck, refrigerated warehouses, cold storage room at the airport) result in shorter shelf life and reduced product quality.
Enabling environment	Exporters and importers highlight the importance of a favorable business environment for exporting perishable goods.

Cold transport chains exist but are partially operated, instead of functioning seamlessly. Products in many cases are delivered into cold storage but in several instances they may be handled by unconditioned logistics. For example, facilities at the airport of Bangkok are relatively new, modern and clean, and contain cold storages. However, temperature settings are not always at the desirable level, resulting in reduced perishable quality and shelf life [6], [42]. Dealing with the challenge of the expensive airfreight transport- which is used mainly for exporting the exotic fruits – it is important to find alternative, cheaper ways to export fruits to the European market. Another challenge is leveraging the Thai fruit sector as a whole by making Thailand serve as a local logistical hub.

Several concepts were proposed in order to tackle the challenges noted above. Putting a container as close as possible to the grower will enable the products to be loaded in it directly at the beginning of the chain and decrease value and/or quality loss. There are several variations of this concept but the most significant seem to be:

- *Container at the farm or container at the packing centre (depending on the accessibility of the farm).*

- *Stuffing of the container with pre cooled products or hot (the latter is called hot stuffing and is depending on the availability of electricity at the farm).*
- *Need or no need for collecting products at different farms for creating volume and mixed containers (depending on product assortment and production volume of the farm).*
- *Using or not using 'specific packaging' at the farm to decrease value and/or quality loss (depending on the learning abilities of the farm) [44].*

Considering the export process, proposed concepts and solutions are listed below [43]:

- *Sea-air bridge:* The idea is to combine sea transport with air freight. Sailing the goods to the United Arab Emirates or Singapore, repacking them and then flying them to the Netherlands. The concept offers opportunities to decrease the transportation costs (compared to flying only) and to decrease the duration of transport (compared to sailing only). With this concept it is also possible to make use of less busy routes that have enough capacity. The fact that the transport is indirect is a disadvantage, since products are undergoing a modal shift from boat to airplane and the cold chain has to be broken.

- *Air-sea bridge:* The idea is to combine air freight with sea transport. This will involve flying the goods to Singapore, re-packing them and then sailing them to the Netherlands. The concept offers similar opportunities to the previous case, to decrease the transportation costs (compared to flying only) and to decrease the duration of transport (compared to sailing only). With this concept it is also possible to make use of least busy routes that have enough capacity. The fact that the transport is indirect is a disadvantage, i.e. products are undergoing a modal shift from plain to boat and the cold chain therefore has to be broken.

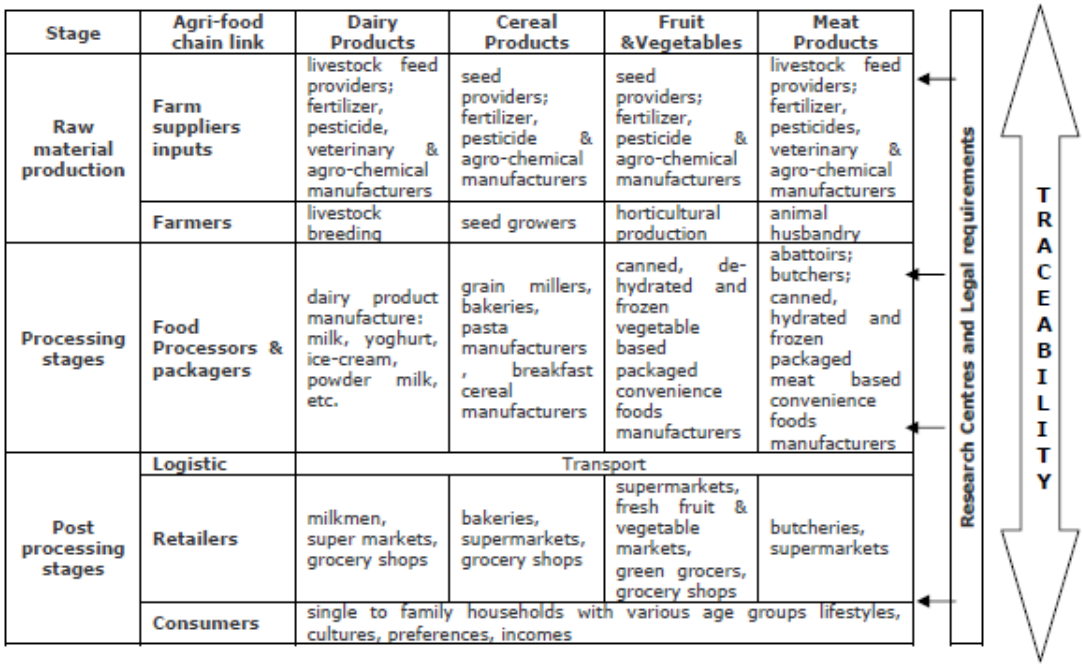
- *Air triangle:* The idea is to charter a plane and to transport goods from Thailand to the Netherlands and return via for example the United Arab Emirates (assuming that there is a demand for exporting goods from the Netherlands to the United Arab Emirates). The concept offers opportunities to transport the products directly and quickly to the Netherlands.

In terms of macro-economic concepts and taking advantage of the strategic location of Thailand, the idea is to become a hub for central collection and distribution of the regional and world market of exotic fruits and vegetables adding value to the trading products. Therefore, Thailand could develop towards a regional market place or hub where products not only from Thailand but also from regional producers are brought in and where (potential) buyers are also present [45].

5. Identification and engagement of key stakeholders

One of the fundamental issues related to the agri-business sector that influence the chain performance is how the individual actors are related and what are the expectations from their involvement in the various stages of the supply chain. It is obvious that each stakeholder has its own objectives and its own performance measures which may differ from the performance of the chain as a whole, so it is crucial to examine the point of view and the needs of some of the key stakeholders.

Even though supply chains of different agricultural products involve different combination of stakeholders, the following table (Figure 10) shows some generic examples of agri-food supply chains, presenting the different stages and different kind of products.



Stage	Agri-food chain link	Dairy Products	Cereal Products	Fruit &Vegetables	Meat Products
Raw material production	Farm suppliers inputs	livestock feed providers; fertilizer, pesticide, veterinary & agro-chemical manufacturers	seed providers; fertilizer, pesticide & agro-chemical manufacturers	seed providers; fertilizer, pesticide & agro-chemical manufacturers	livestock feed providers; fertilizer, pesticides, veterinary & agro-chemical manufacturers
	Farmers	livestock breeding	seed growers	horticultural production	animal husbandry
Processing stages	Food Processors & packagers	dairy product manufacture: milk, yoghurt, ice-cream, powder milk, etc.	grain millers, bakeries, pasta manufacturers, breakfast cereal manufacturers	canned, de-hydrated and frozen vegetable based packaged convenience foods manufacturers	abattoirs; butchers; canned, hydrated and frozen packaged meat based convenience foods manufacturers
Post processing stages	Logistic	Transport			
	Retailers	milkmen, super markets, grocery shops	bakeries, supermarkets, grocery shops	supermarkets, fresh fruit & vegetable markets, green grocers, grocery shops	butcheries, supermarkets
	Consumers	single to family households with various age groups lifestyles, cultures, preferences, incomes			

Figure 10. Key stakeholders in different stages of SC (Source: [2])

A key driver/component in an agro-food supply chain is the consumer and his/her needs which place increasing emphasis on food safety and quality as well as traceability and transparency throughout the supply chain [2]. To meet these consumer expectations, effective relationships among stakeholders need to be established. Firstly, the role of government regarding agricultural supply chain is perceived through multiple levels, from national to local, with the involvement of various Ministries as well as local authorities and municipalities. A main concern of Government Authorities is to guarantee sufficient competition and minimizing monopoly, collusive practices and corruption in the markets [7]. NGO's and non-profit organizations like Federations of Food Industry, Farmers Unions and Federations of Agriculture promote the interests of

each subsector, support international trade and foster innovation through collaboration among companies, knowledge institutions and local governments [32].

Retailers and highly concentrated agro-industrial firms seem to have increasingly dominant role in the agro-food supply chain. Given the fact of interternationalization of trade, supply chains in western markets are shifting towards international suppliers and are looking for steadier supply of agricultural products with higher quality and year-round production. Even where strong relationships exist between producers and domestic markets, the situation tends to change due to competition from global markets absorbing more domestic production [37]. Smaller producers and those that do not collaborate permanently with larger institutions may face difficulties in accessing large retailers as they may not be able to guarantee quantity/quality thresholds and they find it difficult to coordinate their activity within the complex logistic functions [46].

Producers are mainly aware of the volume and the quality of their products in order to meet exporters', supermarkets' and other business partners' requests. In most of the cases, they find it difficult and time-consuming to keep records and apply for standards and certifications. On the other hand, distributors (the retail stores) need strong marketing tools for increasing sales. They also need to offer the consumers products of proven quality and guarantees about food safety. Therefore, they need to check the suppliers' performance along the process [45].

Exporters have strong and direct collaborations with producers as they usually make financial agreements and contracts, which necessitate the monitoring and control of the operations and provide incentives for strictly following the standards. Also, exporters provide technical support and advice to producers in terms of organization of recordings, trainings etc. [45].

Wharehouses and distribution centers are also of a great importance for the logistics network. Retailers try to have absolute control over the selection of the appropriate facilities for the trading products. Through the use of multiple tools like Information Technology, retailers need to have every information needed for the transportation and storage of products in the warehouses. Temperature-controlled warehouses and multi-temperature delivery vehicles are available to meet the strict distribution requirements of the food supply chain, ensuring good on-shelf availability while minimizing wastage [47].

Engagement of key stakeholders from different stages of the supply chain to achieve vertical and horizontal cooperation, can occur through new technologies and collaborative platforms which are useful tools to maximize added value and have better

access to the markets. Therefore, ICT platforms engage consumer groups and producers, and promote cooperation between rural-urban and local-regional initiatives etc. [48].

6. Conclusions

The report provided a descriptive overview of the state-of-the-art and the state-of-practice in the agrologistics sector worldwide. Emerging technologies and new policy directions are developed aiming at efficient management of agricultural products from farm-to-fork. Targeted software and applications combining IoT and AI technology provide several quality and financial benefits during processing and warehousing of the products, which, however can be found mostly in developed economies with advanced agri-business sector. Real time information about the location of products as well as the conditions prevailing in their transportation, storage and packing is of the highest importance for wholesalers, retailers and exporters.

Collaboration among stakeholders using shared transport, shared warehouse and shared infrastructure leads to higher cost efficiency, on-shelf availability as well as less traffic congestion and energy consumption in urban areas. The clustering of activities creating agribusiness parks where businesses can bundle their activities, improve their efficiency and lower their costs seems to be an emerging trend in terms of businesses policy. Companies in the agri-business sector need to reduce the wastage of energy and comply with reprocessing of assets preferring reverse logistics which also help them meet the goal of an environment friendly supply chain.

International examples from the Netherlands, India and Thailand which have strong presence in cross-border agrologistics sector, showed key success factors derived from private investments in infrastructure and government incentives for collaboration among key stakeholders. However, post-harvest fresh fruit and vegetable losses remains a key challenge to be tackled. Agri-business hubs, where several businesses are concentrated, and where processing of products takes place in cold temperature storage facilities, from the early stages of supply chain till consumption, seem to be the answer. Countries which cannot comply with the quality standards of developed markets and are unable to provide seamless cold chain facilities for the perishable products will no longer be able to be competitive.

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Annex I - Definitions of Agrologistics

Table 2. Definitions of agricultural logistics (agrologistics)

Authors	Definition
Li, Li, Chen, Li Li, Qin, Zheng (2012) [49]	Agricultural products logistics (Agrologistics) refers to moving material objects and related information from producer to consumer physically for meeting customer's needs and achieve the value of agricultural products.
Daoping, Feng, Lei (2012) [50]	The logistics of food crops is a special type of logistics of agricultural products. The production, circulation and sales of food crops matters to state strategic reserve.
Liping (2009) [51]	Agricultural products logistics (Agrologistics) is a branch of the logistics industry, refers to physical flows of physical entities and related information from producer to consumer that satisfy consumer demand, including agricultural production, acquisition, transportation, storage, loading and unloading, handling, packaging, distribution processing, distribution, and information activities.
Zhang, Wang (2011) [52]	Agricultural products Logistics (Agrologistics) is one important part of economic behaviour, which is to create value and surplus value with the purpose of the act. Modern agricultural products logistics is to use modern science and technology to service in modern society.
Xu (2011) [53]	Based on the understanding of modern logistics, modern agricultural logistics can be defined as: an integrated industrial activities of integrated operation and management relying on advanced computer networks and information technology, integrating the use of modern transport and storage facilities, through a large number of business information instructions, engaged in agricultural transportation, storage, processing, handling, packaging and distribution processing, distribution and information processing. The aim is to optimize the distribution channels of agricultural products, reduce operating costs of agriculture-related enterprises in full range, and provide faster and better service to consumers of agricultural products.

ANNEX II
CASE STUDIES FACTSHEETS
The Netherlands

Reduction of post-harvest losses in the Netherlands

LOCATION: Rotterdam, the Netherlands
PRODUCTS: Vegetables, onions, potatoes, pork, poultry products, cheese, outdoor plants and herring

INITIAL PROBLEM AND TARGET GOAL

Fresh produce supply chain is characterized by relatively high losses due to the steps and processes between harvest and consumption and that remains one the most challenging factors that need to be tackled

INTERVENTIONS (PERFORMED OR DETECTED)

-Co-operation between the private and public sector as well as research institutes in order to ensure food security and nutrition in the Netherlands
- 'Rotterdam Food Hub'- a 60 hectare Business Park in the heart of port of Rotterdam provides optimum facilities for businesses in the agri-food sector. Offers close proximity to deep-sea container terminals while giving to the settled businesses access to multiple berths for vessels especially equipped for refrigerated cargo and warehouses located immediately adjacent to the quays

KEY SUCCESS FACTORS

-Port of Rotterdam operates as the core of agrologistics sector
-All-round port for import, export and transshipment of agricultural commodities
-Remains the first port in Europe in trading of refrigerated and frozen cargo in reefer containers
-Added value for products through re-export processes and a network of agribulk-related services
-Technologically sophisticated and efficiently organised network for the production and distribution of vegetables and fruits

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CASE STUDIES FACTSHEETS
India

Enhance primary processing of commodities in India

LOCATION: India
TRADING PRODUCTS: Grains, fruits and vegetables, dairy products, meat and poultry

INITIAL PROBLEM AND TARGET GOAL

-Despite being one of the largest producers of various agri-food products, food processing sector should be developed in an efficient way that can possibly work as a driver of economic growth for the country
-Better terms in the trade of agricultural products should be achieved in the international markets
- Proper food processing procedures including clean water and access to adequate equipment is crucial for the security of the food for exports as well as for internal consumption

KEY SUCCESS FACTORS

-Investors recognized the huge potential that India has to offer for further growth in the food processing industry and took advantage of the strong government support, which is provided through targeted incentives
- Creation of ambient temperature storage facilities, cold chain network and training of farmers in collaboration with universities

INTERVENTIONS (PERFORMED OR DETECTED)

- Manufacturers trying to make linkages between raw material producers (farmers) and logistics providers
- e-Choupal initiative, aims to link directly with rural farmers via the Internet for procurement of agricultural products like soybeans, wheat, coffee, and prawns. The programme installs computers with Internet access in rural areas of India to offer farmers up-to-date marketing and agricultural information
- Government, as the key stakeholder invests in specialized infrastructures like agro-export zones and mega food parks

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CASE STUDIES FACTSHEETS
Thailand

Fresh fruit agrologistics in Thailand

LOCATION: Thailand
TRADING PRODUCTS: Export tropical fresh fruit and import apples, grapes and oranges

INITIAL PROBLEM AND TARGET GOAL
-Although the country can produce a great variety of exotic fresh foods, export markets are regarded as an option during times of oversupply in domestic ones-> lower product quality and poor brand recognition
- High costs of distribution due to substantial distances
- There is no consistent and well implemented policy on residue/chemical control
- Deficient logistics and quality infrastructure (cool chain refrigerated truck, refrigerated warehouses, cold storage room at the airport) result in shorter shelf life and product quality.

INTERVENTIONS (PERFORMED OR DETECTED)
-Container at the farm or container at the packing centre (depending on the accessibility of the farm)
-Using or not using 'specific packaging' at the farm to decrease value and/or quality loss (depending on the learning abilities of the farm)
-Air-sea bridge or sea-air bridge: combine air freight with sea transport. The concept offers opportunities to decrease the transportation costs (compared to flying only) and to decrease the duration of transport (compared to sailing only). With this concept it is also possible to make use of least busy routes that have enough capacity. The fact that the transport is indirect is a disadvantage, i.e. products are undergoing a modal shift from plain to boat and the cold chain therefore has to be broken.

KEY SUCCESS FACTORS
-There are no specific success factors in this case, but high potential for growth exists
- Also, there is high competitiveness potential as the country is already one of the major export markets in tropical fresh fruits

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