Proceedings Expert Consultation Meeting on the Status and Challenges of the Cold Chain for Food Handling

in the Middle East and North Africa (MENA) Region

PROCEEDINGS

Expert Consultation Meeting on the Status and Challenges of the Cold Chain for Food Handling in the Middle East and North Africa (MENA) Region

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5-7 July 2011

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THE STATUS OF THE COLD CHAIN IN THE FOOD SECTOR IN THE
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INTRODUCTION

Elhadi Yahia

Our region is food insecure and a net importer of foods. It produces much less food than it requires due to many factors, such as limited arable land and shortage of water resources, and below world average agricultural productivity in many cases. In addition, the region suffers from excessive food losses and wastes.

FAO estimated recently that food losses and waste in the world amounts to about 1.3 billion metric tons, and we estimate that our region's share of these losses and wastes is very significant. Therefore, in addition to improving food productivity, it is vital to explore every possible means to reduce food losses and wastes throughout the distribution systems. Such efforts will increase food availability, wholesomeness and safety, reduce the food shortage, and achieve food security in our region.

Food losses and waste are very high in developing countries (including our region), where food is needed most because it is where about 80% of the global population lives. These excessive food losses and wastes are due to several reasons, including lack of adequate infrastructure and knowhow, lack of investment, lack of proper training and education, among others. For example, the refrigerated storage capacity in M3 per 1000 inhabitants in developing countries (including our region) is only 19, compared to 200 in developed countries.

In addition to the clearly limited infrastructure for maintaining the cold chain for Food handling in developing countries, including our region, the efficiency of utilization of exiting cold chain facilities is lower due to poor maintenance and management. This situation results in high quantitative food losses and wastes, and quality deterioration, especially nutritional quality, and food safety problems, which can result in significant health risks.

Food losses and wastes affect food security in our region in several ways. In addition to contributing to food shortage, they affect rural economies by markedly widening the gap in food prices between what consumers pay and what producers are paid, thus discouraging them from producing and supplying markets.

The wasting of millions of tonnes of foodstuffs in our region also results in wasting of very scarce or non-renewable resources required to produce foods, such as land, water, energy, and chemical fertilizers and pesticides, and also contributes to global warming.

Rising urbanization in our region, with increased distances between production areas and consumers, and an expanding middle class in these urban centers are generating increased demand for more diversified foods, including highly perishable foods, thus requiring an adequate cold chain in order to properly preserve foods during transport and distribution without major losses. Another factor is the inadequate utilization and/or poor food processing technologies for preserving food quality and safety, and extending storage-life.

Therefore, the establishment of adequate cold chain infrastructure and adequate application and management is essential to assure food security. The costs of establishing an adequate cold chain industry, both economic and environmental, can be more than offset by the economic and environmental benefits of maintaining adequate quantities and quality of food.

Economically speaking, the cold chain and its proper management play a major role in supporting a stable economy in the sector of agribusiness. Without an integral cold chain infrastructure in place supported by proper management, not only is the overall health of a society is put at risk, but also consumers will no longer trust the food sector. Increased demand and distribution for agricultural products is linked to better quality, which can only be assured through a commitment to cold chain management starting with producers and carried out by transporters, distributors, handlers, and ending with the end consumer.

Maintaining and monitoring temperature control of food from the moment it is produced is imperative. From the moment fruits and vegetables are picked from the plant, fish is harvested, milk is milked, meat is taken from an animal, or an egg is laid by a chicken, a safe temperature of the product must be reached and maintained. For example, the cold chain process for fish products starts at the sea and continue until the consumption site. Cold Chain involves all of the elements and activities needed to ensure the quality and safety of food products. Without temperature control, food is vulnerable and unprotected from the invasion of harmful microorganisms and metabolic changes that can transform it from a healthy product to a potentially dangerous one.

The essential links in an effective cold chain include pre-cooling, refrigerated storage, refrigerated transport, and refrigerated distribution and retail. Refrigerated storage by the consumers is also very important. The cold chain increases the duration between harvest and consumption of foods, enabling consumers to benefit from longer availability and less variable product prices, and provides producers with adequate conditions to apply proper production and marketing strategies.

The use of adequate cold chain enables the producers to reach distant markets, including export markets, with products of high quality, and therefore it broadens the markets accessibility for producers rendering food sectors economically viable.

Lastly, it should be borne in mind that the establishment of an adequate cold chain industry requires investment, not only in equipment but also in human resources via training and education. Without cold chain education and awareness, not only is food safety threatened but the trade of food products is hindered as a result of poor quality. In order to improve the distribution of safe and wholesome food, an increased awareness and accountability for proper cold chain management must be facilitated.

As it is the case in all chains, the cold chain is only as reliable and strong as its weakest link, and a failure at any link is harmful for all stakeholders, therefore it is important that a reliable and efficient cold chain industry, with sufficient capacity, be effectively integrated into the whole value chain, including the production sector.

MAINTAINING THE COLD CHAIN IS ESSENTIAL FOR PRESERVING FOOD QUALITY AND SAFETY

Adel A. Kader

Regardless of growing region or scale of operation, temperature and humidity management procedures to maintain quality of fresh produce include: harvesting during the coolest part of the day possible, and keeping produce in the shade while accumulating it in the orchard or field; transporting produce to packinghouse and/or direct-marketing outlet as soon as possible after harvest; protecting produce on display from exposure to direct sunlight; shipping packed produce to the market in refrigerated transit vehicles, and maintaining proper temperature and relative humidity in display cases and cold storage rooms (Thompson et al, 1998 & 2000; IIR, 2000 & 2010; Nunes et al, 2009).

Availability and efficient use of the cold chain is much more evident in developed countries than in developing countries. Unreliability of the power supply, lack of proper maintenance, and inefficiency of utilization of cold storage and refrigerated transport facilities are among the reasons for failure of the cold chain in many developing countries. Cost of providing the cold chain per ton of produce depends on energy costs plus utilization efficiency of the facilities throughout the year (Kader, 2010).

In many developing countries, some good facilities that were built a few years ago are currently “out of order” or not functioning properly because of lack of maintenance and unavailability of spare parts. This problem is especially true of public-sector facilities. Any new project should include in its plan adequate funds for maintenance to ensure its success and extended usefulness (Kader, 2005).

Appropriate postharvest technologies when used effectively can greatly enhance profitability, but no single technology is a substitute for the many integrated steps involved in proper postharvest management for assuring quality and safety of horticultural crops (Kader, 2006). Effective use of the cold chain between production and consumption sites is the most important strategy for maintaining quality and safety of horticultural perishables and other foods in developed and developing countries.

Importance of temperature and humidity management

Temperature is the most important environmental factor that influences the deterioration of harvested commodities. Most perishable food commodities last longest at temperatures near 0ºC. At temperatures above the optimum, the rate of deterioration increases 2- to 3-old for every 10ºC rise in the temperature (Table 1). Temperature influences how other internal and external factors influence the commodity, and has a dramatic effect on the spore germination and growth of pathogens (Kader, 2002).

Table 1. Effect of temperature on deterioration rate of a non-chilling sensitive commodity

Temperature (°C)	Assumed Q10*	Relative velocity of deterioration	Relative postharvest-life	Loss per day (%)
0	____	1.0	100	1
10	3.0	3.0	33	3
20	2.5	7.5	13	8
30	2.0	15.0	7	14
40	1.5	22.5	4	25

*Q_{10} = Rate $\frac{\text{of deterioration at temperature T + 10°C}}{\text{Rate of deterioration at T}}$

Temperatures outside the optimal range can cause rapid deterioration due to the following disorders:

a. Freezing injury. In general, perishable commodities are high in water content, and possess large, highly vacuolated cells. The freezing point of their tissues is relatively high (ranging from –3°C to –0.5°C), and the disruption caused by freezing usually results in immediate collapse of the tissues and total loss of cellular integrity. Freezing is normally the result of inadequate refrigerator design, or failure of thermostats. In winter conditions, freezing can occur if produce is allowed to remain for even short periods of time on unprotected transportation docks.

b. Chilling injury. Some commodities (chiefly those native to the tropics and subtropics) respond unfavorably to storage at low temperatures well above their freezing points, but below a critical temperature termed the chilling threshold temperature or lowest safe temperature (Table 2). Chilling injury is manifested in a variety of symptoms including surface and internal discoloration, pitting, water soaking, failure to ripen, uneven ripening, development of off flavors and heightened susceptibility to pathogen attack (Kader, 2002; Gross et al, 2004).

Table 2. Classification of chilling-sensitive fruits and vegetables according to their lowest safe temperature for transport and storage

Lowest safe temperature (°C)	Commodities
3	Asparagus, cranberry, jujube
4	Cantaloupe, certain apple cultivars (such as McIntosh and Yellow Newton), certain avocado cultivars (such as Booth and Lula), lychee, potato, tamarillo
5	Cactus pear, cowpeas, durian, feijoa, guava, kumquat, lima bean, longan, mandarin, orange, pepino
7	Certain avocado cultivars (such as Fuerte and Hass), chayote, okra, olive, pepper, pineapple, pomegranate, snap bean
10	Carambola, cucumber, eggplant, grapefruit, lime, mango (ripe), melons (casaba, crenshaw, honeydew, persian), papaya, passion fruit, plantain, rambutan, squash (soft rind), taro, tomato (ripe), watermelon
13	Banana, breadfruit, cherimoya, ginger, jackfruits, jicama, lemon, mango (mature-green), mangosteen, pumpkin and hard-rind squash, sapotes, sweet potato, tomato (mature-green), yam

c. Heat injury. High temperatures are also very injurious to perishable products. In growing plants, transpiration is vital to maintaining optimal growth temperatures. Organs removed from the plant, however, lack the protective effects of transpiration, and direct sources of heat, for example full sunlight, can rapidly heat tissues to above the thermal death point of their cells, leading to localized bleaching or necrosis (sunburn or sunscald) or general collapse.

Relative humidity (RH):

RH is the moisture content (as water vapor) of the atmosphere, expressed as a percentage of the amount of moisture that can be retained by the atmosphere (moisture holding capacity) at a given temperature and pressure without condensation. The moisture holding capacity of air increases with temperature. Water loss is directly proportional to the vapor pressure difference (VPD) between the commodity and its environment. VPD is inversely related to RH of the air surrounding the commodity.

RH can influence water loss, decay development, incidence of some physiological disorders, and uniformity of fruit ripening. Condensation of moisture on the commodity (sweating) over long periods of time is probably more important in enhancing decay than is the RH of ambient air. An appropriate RH range for storage of fruits is 85 to 95% while that for most vegetables varies from 90 to 98%. The optimal RH range for dry onions and pumpkins is 70 to 75%. Some root vegetables, such as carrot, parsnip, and radish, can best be held at 95 to 100% RH (Kader, 2002).

Produce Compatibility Groups:

Most compatibility charts for mixing produce items during postharvest handling divide fruit and vegetables into 8 or more groups, which is very difficult to implement in commercial practice. Thus, we developed an easier-to-use grouping that places most produce items into the following three groups (Thompson et al, 1996):

Group 1		Group 2	Group 3
Temperature range:	0° to 2°C	7° to 10°C	13° to 18°C
RH range:	90 to 98%	85 to 95%	85 to 95%
Commodities:	Temperate fruits	Subtropical fruits	Tropical fruits
	Non-fruit vegetables	Immature-fruit vegetables	Mature-fruit vegetables
	(cool-season vegetables)	(warm-season vegetables)	Tropical root vegetables

Although this grouping was intended for short-term (less than 10 days) storage, it can be used for longer storage if ethylene is scrubbed (to below 1ppm) from the circulating air in the storage room and/or if fruits and vegetables in Group 1 are stored in separate rooms.

Return on investment in maintaining the cold chain

In a University of California study, it was shown that a one-hour delay in cooling strawberries after harvest resulted in a 10% loss due to decay during marketing. The resulting economic loss was greater than the increased cost of expedited handling of the strawberries by more frequent deliveries of harvested fruits to the cooling facility and initiation of forced-air cooling. In a University of Georgia study, it was shown that the average net revenue for lettuce kept below 5ºC was $9.75 per carton, compared to $9.06 per carton for lettuce held at 5ºC or higher. This loss of $0.69 per carton due to quality deterioration caused by poor temperature management resulted in a loss of $172.50 per truckload of 900 cartons (Kader, 2006).

Return on investment in reducing water loss

In a University of California study, table grapes handled near ideal conditions of prompt cooling after harvest and maintenance of proper temperature (0-2ºC) and RH (90-95%) throughout handling from shipping point to the retail market lost about 2% of their weight at harvest. In contrast, grapes that were subjected to delays between harvest and cooling and were handled at temperatures above the optimal range (higher than 5ºC) and relative humilities below 90% lost about 7% of their weight at harvest. The stems of these grapes turned brown, which reduced their quality. The combination of the additional 5% weight loss and lower appearance quality resulted in a 15% loss in value of the grapes and returns to the shipper and marketer. This economic loss is greater than the cost of improved management of temperature and RH by using perforated plastic liners in the boxes and by minimizing delays before cooling with humidified, forced air (Kader, 2006).

Animal-source Foods:

Optimal ranges of temperature and relative humidity to preserve quality and safety of animal-source foods during handling

Food group	Food	Temperature (°C)	Relative humidity (%)
Dairy products	Butter (fresh)	3 to 5	75 to 85
	Butter (frozen)	-23 to 20	---------
	Cheese	-1 to 1	65 to 70
	Ice cream	-26 to -23	---------
	Milk	0.5 to 1	---------
Eggs		1 to 4	80 to 85
Meat (fresh)	Beef and buffalo	0 to 1	88 to 92
	Lamb	0 to 1	85 to 90
	Poultry	-2 to 0	90 to 95
Meats (frozen)		-23 to -20	---------
Seafood		0 to 1	95 to 100

References

Gross, K., C.Y. Wang, and M.E. Saltveit (editors). 2004. The commercial storage of fruits, vegetables, and florist and nursery stocks. USDA Agr. Handb. 66 (available electronically at: http://www.ba.ars.usda.gov/hb66/index.html).

International Institute of Refrigeration. 2010. Guide to refrigerated transport. Paris, France: IIR, 150pp.

International Institute of Refrigeration. 2000. Recommendations for chilled storage of perishable produce. Paris, France: IIR, 219pp.

Kader, A.A., ed. 2002. Postharvest technology of horticultural crops. Oakland: University of California, Division of Agriculture and Natural Resources Publication 3311, 535pp.

Kader, A.A. 2005. Increasing food availability by reducing postharvest losses of fresh

produce. Acta Hort. 682:2169-2175.

Kader,A.A. 2006. The return on investment in postharvest technology for assuring quality and safety of horticultural crops. J. Agric. Invest. 4:45-52.

Kader, A.A. 2010. Handling of horticultural perishables in developing vs. developed countries. Acta Hort. 877:121-126.

Kitinoja, L. and A.A. Kader. 2002. Small-scale postharvest handling practices: A manual for horticultural crops. Fourth edition. Davis: University of California, Postharvest Horticulture Series 8E, 260pp.

Kitinoja,L. and J.F. Thompson. 2010. Pre-cooling systems for small-scale producers. Stewart Postharvest Review, 2010, 2:2, 14p.

Nunes, M.C.N., J.P. Emond, M. Rauth, S. Dea, and K.V. Chau. 2009. Environmental conditions encountered during typical consumer retail display affect fruit and vegetable quality and waste. Postharv. Biol. Technol. 51:232-241.

Thompson, J.F., A.A. Kader, and K. Sylva. 1996. Compatibility chart for fruits and vegetables in short-term transport or storage. Oakland: Univ. Calif. Div. Agric. Nat. Res. Publ. 21560 (poster).

Thompson, J.F., F.G. Mitchell, T.R. Rumsey, R.E. Kasmire, and C.H. Crisosto. 1998. Commercial cooling of fruits, vegetables, and flowers. Oakland: Univ. Calif. Div. of Agric. Nat. Res. Publ. 21567, 61pp.

Thompson, J.F., P.E. Brecht, R.T. Hinsch, and A.A. Kader, 2000. Marine container transport of chilled perishable produce. Oakland: Univ. Calif. Div. Agric. and Nat. Res. Publ. 21595, 32pp.

Maintaining The Cold Chain For Perishables

Harvest

- Protect the product from the sun
- Transport quickly to the packinghouse

Cooling

- Minimize delays before cooling
- Cool the product thoroughly as soon as possible

Temporary Storage

- Store the product at optimum temperature
- Practice first in first out rotation
- Ship to market as soon as possible

Transport to Market

- Use refrigerated loading area
- Cool truck before loading
- Load pallets towards the center of the truck
- Put insulating plastic strips inside door of reefer if truck makes multiple stops
- Avoid delays during transport
- Monitor product temperature during transport

Handling at destination

- Use a refrigerated unloading area
- Measure product temperature
- Move product quickly to the proper storage area
- Transport to retail markets or foodservice operations in refrigerated trucks
- Display at proper temperature range

Handling at home or foodservice outlet

- Store product at proper temperature
- Use the product as soon as possible


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٧ - ٥
Dr. Abd A. Kader
Dr. Ehsan Abou
Dr. Ehsan Fahia

SESSION I.
HORTICULTURAL PERISHABLES

THE STATUS OF THE COLD CHAIN IN HANDLING HORTICULTURAL PERISHABLES IN THE MENA REGION

Ahmed Ait-Oubahou, Abdullah Alhamdan and Atef Elansari

1. Rationale

Fruits and vegetables are the most perishable crops. They are living plant parts with high water content and they continue their physiological and biochemical changes after separation from the mother plant. Therefore their postharvest life depends, at large extent, on the rate of deterioration due to water loss, depletion of their constituents by respiration, decay and rots by pathogens and the development of postharvest physical and physiological disorders caused by mishandling and exposure to adverse storage conditions such extreme temperatures (low and/or high), low relative humidity, ethylene effects and unsuitable atmospheric conditions during storage. If no care is taken during harvesting, transport, handling, packing, storage and distribution, perishable crops will deteriorate easily making them unsuitable for human consumption. Even though it is not easy to know the exact extent of postharvest losses of fruit and vegetables in developing countries, many reports (i.e. FAO) made estimations of 25 to 30% of harvested fresh products. These losses take place at different stage of supply chain from harvest to household consumption and will never reach the consumer. They constitute a waste of efforts made and expenditures involved in the production as well as during postharvest operations and therefore a huge economical loss for the country. In general, the main causes of perishables loss in developing country include mishandling practices from harvest to market, inappropriate techniques and technologies of storage, packaging, transport, lack of cold storage facilities, lack of maintenance and skills for better use of the existing facilities, complexity of marketing and distribution channels, amongst other factors. Reducing the importance of these losses lays on temperature management practices throughout the supply chain. The advantages of cold chain for fresh produce are:

- Keeping quality characteristics of the produce (freshness, color, weight, texture, nutritional value and many more intrinsic quality characteristics)
- Extending postharvest life by reducing the rate of crop deterioration
- Increasing the availability of the produce in the market all-year around
- Increase the profitability for growers and/or traders
- Contributing to price stabilization of products in the market
- Allowing good conditions of transport to more profitable markets inside or outside the country.

2. Importance of agriculture in the MENA economy

Agriculture plays an important role the economy of many countries in the region. For the Arab Gulf states, the Arab Authority for Agricultural Investment and Development (AAAID) reported that the agricultural GDP volume amounted to an average of $14.1 billion between 2003 and 2006 with Saudi Arabia representing 73% of this GDP and United Emirates 21% (AAAID 2009). For North African countries, the Agricultural GDP participates in the national GDP at 13% for Tunisia, 12% for Algeria, 15% for Morocco, 22% for Mauritania and only 4.2% for Libya. Horticultural production and destination varied widely in these countries. Egypt, Morocco, Tunisia, Algeria, Saudi Arabia, Iraq and Oman produce significant quantities of fruit and vegetables. In contrast other countries in the region such as Libya, Mauritania, UAE, Kuwait, Yemen and Bahrain import large quantities, if not most of fresh produce for their domestic consumption.

3. Cold chain in the MENA region

In the following sections we will highlight the importance of horticultural perishables production and the status, trends and constraints of cold chain in North Africa and Gulf States. Many countries will not be discussed enough because of the scarcity of available of information. Thus, this paper may be amended in the future if more information and statistics are available.

A. Maghreb countries

1. Morocco

Morocco is considered among the largest producers and exporters of fresh products in the area followed by Tunisia and Algeria takes up the third place. During the last 5 years the average production of fresh vegetables was around 7.5 to 8 million metric tons annually. The production is composed, at large part, of crops geared for both export and domestic markets. Horticultural fresh produce include tomato (1.3 million tons), potatoes (1.5 million tons), onion (720 000 tons), sweet potato, green beans, fresh peas, cucumber, zucchini, eggplant, green pepper, hot pepper, onion, cauliflower, cabbage, carrots, turnips, pumpkins, various leafy crops, okra, asparagus, melon, watermelon and many other fruit crops such as citrus fruit strawberries, olives, almonds, apples, plums, apricot, peaches, nectarines, grapes, kiwi, figs, pomegranate, cherries, dates, banana, etc. Overall, 1 to 1.2 million tons, from which citrus represents 600.000 tons, are exported to EU markets, North America, Russia, Gulf States and African countries. The remaining part is either sold fresh at domestic markets or geared for processing industry. For citrus sector, the new strategy program developed jointly between the Association of producers of citrus in Morocco (ASPAM) and the government of Morocco (GOM) aims to reach a production of 2.9 million tons of citrus by 2018 from which 1.3 to 1.4 million tons will be exported and around 400.000 for juice production. To reach that goal the two parties have defined a road map combined with incentives to growers and exporters consisting of increasing the actual planting area of 85 000 ha to over 100 000 ha by 2020. In the meantime the US Millennium Challenge Account program with a budget of over 300 million dollars is underway for the period of 2009-2014 and consists of improving the production and infrastructure for several crops (olive, almonds, figs, and dates) within the country.

1 General characteristics of cold storage facilities in Morocco

Based on the national survey conducted on cold storage facilities within the country, the capacity reserved for fresh fruit and vegetables was estimated in 2003 to be 244.000 tons. However, these data are out of date as a large number of cold storage facilities were built during the last 5 years mostly by the private sector. According to some experts, the total capacity of storage of horticultural products in Morocco may exceed 300 000 tons in 2010. The increase is due largely to the incentives and subsidies allocated by the GOM for construction of cold room for fresh products. The average capacity for each room is little less than 200 tons for fresh products at the packinghouses. While at retail level and distribution level, in the wholesale markets and supermarkets, the volume of an individual room is rather small and varies from 5 to 120 tons. Cold storage facilities are located in 4 main areas; Casablanca- El Jadida (25%); Fès-Meknès (19%), Agadir (17%) and Berkane in the North East part of the country with 7% of total capacity intended for fresh perishables. These regions are the main areas of production of fruit and vegetables in the country.

2 Export oriented products

As large part of the production in the country is oriented to export to EU markets, ALENA and Russian markets, most of the packinghouses of fruit and vegetables were forced to install cold rooms as prerequisite for obtaining a permit for handling perishable crops as required by importers. Therefore, fruits are placed before or after packing in modern cold chambers where the temperature is set depending on the type of the produce to remove field heat. The technique is becoming necessary with increasing use of refrigerated trucks and refrigerated containers for export. Most, if not all, the packinghouses are equipped with forced air cooling system to reduce rapidly the product temperature after packing to a desired temperature during transport as both refrigerated trucks as well as reefers or refrigerated containers are not designed and do not have the capacity to cool down fresh commodities but only to maintain the temperature of pre-cooled produce. Similarly, cold storage rooms used to keep fruits before packing do not have the refrigeration capacity neither the air movement sufficient for rapid cooling. Despite the existing facilities for pre-cooling, their utilization and management are still not optimized in many cases. Often, the time to achieve the desired temperature of 8°C for tomato and 4°C for citrus fruit may require sometimes more than 12 hours.

3 Domestic market

For domestic markets, the use of cold chain is still very limited both during the transport and distribution. More than 90% of fresh produce are still transported in non refrigerated trucks or vans from the farm to the wholesale market. In addition to lack of refrigeration, fruit and vegetables are stacked on wooden boxes and covered with plastic sheets which therefore may increase the temperature of the product and hasten its deterioration (Figure 1). Within the country, the largest wholesale markets are located in the main production areas or in the big cities such as Casablanca, Inezgane-Agadir, Marrakech, Meknès, Beni Mellal and Kenitra. Casablanca wholesale Market has a cold stores capacity for holding perishable crops of about 12 000 T composed of 66 cold rooms of a total capacity of 11 000 tons for storage of fruit and vegetables and 1.100 tons capacity for ripening and storage of bananas.

Figure 1. View of the entrance of the wholesale market of Inezgane

At retail level, except in modern supermarkets, such as Marjane, Metro, Aswak Assalam and LabelVie, where all perishables are sold and kept in cool areas, these crops sold in small shops, at weekly markets, street markets around the country and even in many wholesale markets at ambient temperature which often can exceed 35°C associated with low humidity during the summer period (Figure 2) with or without shade. The lack of refrigeration and unawareness of the retailers on the effects of adverse conditions on fresh produce quality are the main cause of postharvest heavy losses.

Figure 2. View of local market or (souk) in open air and fruits were protected by blankets during hot days.

For deciduous fruit, large producers such as Arbor (Casablanca), Zniber (Meknes) and ABS (Sidi Allal El bahraoui) who dominate deciduous fruit production sector have installed cold facilities for long term storage and several are equipped for Controlled atmosphere storage conditions. Besides their own facilities they are leasing other cold storage and warehouses for keeping their products to stabilize the market demand. However, despite the existing facilities, postharvest disorders are still high due to mismanagement of these units but also to the quality of the products before storage.

For Potatoes and onion, the country produces large quantities of potatoes and onions respectively with 1.5 and 075 million tons annually. From which approximately 50.000 tons of potatoes are exported every year to EU markets mainly to France. The two crops with high consumption rate within the country are stored during the high harvest season throughout the year. If large quantities of potatoes are cold stored, use of refrigeration for storing onions is still limited and are often stored in very traditional way in the open air (Figure 3). Such techniques are responsible for more than 30 to 40% of losses of onions caused by rots and sprouting mainly during the autumn season.

Figure 3. View of onion field and a traditional storage of onions in a common horizontal silos made with loose-rock walls, straw and a plastic sheet on the top.

For many other crops such as carrots, turnips, eggplants, cabbage, lettuce, leafy crops, melon, cucumber, zucchini, etc. is still very limited and the trend is the consumption of these products fresh without long term storage as they can be produced all year around in the country. For the case of pumpkins species and watermelon the storage is mainly done in non refrigerated rooms.

4 Transport

As stated above, large parts of the fresh produce are transported from the farm to the markets in non-refrigerated trucks and vans (Figure 4). Meanwhile, few large companies have started using refrigerated trucks for long distance between the production sites (i.e. Dakhla in the Extreme south of Morocco to Agadir or Casablanca) and also for very perishable products such as strawberries, green beans, asparagus and some leafy vegetables.

Figure 4. Dominant mode of transport of fresh products within the country in non refrigerated trucks and vans.

For export, the use of refrigerated trucks has becoming the dominant way for vegetables to reach foreign markets in Europe and Russia. While refrigerated containers are used for North America, UK and Gulf States. During the last 5 years, over 95% of vegetables and small fruits, estimated to about 400 000 T are exported that way as illustrated in Figure I.5.

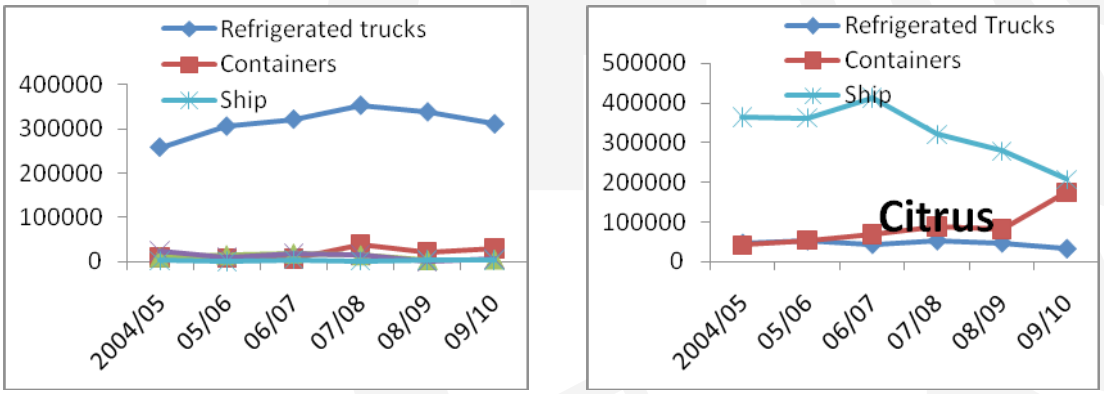


Figure 5. Type and mode of transport used for vegetables (left) and citrus (right) during export to foreign markets.

Refrigerated trucks are either owned by the nationals such as SNTL, SDTM and NTI or leased from foreign companies in Spain, France and Germany (Figure 6). Each truck carries 22 to 24 pallets with an average weight per pallet, depending on the type of produce, of 600 to 700 tons. Therefore, for total export of vegetables and small fruits that exceeds 500 000 tons, more than 20 000 refrigerated trucks and containers are used to ship the indicated quantities every year. In the last couple years, more and more vegetables are exported by containers in compliance with EU programme Marco Polo 2003-2006, which aimed to develop more environmental friendly transport means such as sea transport, rail roads rather than terrestrial roads. Shipping by containers has increased significantly to 32 % of total exported vegetables and fruits against 46% for refrigerated trucks. This change was facilitated by the construction of the largest port for containers at Tanger Med (North of the country).

Figure 6. Refrigerated trucks and containers used for exporting fresh products

5 Main Remarks

a. There is big discrepancy between the products oriented to export and the ones consumed locally in term of quality requirements and standards as well as on the implementation of cold chain. While most of the companies exporting fresh produce have cold storage facilities and good packinghouse facilities, the distribution within country as well as most of the products that are not exported suffer from mishandling practices, insufficient cold storage facilities, bad transport conditions in non-refrigerated trucks in addition to holding the produce at ambient temperatures at retail places in shops and markets without any protection from the sun and high temperatures.

b. The total capacity available for storage of fresh fruits and vegetables is roughly 300 000 tons. In the meantime, total production requiring refrigeration was estimated to more than 7.6 million tons annually. Taking onto account the available capacity and if used at a rate of 4 turnovers, the required capacity to meet the needs for refrigeration should be at least 730 000 tons. This means that another 430 000 tons of cold facilities are needed to be built in the coming years. With the Plan Maroc Vert aiming of increasing production and improving infrastructure for agricultural products, more storage facilities and associated equipment and infrastructures are needed.

c. Even with the projected construction of new facilities, the distribution per inhabitant of cold capacity will still remain low in the country if compared to other countries. Nowadays, Morocco has less than 60 liters/inhabitant against 120 liters/inhabitant for Argentina, 250 liters for Spain, 500 liters for France and 2000 liters for New Zealand 2000.

6 Main constraints

Several constraints that limit the generalization of cold storage in the country are listed:

- Large number of small farmers are unable to invest on on-farm cold storage facilities
- Seasonality of the production and irregularity in the surplus
- Production of some crops throughout the year
- High investment cost for cold storage construction and rent
- Non-continuous cold throughout the supply chain.
- Low utilization of cold transport for domestic markets due to the high fare per kg
- Lack or insufficient refrigeration facilities in the main markets and at retail shops
- Lack of pre-cooling systems before entering cold rooms for many crops
- Insufficient knowhow and misuse of existing facilities (mix of commodities) and inappropriate storage conditions (temperature, humidity air circulation and air change)
- Insufficient awareness of the traders and authorities on the extent of postharvest losses and its economic importance

7 Action of the GOM

With the awareness of the authorities of the importance of cold chain to maintain quality of the produce while reducing waste and quality losses, the GOM has launched several initiatives to help and organize the sector. Some of the these initiatives rely of organization of small growers onto cooperatives and/or to associate with larger growers to facilitate the dissemination of new technologies and improving marketing channels. The GOM through the Bank Credit Agricole has guaranteed financial aid as incentives and subsidies since 1989 and was renewed in 2004 to facilitate the acquisition of new equipments and build storage facilities and packinghouses. These measures aim to meet the requirements and needs of rising production and to catch the attention of private investment. These subsidies concern the construction and the importation of equipment for new storage facilities and packinghouses. The total amount allocated was fixed at 2 million MAD equivalent to US$250 000 (Table 1). It is important to mention that all the agricultural sectors in the country are exempt from VAT both at purchasing inputs or selling the products.

Table 1. Rate of incentives and subsidies offered for cold storage and handling facilities.

Type	Capacity	Subsidy rate of project cost	Maximum of subsidy	Maximum per project (MAD)
Cold storage facility	Less than 500 m^3	0%	0	0
	500 to 5000 m^3	15%	180 MAD/ m^3 (89 to 2004) 150 MAD from 2004 to date	2.000.000
	5000 m^3 and plus	10%	120 MAD/ m^3	2.000.000

Ministry of Agriculture (2011)

8 Examples of success cases

There are several examples of private or semipublic companies that have succeeded in the implementation of good cold chain in the country. These companies have a good cold chain facilities including good storage facilities and state of the art packinghouses with pre-cooling systems, own brand and packaging, etc.. These facilities are also certified ISO 9001, British Retail Consortium and ISO 22000 amongst other certifications required by the potential clients. Large part of their products is export oriented with an average 20 to 30% of pack outs for domestic markets. Some of the companies, not all of them, are listed:

- Azura company which exports annually over 80 000 T of vegetables (Azura-group.com)
- Saprofel company which has a potential for export of more than 75 000 T of fresh fruit and vegetables with an autonomous control from production to packing and good logistics for handling various types of fresh produce (www.idyl.fr)
- Cooperative Copag and associates with a capacity of export of over 40 000T
- Groupe Kabbage with a total cold storage capacity of 15 000 T (www.GPA-export.com)
- Groupe Maroc Fruit Board with a total capacity for storage exceeding 40 000T and exporting more than 350 000 T of citrus fruits
- Arbor Company with controlled atmosphere storage facilities for deciduous fruit, kiwi and grapes with a total cold storage facilities of 6 000T. The company assures storage, packing and distribution to major markets in the country. (www.arbor.ma)
- SOCOMAR with more than 65 000 T cold storage capacity in Agadir, Casablanca and Berkane and are used for storage of various types of fresh horticultural products

2. Tunisia

The Tunisian horticultural industry is composed of 1 430 000 T composed of citrus (350 000T), apples (126 000T), Almonds (60 000 T), pears (66 000 T), prunes (12 000 T), nectarines and peaches (114 347 T), Apricots (23500 T), figs (26 000 T), pistachio (2 300 T), plums (13 000T), cherries (1 900 T), Figs (26 000T), pomegranate (77 000 T), quince (2 600T), Grapes (35 760 T) and dates (174 000T). While vegetable production was estimated in 2010 to more than 2.9 million tons. The latter sector is dominated by the production of tomatoes, potatoes, onion, peppers, artichoke, etc. Most of the production is intended to supply the domestic market with a surplus oriented to export to EU markets. Total amount of exported vegetables has increased from 6.9 thousand tons in 2001 to more than 55 000 T in 2010. The main products exported from Tunisia are tomato, watermelon, potatoes and salads. Export products are oriented to France (45%), Italy (23%), Germany (9%) and the remaining to other EU markets.

1 Cold storage facilities

According to the survey made in 2004 by the Ministry of Agriculture and DGIAA in Tunisia, the total capacity of cold storage in the country was estimated to more than 185 000 tons equivalent to 923661 m^3 for fresh fruits and vegetables. The number of units is 770 with 275 employed more than 10 workers permanently. Storage facilities for perishables produce represent 63% of the available capacity using cold storage. It was concluded from the report of DGIAA that the existing facilities were used at only 50% of their capacity. This is due in part to seasonality of horticultural products, on insufficient production and supply of the units and, to misuse of the existing facilities by the owners or managers due to lack of specialized personnel with good background on refrigeration stores management. The main products that are stored in the country are dates and citrus oriented for export and the imported products for domestic consumption. The distribution of cold facilities and the quantities stored within the country during the year 2004 are as presented in Table 2. Certainly the capacity has been changed due to an increase in the production for various products in recent years and for the implementation of several international companies specialized in food distribution. These companies represent in 2010 more than 20% of the distribution sector and require from their suppliers a strict control of cold chain of the fresh products.

Table 2. Importance of exported and imported products in Tunisia (DGIAA 2004)

	Product	Tons
Exported products	Dates	50 200
	Citrus	19 000
	Other fruit and vegetables	25 000
Imported products	Banana	20 800
	Potatoes	22 000

2 Transport

No sufficient information for a better appreciation of the extent of using cold storage within the country is available. Except for exported products which are shipped in containers or reefers, transport of products within the country is still limited and often done with non-refrigerated trucks or vans. However, some producers of dates in the Southern part of the country are using refrigerated trucks to ship their products to the packinghouses in the north near the capital Tunis.

3 Retail and distribution points

Except for modern distribution enterprises, the use of cold stores for fruits and vegetables is still limited, even though some wholesale markets within the main cities have storage facilities which are considered insufficient to hold all the perishables that need to be cooled. For instance, the main wholesale market of Bir el Kassâa (Figure 7) which supplies the capital Tunis receives 51% of total marketed production within the country has only very small storage facilities with only 6 cold rooms of 100 m² for different fresh products and 42 other cold rooms were recently built for fruit and vegetables (Sotumag at www.sotumag.com.tn 2011).

Figure 7. A General view of the wholesale market of Bir el Kassâa, Tunisia

4 Main constraints

The main constraints reported by Mr Foued Benhmida from GIF (Groupement Interprofessionnel des fruits) are due:

- Predominance of small farms
- Large numbers of middlemen in the sector
- Seasonality of the products
- Imports of fruits and vegetables by the supermarkets
- High costs for the construction and maintenance of cold facilities
- High cost of electricity in the country which tend to raise the price of products
- The rate of use of existing facilities is less than 60%
- Poor management and lack of know-how for the technical labor
- Inefficiency of some facilities due to mix of various crops with different storage requirements
- Lack of pre-cooling facilities
- Expensive transport by refrigerated trucks (more than double in comparison to non-refrigerated trucks or vans
- Lack of regulations policies and enforcement from the authorities on the manner to handle fresh crops

5 Action Plan

In order to boost the sector of cold storage in the country, the GOT has planned a large program to help the implementation and construction of cold storage facilities. To achieve that goal a need of 7.4 MTND was estimated and will include 3.7 MTND for upgrading the existing facilities and improving the storage conditions of various fruit and vegetables and another 3.7 MTDN for the improvement of supply chain, construction of new facilities, marketing, management and institutional organization.

3. Algeria

Similarly to other countries in the Maghreb, Algeria produces a large number of fruit and vegetables in different parts of the country. Most of the products are oriented for domestic markets. Therefore, handling, packaging and storage of various crops is done in traditional manners. For this report, the authors were unable to get sufficient information in order to make a better judgment of the situation of the cold chain in Algeria. Cold storage capacity in Algeria for different products was estimated in 2010 by the Ministry of Agriculture to 2.5 million m^3 which seems to be insufficient for the total production of fruit and vegetables in the country. The authorities of the country estimated the need of cold storage in the country between 10 to 12 million m^3. One of the main crop exported from Algeria is date. With a total production of about 600 000 tons in 2010, Algeria exports only 10 to 12 000 while a large quantities are smuggled to neighboring countries as especially to Tunisia (Algeria-DZ.com 2011). One of the main constraints for the export in the country is the lack of storage facilities and supply for the existing packinghouses in the area of Biskra and Ghardaya. The government

of Algeria has launched in 2007 a program called Green corridor (Couloir vert) aiming the development and introduction of Good production practices and the construction of adequate facilities for packing, transport and storage of dates in the above regions.

B. Gulf States

1. Imports of Gulf countries

For the Gulf Countries mainly the United Arabic Emirates (UAE) and Saudi Arabia import fruits and vegetables and the UAE also re-exports a lot of products. The third biggest importer of fruit and vegetables is Kuwait, but importing only a third of what UAE or Saudi Arabia is importing. It is therefore concluded that UAE and Saudi Arabia are the most important markets for fruits and vegetables in the area. Currently Saudi Arabia imports its fruits and vegetables mostly from Egypt, followed by imports from Asian and Middle East countries. UAE imports most fresh produce from other Middle East countries and secondly from Asian countries. Both countries import substantial amounts from Egypt and South Africa. Both Saudi Arabia and UAE import much more fruits (and nuts) than vegetables (and roots/tubers) in terms of their value. A huge import crop in Saudi Arabia is oranges from South Africa and Egypt. Bananas are mainly imported from the Philippines and apples from the USA, Chile and France. Fruits such as guava, mango and avocado are imported from different countries as Egypt, Pakistan, Iran and India. Grapes are imported from nearby countries as Iran, Lebanon and Turkey. Vegetables as tomatoes and onion are coming from nearby countries or from Egypt, China and India.

2. Local agricultural production of Saudi Arabia

According to the statistics published by the Ministry of Agriculture for 2008, the total number of greenhouse projects reached 244 projects in the different provinces of Saudi Arabia. As recognition of the importance of this sector, most of these projects are partially funded by the Saudi agricultural fund. This fund is a reflection of the government policy that focuses in certain segments as water conservation policy proceeds. One of these segments is greenhouse agriculture. Greenhouse reached to 49,050 Hectare in 2008 after it was 59,706 Hectare in 2001. The decrease in the area was for the open field while there was an increase towards the green house farming. There was a significant development in the vegetables production where it was 1,059,260 in 2001 and became 1,437,466 ton in 2008. It can be noted that the production of greenhouse vegetables during this period was doubled, from 381,437 ton in 2001 to 738,022 in 2008. It should be noted although that the total farmed area was decreased, while the total production increased during this period.

Tomato production significantly increased in the cultivated areas of greenhouses, from 1782 Hectare in 2001 to 3915 Hectare in 2008. Following the same pattern, there was a major development in the production of tomato grown at greenhouse where it reached 336,926 ton in 2008 after it was only 152,126 in 2001.

For cucumber, there was a significant increase in the cultivated areas of greenhouses, where it was 2090 Hectare in 2001 and became 3688 Hectare in 2008. Following the same pattern, there was a major development in the production of Cucumber grown at greenhouse where it reached 297512 ton in 2008 after it was only 154785 in 2001.

For other vegetables such as lettuce, carrot and leafy products, the cultivated area of these vegetables has developed over the year along with its production. It increased from 20875 Hectares in 2001 to 23097 in 2008 with an increase of its production from 392791 ton in 2001 to 481730 ton in 2008.

It should be emphasized that government agricultural policies have been aimed at encouraging farmers by providing them with soft and interest free loans, distributing farm land and purchasing products from farmers at subsidized prices. Therefore, sophisticated technology and modern machinery were introduced, new crops and varieties were cultivated, therefore, greenhouse industry and large agricultural projects were established.

The Kingdom produces many vegetables, including potatoes, onions, etc. Saudi Arabia is not only producing best potato varieties, but has also been exporting them to other parts of the Gulf on an increasing scale. Potato cultivation was non-existent in Saudi Arabia prior to the mid-1970s, although the crop's growing popularity was reflected in rapidly rising imports since 1978. It was then that the Ministry of Agriculture and Water negotiated an agreement with the Netherlands establishing the Saudi Potato Development Program, which initiated experimental trials in Qassim and Khang. Since then production has expanded rapidly. This expansion has been due in part to state price supports and subsidization of seed and other inputs. The area around Riyadh and Buraidah, about 300 km to the northwest, accounts for about 35 percent of Saudi production. The south area as Sulayyil produces another 10 percent. Minor producing areas include Madinah, Hail, Tabuk, Hofuf and Dhahran.

Due to non-availability of adequate storage facilities in most of the production areas or preservation/dehydration facilities, the surplus/excess is wasted. If some percentage of these losses is saved they can be used locally or exported. Although food-processing industry has made some headway, it is still inadequate. There is no statistics or published research available that evaluate this loss due to the absence of a proper cold chain.

1 Postharvest losses

Postharvest handling and storage losses including losses due to spillage and degradation during handling, storage and transportation between farm and distribution. It was reported that food losses in industrialized countries are as high as in developing countries, but in developing countries more than 40% of the food losses occur at post harvest and processing levels, while in industrialized countries, more than 40% of the food losses occur at retail and consumer levels (Gustavsson et al, 2011).

Some published data illustrated that the highest marketing loss for producers in Saudi Arabia was the tomato and fig with 17% and 19.8%, respectively. Grape and cucumber account for the highest marketing loss for wholesalers and importers with 22.8% and 21.3%, respectively. For retailers, imported grape and some types of dates were the highest marketing loss with 15.9% and 15%, respectively. According to the same reference and due to the marketing loss for the crops covered in this paper, other economic resources such as land, water, and fertilizer will face losses by 25.94 thousand hectare, 599.4 million cubic meter, and 9.43 thousand ton, respectively (Kahtani and Kaleefah, 2006).

2 Challenges to establish the cold chain in the Kingdom

There has been significant shortage in research that address postharvest losses in Saudi Arabia in particular and in the GCC countries in general. There are diverse problems and challenges related to the establishment of an appropriate cold chain program that minimize losses in Saudi Arabia and it can be summarized as follow:

1 Harvesting procedures

1. Due to the high ambient temperature, and for certain produce such grapes it is being harvested at more than 30°C.
2. The transported cars that move the produce to the backhouse are not appropriate in most cases.
3. For some big companies (Tabok, Astra and Hadco) they developed some shaded cares with flat tires to transport stone fruits and grapes to the packhouses (Figure 8)

Figure 8. Car to transport produce of Stone fruits from the field to the packinghouse

2 Packinghouses

1. Most packinghouses are not equipped with the appropriate elements to maintain the cold chain such as cold storage (Figure 9).
2. For most facilities, we cannot find any postharvest laboratories that evaluate the quality of produce and trace it all the way down and no shelf life assessment is being done.
3. Hygiene and it is required certificates is not a concern for most growers and producers.
4. For some companies such Tabok and Hadco they have excellent facilities.
5. It was reported that more that 60% of the locally produced vegetables does not sorted or graded (Ismaiel, 2011) and poorly packed and stored (Figure 10)

-A- -B-

Figure 9. Table grape packinghouse in Hial (A and B) and for stone fruit in the north of KSA

Figure 10. Potato packinghouse (left) and poorly stored zucchini. (right)

2 Precooling

For most of the farms there are no pre-cooling facilities even for the major agricultural companies. We found major problems in management such pre-coolers.

In the south at Jazan precooling facility does not exist for the main crop which is mango. In 2005 the area lost 6000 carton because of the lack of proper cold chain.

Table 3. Precooling facilities in Saudi Arabia

Company	Type of precooling	Location	Capacity
Tabok (stone fruits and Grapes)	Wet deck system	Tabok	5 tons/hr
Astra (stone fruits and Grapes)	Wet deck system	Tabok	2 tons/hr
Hadco (Grapes)	Wet deck system	Hail	3 tons/hr
Nadec (Store fruits)	Dry system	Gouf	2 tons/hr
Elgouf (Store fruits)	Wet deck system	Gouf	2 tons/hr
Elboutain (Genral) not working	Wet deck system	Qassim	5 tons/hr
Thimar (Genral)	Dry system	Riaydh	3 tons/hr
Panda (General) not working	Wet deck system	Riyadh	5 tons/hr

Most of the units are not efficient for many reasons. Since most of the facilities are classified as wet deck system (Figure 11), so it has the following disadvantages:

- Limited temperature drop since water freezes at 0 C.
- The minimum temperature can be achieved is about 2-3°C. This temperature is not appropriate for grapes and stone fruits.
- All water used is not treated so cross contamination is a major risk.
- Fiberboard carton gets wetted since the sprayed water is not fully vaporized.
- Limited airflow rate due to its higher density because of water.

-A-

-B-

-C-

Figure 11. Wet deck pre-cooling system, (A) dry coil high humidity cooling system in Riyadh (B) and inefficient cooling management for stone fruit in north KSA (C).

3 Packaging

1. Most of fresh produce packaging dose not match the requirements of the cold chain in terms of ventilation, type of vents and strength (Ismail, 2011).
2. Punnets is used via big companies for stone fruits (Figure 12)
3. For most of the produced fresh produce, it is not sorted or graded where the losses is ranged from 30% to 11 according to products type, cultivation (open or greenhouse) harvesting season and transportation type (AL-Kahtani et al; 2009).

Figure 12. Foam boxes for packing vegetables and fiberboard boxes of fresh produce.

4 Refrigerated transportation

- Most refrigerated trucks used to transport perishable in Saudi Arabia use a horizontal air flow system whereas reefers (marine containers) use a vertical air flow system, which is better in terms of maintain product temperature. The current regulation in Saudi Arabia does not allow for the reefer container to cross the port border.
- Most of the refrigerated trucks available are in very poor conditions and do not have the modern equipment to monitor and control temperature or relative humidity (Figure 13).
- The design of the existing refrigerated transport fleets cause a lot of mechanical damage for the fresh produced weather it is locally or imported since the installed ride system is mechanical and not air ride system.
- The cooling capacity and the air recirculation pattern of the installed refrigeration units do not match the need of produce and cause excessive water loss.
- For specific commodities, such as potatoes, are mostly transported in open trucks.

-A-

-B-

-C-

Figure 13. Inappropriate design for the receiving dock (A), refrigerated transportation used for fresh produce (B) and very poor insulating conditions for the refrigerated trucks (C)

5 Wholesale markets

a. Most of the wholesale markets without cold stores. Even for the existing cold stores in the wholesale market of Riyadh, they are not appropriate to maintain the quality and the shelf life for perishable (Figures 14 and 15).

b. The display docks are not sealed or refrigerated in most of the wholesale markets.

c. Most of the producers of fresh produce do not have any capabilities to cold store the harvest and this way they push it directly to the wholesale market.

d. For dates it is estimate that 59% of growers have cold stores to store dates for about 5 months.

e. About 68%of fresh produce brokers in the wholesale market do not have cold store and this way they market it directly.

Figure 14. The wholesale market in Riyadh with pronounced shriveling in imported pepper.

Figure 15. Wholesale market for vegetables and fruits in the eastern province of KSA

3 Cold storage capacity in Saudi Arabia

Post-harvest losses in perishables amount to 20-40% of the total production within Saudi Arabia. These losses occur at several stages in the postharvest management, harvesting, grading, packing, transport, storage and marketing. Since the cost of conservation requires less expenditure than the production cost, it is better to put more attention to the post harvest management of these perishables. Ability to store successfully without excessive losses enables farmers to negotiate with forces of marketing for better prices. By storage and off-season sale, 20-50% higher price can be earned.

Refrigeration or low temperature storage can most effectively extend shelf -life of vegetable (potatoes and onions) and fruit (dates) in order to reduce post-harvest losses by arresting metabolic breakdown and fungal deterioration of the commodity.

The supply of various crops depends upon harvesting season. A good harvest will result in large quantity of products available in the market. The harvesting season is well distributed over the different production regions within the Kingdom in which guarantees a sustainable supply for the raw materials to the processing factory throughout the year. Part of these crops is marketed as fresh for either direct consumption or processing and part goes into cold storages. Potato can be safely stored up to 6 months. The stored potatoes are then gradually released during the lean crop periods generally from June onwards. The size of the hill crop directly impacts price of stored potatoes. Commercial long-term storage facilities for onion do not exist. Therefore, onion crop can't be held beyond certain period and has to be marketed. The lacking processing facilities further compound the marketing problems of onions.

Table 4. Potato cold stores in Saudi Arabia.

#	Area	Company	Capacity
1	**Riyadh**	Leha	5000
2	**Qassim**	El-Botian	5000
3	**Hial**	Hayiat	5000
		Massara	4000
		Leha	5000
		Hadco	5000
5	**El-Gouf**	Gouf	7000
		Nadec	3000
		Wataina	4000
6	**Tabook**	Tadco	20000
7	**Wadi El-Dawaser**	Enma	4000
		Nadec	3000
		Leha	5000
8	Others		25000
Total			**100,000**

The current storage capacity specialized to meet the postharvest requirements of Potato and Onion is very limited (about 100,,000 tons) and even with very poor technology. Most of these stores are not available for public. They are owned by privet companies that produce potatoes such as Hadco, Nadec, Enma, Tabook, El-Watania. Most of these companies are contracted with sank food factories to supply raw materials on a regular bases based on measurable quality parameters. Therefore the dry matter and sugar content in addition to the weight loss should be closely monitored and controlled during the cold storage. This will force many producing companies to modernize and expand their cold stores. For example, Nadec company is applying for a loan from the Agricultural bank to build 15,000 tons potatoes cold store. Also there is a cooperative especially for potato growers that are doing the same.

Cold storage of dates in Saudi Arabia has been facing a real crisis since the year 2009, according to warnings of agricultural experts. That is because the season of Ramadan occurs before harvest dates, which requires storing dates for a period of 11 months, for use in the holy month. The current cold storage capacity in Saudi Arabia (about 100,000 tons) is inadequate for storing the entire production of dates (about one million tons). About half of the produced dates is consumed during the holy month of Ramadan. The Agricultural bank has increased its lending to finance the construction of cooling warehouses for the agricultural sector. The Qassim region alone is expected to build cold storage warehouses with a total cost of 200 million SR. Other important crops in Qassim that take advantage of cooling warehouses are potatoes, onions, fruits, vegetables and other foodstuffs.

1 International trends in refrigerated warehouse

Public refrigerated warehouse (PRW) storage capacity is increasing around the world, according to the International Association of Refrigerated Warehouses (IARW) Global Cold Storage Capacity Report. IARW has collected data for the 2008 report from over 40 countries, more than ever before. In addition, IARW has compiled profiles of national PRW markets in 18 countries, including several emerging and developing markets. This is also the first year that the report has shown a full decade of industry growth.

IARW monitors PRW capacity in 45 nations and regions. In those places where data was collected in 2006, capacity increased in 17 places while it remained flat in six nations. Data in other areas was insufficient to draw any conclusions. Areas showing the greatest increases were France, Germany, the Netherlands, Spain and Brazil. Total global capacity for these countries for 2008 is 179.82 million cubic meters, which represents a 15 percent increase from 2006.

The total refrigerated warehouses storage capacity in the United States is about 94 billion cubic meters (USDA 2008).

This growth suggests a worldwide trend toward increasing cold storage capacity driven by a greater reliance on the cold chain to meet growing trade and consumption rates of perishable products. Overall global capacity in 2008, including the 25 original countries surveyed, is approximately 247.77 million cubic meters.

This report also marks the first time that IARW has been able to collect accurate data for the cold storage industries in China and India since 1998. In both countries,

there has been significant increase in capacity since then. China shows a 20 percent increase and India's capacity has more than doubled since 1998.

"The cold storage industry is continuing to grow rapidly around the world," notes IARW President and CEO Bill Hudson. "Additionally, we are seeing more and more companies choose to rely on the expertise of the third party logistics industry to meet their storage and distribution needs."

2 Projections of required cold storage capacity

According to this statistics of IARW, the refrigerated warehouse capacity in 2008 were 3.5 Million cubic meter for the Middle East. Using the recommendation of the International Institute of Refrigeration that each 200 kg of products occupies 1m3, its means that 3.5 Million cubic meter equals to 700,000 Tons refrigerated storage.

For Saudi Arabia, a previous study funded by the Riyadh Chamber of Commerce and Industry in 2006, showed that 25% of the total refrigerated warehouse capacity in the Kingdom is located in Riyadh. By other words the total refrigerated capacity in Saudi Arabia is about 440,000 tons or 2.2 Million cubic meter.

By comparing the available storage capacity per capita for different countries, we find that for Japan, it is 0.21 m3/capita; for France, it is 0.141 m3/capita, for USA, it is 0. 313 m3/capita; while for Saudi Arabia it is 0.096 m3/capita. This figure implies that the current cold storage capacity is not adequate to the harsh weather conditions and the vast areas of the kingdom. This capacity should to be tripled within the next few years in order to meet different changes of the increasing population and growing consumption rates.

Total projections of the amount of cold storage tonnage that will be built in Saudi Arabia is difficult to judge, but all indications are that they are likely to be high. Larger growers and other Community and Agricultural Development associations already send tens of funding requests to the agricultural bank for their projects. These suppliers and growers are planning to expand and improve their marketable yields each year, so eventually we believe that available produced volumes will be even higher. The development of refrigerated warehouse is likely to be a catalyst for further increased production and demand.

3 Special cases

a. The National Company for Agricultural Marketing (Thimar)

The company was suffering from a lack of storage space that saves fresh produce handled and supplied. The company was suffering from a lot of loss and a reduced ability to obtain a high price, as well as lack of access to distant markets due to the limited shelf life of their fresh produce. The goal of project was to create a series of cold chain elements including, cold storage, pre-cooling and four refrigerated trucks. A feasibility study was conducted to determine the feasibility of the project.

A dry coil high humidity system was designed and consisted of two forced air cooling tunnels each one to hold 5 tons in one pre-cooling cycle of two hours seven eights cooling time.

The cold store was to maintain high relative humidity to minimize weight loss and to limit temperature fluctuations.

A packinghouse was designed that include efficient and economical local sorting and grading line for different types of vegetables. .

Four refrigerated trucks were selected to serve the following purposes:

- To hold as much as possible of pallets so the width was designed to hold two industrial pallets through the sacrificing of some mechanical strength features insulated panels not its R-value.
- To accommodate a wide range of product mix.
- To minimize vibration and mechanical injuries via installing air ride suspension system rather than mechanical system.
- To have the most efficient cooling capacity.
- To minimize weight loss.
- To have all required control, monitoring and tracing capabilities.
- To accelerate loading and unloading by forklifts by using the most appropriate dimensions of horizontally and vertically that do contradict the traffic regulation either in the dimensions not in the gross weight.

Results of the project showed a significant improvement to the company's revenue due to the investments made. The company got access to more distant markets and has improved the quality and safety of horticultural crops handled by maintaining quality and doubling the shelf life of certain products such as tomatoes and cucumbers.

b. Hail Agricultural Development Company (HADCO)

The company experienced a jump in grape harvest for 2004 season, which necessitated some development in their cold chain. A techno-feasibility study was conducted that include all the details of the production process, current and future handling systems and marketing, future expansion and available capital they are willing to invest. The project included several phases; the first phase was to insulate the packinghouse, increase the efficiency of pre-cooling system and finally developing a program for long-term storage of grapes.

The results obtained after the application of the first and second phases were a significant improvement in the sale price of grapes, where there was an increase in the average selling price by about 60% as a result of maintaining quality and providing better conditions for trade. Also they succeeded in exporting by sea a large amount of their production as a result of the enhancement of precooling. The company has succeeded for the first time to store the desired quantities of grapes for periods of more than three month in order to avoid low prices due to the large supply during the harvest season.

c. ENMA Company

The company contracted with the largest potato processing company in Saudi Arabia to supply sustainably raw material all the year around. The company has limited storage capacity with out of date technology. A new unit was designed to achieve all required conditions for the long storage of potato. The design controls the supply of fresh humid and cool air to maintain a consistent level of CO_2 within the store. For

the first time, ventilated, wooden bins were used to store the potatoes. The bins were treated with organic material to prevent moisture absorption. The material selected was subjected to all required tests to guarantee its strength with a maxim axial load of 1500kg. The dimensions of the bin were to accommodate refrigerated transporting via the normal refrigerated trucks.

4. Case Study: Cold chain in the dates industry in the Gulf region

1. Introduction

The date production is one of the most important agricultural sectors in Arabian Gulf region. Date palm trees (Phoenix dactylifera) is the most widely grown fruit in the Gulf countries and north Africa. The annual production of dates estimated to 7.5 million tons represents a large portion of total fruit production in the area. Saudi Arabia, alone, produces 1.05 million tons of dates from more than 3 million palm trees which represents 55% of total fruit production in the country. This production accounts to about 13.5 % of the total world production of dates (FAO, 2011). Currently, the Kingdom is the third largest date producing country in the world preceded by Iran and Egypt. There are more than 400 different date cultivars of which 60 are predominant in production and popularity.

The date palm has been an important staple food crop and a main source of energy for centuries in people diet of the Middle East regions. It also contributed to human health, when consumed with other food constituents of the daily meal. Fruits of Date Palm trees are rich in sugars (fructose, glucose and sucrose), minerals, and vitamins. They are generally associated with health foods, and have found their way into sweets, confectionery, chocolates, baking products, preservatives, and breakfast cereals (Hassan and Hobani, 1994; Mashhadi, 2002).

The date industry sector started in 1964 with one factory in Al-Madinah Al-Monawarah with a production capacity of 3000 tons per year, and has grown significantly during the last 25 years to 62 date packaging and processing factories with a total production capacity of 102000 tons of dates per annum. Production capacities of the existing date factories range from 500 to 25000 tons of dates per annum. Most of these factories are traditional packinghouses producing whole non-compressed and compressed dates. Still, these date factories did not exceed 15% of the total production of dates (at the Tamr stage). It is estimated that there is an over-production of dates by 10%. This emphasizes the importance of finding new marketing channels for fresh dates. This would eventually assist in utilizing this strategic national product.

The status of the date and palm sector is still lacking an adequate development and use of the cold chain along the postharvest operations. Mishandling and poor storage conditions are the main causes for heavy losses both quantitative and qualitative of dates in the region. Thus there is a need for a review and evaluation of the practices of the whole process of postharvest practices including the cold chain techniques available. From that, suggestions and recommendations can be addressed to improve the current status of dates handling, processing, and cold chain programs.

The objective of this section of the report is to evaluate cold chain (pre-cooling,

refrigerated storage, refrigerated transport, refrigerated display) in the region, with emphasis on the status of cold chain of dates in Saudi Arabia as an example of such practices in the region and suggestions for improvement of such important sector in the region.

Figure 16. View of newly planted date palm field (left) and the tradition of serving dates with Arabian coffee (right).

4.2.State of Date production in the region

World production is dominated by Arab countries from North Africa to Near East as illustrated in Figure 17 (FAO, 2011). Therefore, these are also the main exporting countries (Fig.18).

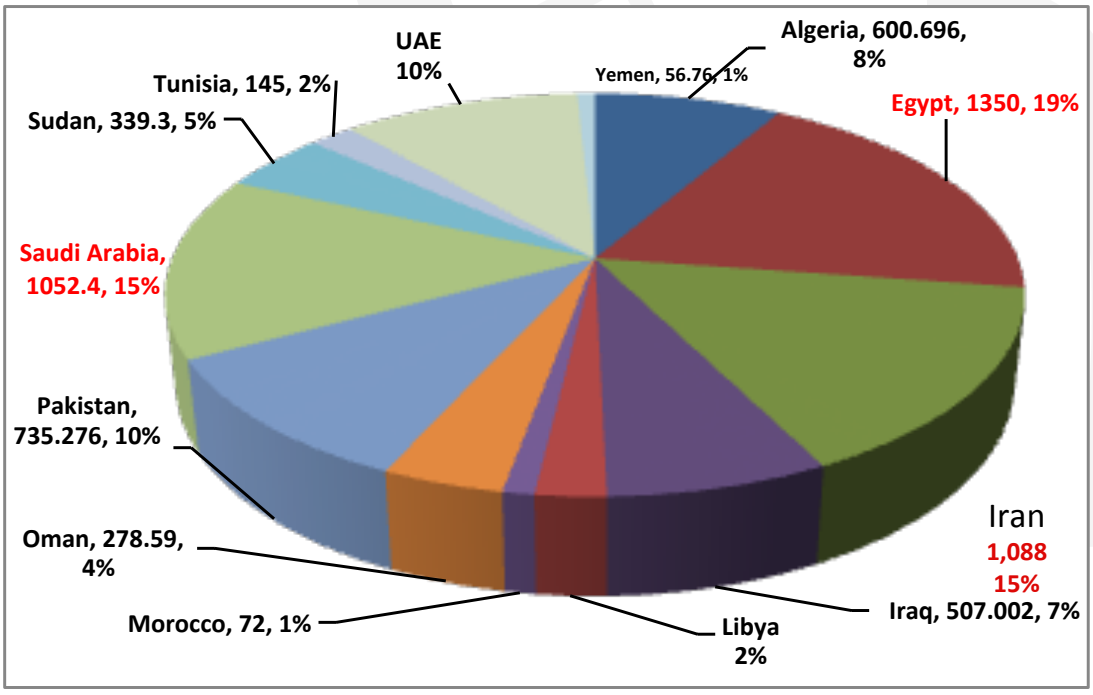
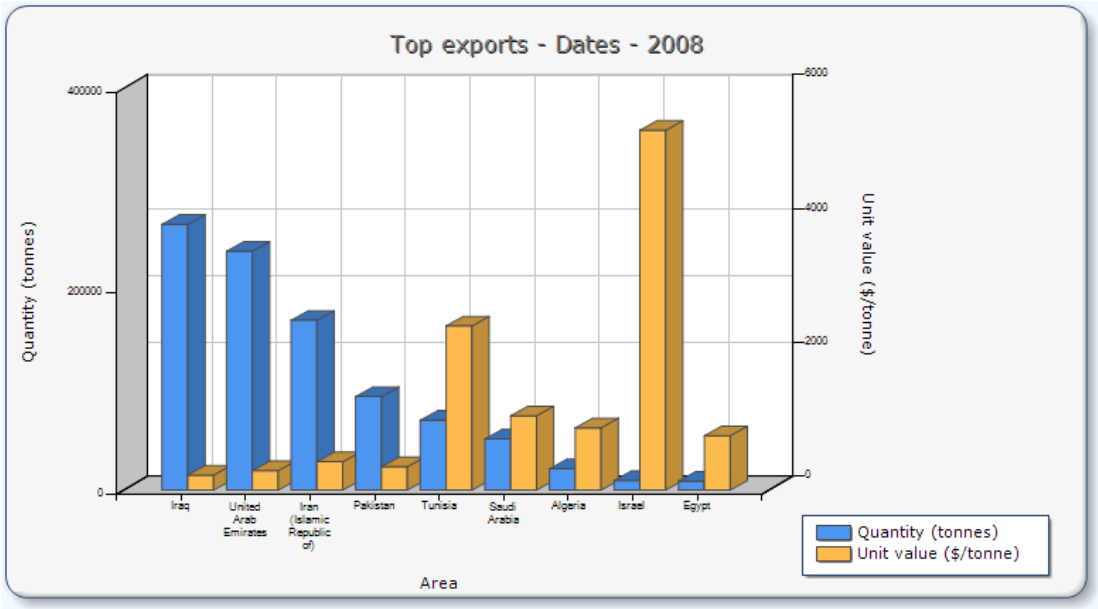


Figure 17. Major producers of dates in the world (2009).



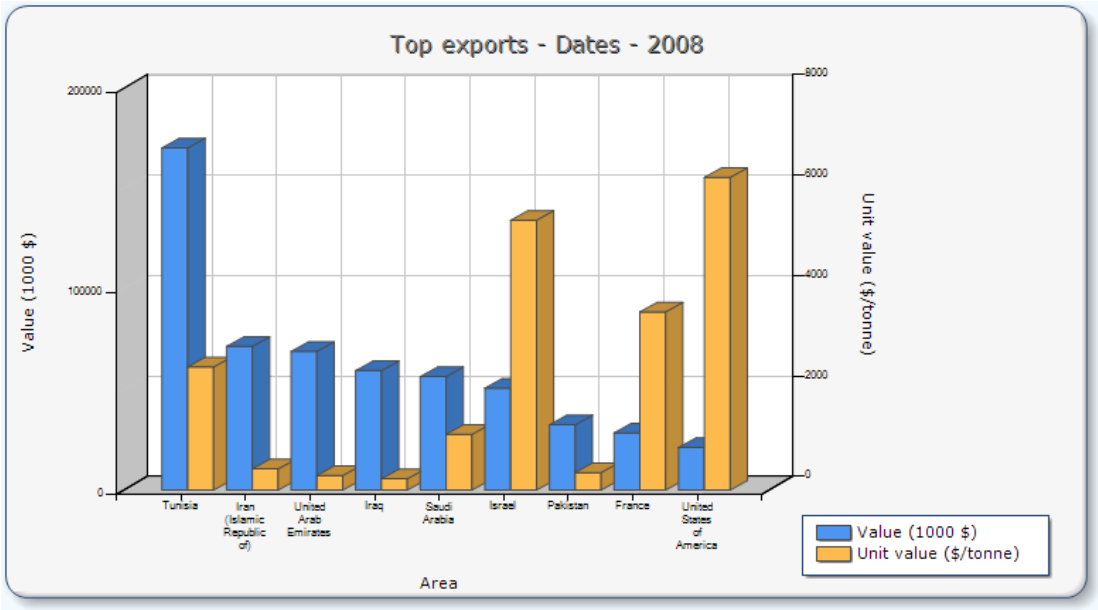


Figure 18. Top exporters of dates in the world by quantity (top) and value (bottom). (Source: FAO Stat., 2011)

In the Middle East and Gulf States, total production has consistently increased in many countries during the last two decades.

Top importing countries of dates are India, UAE, Morocco, France and some East Asian countries (Fig.19). Probably, UAE is doing a good business of importing low quality dates from Iran and Iraq and export them to India. Despite the domination of the world date production, the selling prices (unit value expressed $/ton) of dates from Gulf countries in the international markets are very low in comparison to the value of dates from Israel or the USA (Fig. 18). This is due, in part, to high quality variety such as Medjoul and appropriate postharvest operations of handling, packing and well established marketing and distribution channels. In contrast, in the Gulf States

many pre and post harvest as well as marketing operations are poor and inadequate. One of the main pillars of the postharvest operation to attain high quality produce is the implementation of adequate techniques and technologies in combination with the control of cold chain for dates after harvest to consumption.

Figure 19. Top importers of dates in the world by quantity (top) and value (bottom). (Source: FAO Stat., 2011)

3.Considerations for maturity stages

Though date fruit has one botanical maturity, it has minimum of three distinct commercial maturation levels. Some cultivars are preferred to be consumed due to their higher sweet taste in khalal stage of maturity such as Barhi (yellow color) and Helwah (red color) cultivar.. Most others cultivars are preferred to be consumed in rutab or tamr stages of maturity. The choice of which stage of maturity should be harvested depends on the consumer preference and the marketing strategy of producer. Therefore, in this report we will discuss the cold chain for the three maturity stages.

1. Cold chain for the three stages of maturity

The cold chain for dates is essential to maintain the maximum quality of the produce. As stated above, dates sector is still behind in term of cold chain implementation throughout the supply chain from harvest to consumer.

Facilities used for storage of dates in Saudi Arabia are diverse. There are either (i) private and can be rented by the farmers or buyers, (ii) cooperatives of farmers or buyers, (iii) owned by large farmers, (iv) small stores with only air conditioning system owned by small farmers and (v) cold storage facilities in dates packinghouse facilities.

In this report we will review the status of cold chain in Saudi Arabia for the different stages of maturity. The choice of selecting the stage of maturity for consumption of dates can be summarized in:

The selling price of fruits. For example the selling price of Khlass is higher at Tamr stage compared to Rutab or khalal.

Season (High demand for dates in Rutab stage during Ramadan month).

Financial decision. Khalal and rutab have a fast cash at early season.

Labour in harvesting and handling: Typically, Rutab fruits require care in picking the fruits.

Type of cultivar. This is based on how people prefer stages of ripening to consume the fruit.

The demand/supply of each stages of maturity.

Rutab and khalal should be sold in few days; otherwise, it will spoil. Tamr can be stored without cooling or with normal refrigeration up to one year.

Depending on the agreement between the farmer and the buyers of the production in the farm.

If in khalal or rutab, the farmer can clean his farm few weeks earlier so that of the buyer decided to harvest dates at Tamr stage of maturity. The farmers sell their products directly to buyers (contractors) once the fruit is at khalal stage (not before that). Buyers usually take care of the whole process of harvesting, cultivation, transportation, and marketing.

Depending on type packages and duration

1. Cold Chain for Khalal (Besr)

Products: Prime cultivars: Barhi and Helwah

a. Harvest

The time for harvest started when the workers climb the tree (mostly by a ladder) early morning (~ 4-5 AM to avoid the heat during the days that started at 9:00 AM. Alternatively, picking the fruit would be before the sunset (5:00 PM) and then transport to the cities during the night.

Typically fruits are harvested with whole bunches from the tree to the ground. A piece of carpet (mostly plastic) is placed on the ground to collect dropped fruits while harvesting. Then it will be packed in large boxes (cartoon) and then transported in small trucks to the packing house. Other practices workers are sorting and packing dates with their branches in small board packages. The price for 20 kg box is 3-4 SR and for small ones (2-4 kg) is 1 to 2 SR.

b.Sorting and packaging in packinghouses

Most standards of dates are devoted to fully ripen dates (dry 10-24% MC). To my knowledge, no standard of dates at Rutab or Khalal stages of maturity exist. Alhamdan and Hassan (2003) attempted to measure the several properties of 8 cultivars at Khalal stage.

Since fruits do not ripen evenly in each bunch, typically, trained workers sort the dates by removing the green or yellow green dates in addition to the rutab and ripen fruits in other boxes to be sold separately. Typically the packing house is shaded and sometimes one evaporate cooler is used to reduce the heat stress for workers and the fruit as well. After sorting the yellow (or red) fruit with their branches, they will be placed carefully in the box. Typically the box size varies to handle from 2 to 12 kg. Most of the khalal fruits are sold in 8 kg box and will be capped with the box cover.

c. Transportation

For small farms, mostly the boxes containing the fruit will be packed and transported in a small or medium size truck. Boxes are open to the air, but will be covered on the top layers of boxes with grass and probably will be covered with plastic sheets and then wrapped on top of it. The transportation took up to 5 hrs to the marketing outlets nearby or to other cities.

For large farms, operated by owners, the fruit will be transported in refrigerated trucks. However, it is usually transported with other commodities such as vegetables to the market. They will unload the vegetables first then dates in the auction or the contractors.

In these refrigerated trucks there is no recording or monitoring of temperature; thus no guarantee of the maximum temperature that can reach inside the truck.

d. In the auction market:

Typically the fruit is not placed in storage rooms. It is sold fresh as is and the consumer may buy the fresh khalal fruit from:

i. Auction (if to buy large quantity) under the sun or from vegetable or dates shops.

In recent few years, small shops are started to specialize in marketing dates and its related products. However, individual small shops are buying the fruit directly from the auction.

ii. Others buy the khalal dates from supermarkets. They sell the fresh fruits beside other fruits (apple, orange, etc). They are sold on racks but without cooling. Some dates boxes are sold with wrapped plastic. Most consumers are not in favor of this method because of the low quality of these fruits. That is because of the long chain for distributing the fruit from the main center to the outlet shops. It is not common for supermarkets to sell khalal dates in refrigerated display probably because of the lack of established program for cold facilities.

2. Cold Chain for Rutab

Products: Prime cultivars: most cultivars (some cultivars such as Sequae and Roshodayah have a very short postharvest-life at rutab stage of maturity).

The time for harvest is similar to that of khalal. However, rutab are more sensitive to heat and mechanical damage. Typically fruits are picked individually from the bunches on the tree. A piece of carpet (mostly plastic) can be placed on the ground to collect dropped fruits. Usually, the fruit is picked carefully and placed in already prepared small boxes (cartoon) to avoid the mechanical damage.

At the packinghouse, depending on the % of rutab fruits, workers might sort and pack dates in the packinghouse. Again, Alhamdan and Hassan (2003) attempted to measure the several properties of 8 cultivars at Khalal, rutab, and tamr stages of maturity. Since fruits do not ripen evenly in each bunch, typically, trained workers sort the dates by removing the green or yellow green or yellow dates in addition to the ripen fruits in other boxes to be sold separately. Typically the cartoon box size is in the range of 2 to 5 kg.

For most rutab marketing, the boxes containing the fruit will be packed and transported in a small size truck. Boxes are open to the air, but will be covered on the top layers of boxes with grass and wrapped on top of it. For large farms, if operated by owners, the fruit will be transported in cold trucks. Similar to Khalal chain, there is no cold trucks recording or monitoring of temperature during transport.

In the auction market, the process is similar to that of khalal operation. More care should be considered since rutab compared to khalal due the higher susceptibility of the first to damage.

In the storage, typically the fruit in rutab stage of maturity has two options. The first is to sell in the fresh market, thus has to be sold the same day. The shelf life of fruits at this stage may extend to one week in the consumer refrigerators. The other option is to freeze the fruits either in conventional freezing rooms in field or by renting. Depend on the efficiency of freezing and cultivar, it may extend shelf life to one year. Unfortunately, there is no commercial companies that specialize in this business. All available attempts were made based on personal experience rather than scientific and professional strategy.

At the refrigerated display, most vegetable and dates shops are selling the rutab stages of maturity as well as Khalal. Typically, they are sold in air conditioned shops.

No refrigerated display is found in these stores. It is also not common for supermarket to sell rutab dates in refrigerated display. Again, to keep top quality produce, cool chain should be established and maintained from harvesting to consumption.

Tables 5 and 6 include summaries of the current cold chain status for different stage of maturities of dates (Khalal, Rutab and Tamler).

Table 5. Most farms chain operation from harvesting to outlets.

	Khalal	Rutab	Tamr	
Pre-cooling	X	X	X	
refrigerated transport	X	X	X	for long shelf life of tamr (several months)
refrigerated storage	X	X	√	
refrigerated display	X	X	X	

Table 6. Large farms chain operation of fresh dates from harvesting to outlets.

		Khalal	Rutab	Tamr	Notes
1	Pre-cooling	X	X	X	Existed in Butain facility but not utilized
2	refrigerated transport	√	√	X	Khalal & rutab marketing for 1-3 days
3	refrigerated storage	Not in use	Not in use	√	for long shelf life of tamr (several months)
4	refrigerated display	X	X	X	

3 Cold Chain for Tamr

With no exception, dates of all cultivars can be consumed at Tamr stage of maturity. The ripening occurred naturally after rutab stage of maturity. The time for harvest is typically from September to November. In the past, only dates at tamr stage of maturity can be stored up to one year in special made small rooms or local made packages.

a. At harvest

Typically fruits are harvested after being fully ripen characterized by loosing moisture down to 10-24% MC (dry basis). Some Tamr fruits are harvested from the remaining fruits that were cultivated before ripening takes place. Ladders are used to climb the tree where the whole bunches slide on a rope to the ground on a carpet (mostly plastic). After initial sorting, the fruit is packed (loose) in relatively large boxes (20 kg).

b. At the packinghouse

At the packing house, farmers or buyers decide whether to grade the dates. The fruits can be sorted to two grades (fancy and normal) manually based on subjective judgment. The boxes are made from corrugated paper with plastic sheet covering the interior box surface. The plastic sheets are for protecting the fruit from dust and also to decrease the moisture loss.

In the gulf region, there is no “objective” sorting of dates. It is based on personal judgment and may vary from person to another. However, as general rules consumer prefers dates at Khalal stage of majority with the following characteristics:

a. Larger size.

b. Light in color (close to light brown). Black fruits are not preferred except for Ajwah cultivar because of its spiritual aspects for Muslims.

c. Smooth surface area (less shrinkage)

d. Intact skin (no loosed skin)

e. Standard shape

f. Taste (no high nor low extreme sweetness)

g. Medium texture (mainly based on proper moisture content)

h. Uniformity of properties

i. Free from insects, damage, spoilage, dust, particles, etc.

c. During transport

The boxes containing the fruit will be transported utilizing big truck. Boxes are open to the air, but will be covered on the top layers of boxes with grass and wrapped on top of it. It is not common to transport Tamr dates in cold trucks.

d. In the auction market

It will be sold by placing samples of the boxes on the ground. Usually, there is no shading or cooling in the auction site.

e. Storage

Date at Tamr stage of maturity can be stored at room temperature for several months when properly packaged. For longer shelf life, dates factories and merchants are storing dates in cold storage. The temperature of the cold store for dates ranged between 5 to 15 °C based on the storage duration and type of cultivar. They are stored in either carton or plastic boxed in pallets inside the store. Some stores on metal racks. One major problem for those dates is the loss of moisture resulting in very dry dates (below 10% MC). It is advisable to have proper plastic sealed wrapping or controlling the relative humidity inside the storage by means of humidifier or evaporator design. Based on marketing strategy and demands, the fruit will be transported from the storage to the processing line. The processing line will either compress dates or packed in loose form based on the market to be sold in. Then the dates will be stored in the delivering area (room temperature) for few days ready for shipment. The transportation would be in small trucks (without cooling). In some dates factories, dates will be stored in frozen stores for maximum quality of their produce. One dates factory intended to use freezing method as disinfection of insects.

f. Refrigerated display

Most dates are sold at room temperature in dated shops or in the supermarkets. The fruits are sold either compressed or loose dates.

From this report the following conclusions are drawn

a. Must improve and design simple cold store systems for small farmers.

b. Increase Coop. Soc to build and control cold stores.

c. Must set standards for the cooling chain.

d. Must emphasize effective methods to increase the shelf life of fresh produce.

e. Must introduce CA systems for perishable fruits/vegetables.

f. Must shade the auction site

g. Use evaporative cooler where applicable.

h. Establish a standard procedure for cold chain.

i. Lack of expertise/technician after installation.

j. Review of all procedures that are practice and suggest standards by expertise in this field.

k. Must establish standards/specifications of dates marketing.

l. Introduce The Rutab to the International market.

m. Set standards of Khalal and Rutab stages of maturity.

n. There is need for mechanization for harvesting. High cost of labor during peak season is a nightmare for the farm owner.

Summary

There are many similarities for all the countries discussed above in term of constraints that limit the development of appropriate cold chain for products sold within these countries. Some of these constraints are listed:

- High postharvest losses and poor produce quality at destination
- High cost for the construction, maintenance and management
- Deficiency in professional organization of small producers, handlers and even importers
- Irregularity of supply for packinghouses for domestic markets
- Contractual marketing, absence of market information system, and lower returns to growers.
- Lack of modern packing for sorting, grading, packing and storage facilities mainly for domestic markets
- Lack of quality standards for local domestic markets

- Poor management of the existing facilities and lack of know-how and technical labor
- Difficulties to meet the compliance requirements of Quality standards, Phytosanitary issues, Food safety and Traceability)
- Unavailability of independent Food Testing Laboratories
- Poor transportation systems for domestic markets and absence of cold chain infrastructure in most of weekly and even in the wholesale markets
- Absence of any standard R&D facility for postharvest and cold chain.
- Lack of integration between research, academia and extension

A. Constraints

The main constraints that face the development of cold chain for perishables in MENA region are summarized in the following points:

1. Farm size and range of products

a. Predominance of small farms in many countries with no financial capacities to implement adequate techniques and technologies. Most of the farms tend to sell their produce immediately after harvest in order to buy other needs of their daily life. Very often the produce is sold on the farm before the harvest (i.e. dates). Small farms are using very primitive techniques for the transport of their produce to nearby markets where the prices are low in comparison to large cities markets.

b. Deficiency in the professional organizations of small producers, handlers and even importers in addition to the presence of a multiple middlemen in the sector with the sole aim is making profit rather than searching for better ways to maintain the quality of the produce.

c. Seasonality of the production for several crops with high offer at harvest peaks (low prices for growers, waste of non -stored products, etc.). To ensure market demand, part of the production must be stored for several months.

d. Lack of national standards and/or regulations in the countries that force the vendors to respect those requirements. These regulations should include harvesting practices, transport conditions, sorting and grading and storage conditions

2.Costs of investments

Farmers as well as traders are not able to make heavy investments for acquiring;

a. Pre-cooling facilities

b. Refrigerated trucks

c. Packinghouses and packaging materials

d. Storage facilities

e. Operational costs such as salaries for specialized technicians and trained labor, necessary equipment for loading and unloading the rooms (i.e. forklifts), appropriate packages such as crates and pallets for high rise storage rooms.

3. Lack of sufficient infrastructure and misuse of the existing facilities

a. Misuse (mixing incompatible products, not optimized conditions) and/or under-use of the existing facilities to less than 60% due to insufficient supply.

b. Facilities in many areas do not meet the basic requirements for cold stores. These failures concern the design, the choice of equipment, their installation as well as the maintenance due to lack of know-how both of the managers as well as for the workers.

c. Except for the exported crops by private companies, a large part of the horticultural products are not pre-cooled after harvest and no appropriate operations such as sorting, grading and packing are regularly applied.

d. In many countries, if not all, high percentage of the production oriented for domestic markets are transported in non-refrigerated trucks with fresh produce are transported as a bulk or in large wood crates with no ventilation. Even, in some cases where refrigerated trucks are used, these vehicles do not have the required characteristics to meet the needed requirements of keeping temperature and humidity in the air surrounding the commodities.

e. There is a huge deficit in the capacity of cold storage facilities in the major markets where fruits and vegetables are sold, except for some supermarkets. In many cases, the production transported to the markets stays under direct sunlight for several hours.

b. Recommendations

Due to the high extent of postharvest losses in the horticultural perishables in different countries, attention should be given to better understand the causes and thus to develop strategies to reduce these losses. This can be achieved through:

1. Training and Education

a. Effort should be given to training different actors involved in the production, handling and distribution of fresh commodities to better acquire the best practices of production, harvesting and handling the commodities along the supply chain

b. Increase the awareness of various actors on the importance of cold chain to maintain quality and safety of the products and to increase the economic benefit for the whole chain

c. Develop expertise and know-how of the managers and specialized technicians for running and maintenance of the facilities

d. Compliances with Quality management Systems, phytosanitary and hygiene requirements for safe produce

2. Institutional organization

Because of the predominance of small growers, the governments should facilitate the institutional organizations of the sector such as cooperatives, associations, private owners, Economic Interest Groups (EIG) to facilitate:

a. Access to new techniques and technologies, obtaining loans from banks and subsidies from the government for acquiring appropriate equipment (i.e. pre-coolers, refrigerated trucks, cold stores, plastic crates, packinghouses, etc.

b. To increase and guaranty the availability of enough supply for packinghouses and cold stores throughout the year

c. Facilitate the dissemination of information and know-how and adoption of appropriate practices

3. Development of cold chain in the region

Due to lack and an insufficient control of cold chain in many countries, the governments should develop strategies and means to encourage the involvement of the private sector through:

a. facilitating bank loans at low interest rate

b. providing subsidies for the investment in the sector at different levels (wholesale markets, transport and long term storage

c. providing adequate infrastructure (i.e. shade the auction and wholesale markets, adequate farm to market roads, railway, airways and shipping in addition to packing, storage, reefer containers)

d. reducing the taxes on the imported equipment destined to maintain cold chain conditions along the supply chain

e. reducing electricity fees of facilities used for storage and handling fresh crops

f. encouraging development of market intelligent system

g. development and enforcement of the regulations

h. developing of media support, educational tools and programs.

i. establishment of regional center of Excellency of cold store R&D

j. Encourage the "Green cold chain technology".

4. Research and Development

a. R & D capacity building in the area of fresh produce cold chain, by establishing a Centre of Excellence in Postharvest Science and Technology.

b. Development of quality standards for different crops and cooling chain

c. Development of appropriate conditions of harvesting, handling and storage for specific products (i.e. dates)

d. Development of information on protection of crops postharvest (various types of chemical, etc);

e. Appropriate technologies suitable for hot areas (i.e. evaporative cooling)

f. Development more collaboration between the different actors involved in production and handling commodities with research institutions, academia and extension services

g. Encourage the development of laboratories for quality parameters testing, pesticides residues analyses

5. Development of database on:

a. Harvesting practices and equipment used

b. Importance and type of transport

c. Importance and type of storage rooms

d. Companies involved in cold chain in the country

6. Regional and International collaboration

a. Getting the support of different international organizations such as FAO, IIAR, WFLO, GCCA and IARW

b. Organize conferences and seminars on various issues related to the cold chain in the region at regular period in different countries

c. Develop exhibition (agricultural fairs) to encourage the growers and handlers to be up-to-date on the available technologies

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Literature cited

AL-Kahtani, S. H; AL- Qunaibet, M.H; Ismaiel, M.S , Husain . Hebaisha. (2009). Agricultural Marketing in the Kingdom of Saudi Arabia: Existing Situation, Problems, and Solutions. Funded project, king Abdul-Aziz for science and technology. Riyadh.

Gustavsson, J; Cederberg C; Otterdijk, R.V. (2011). Global food and losses food waste. Food and Agriculture Organization of the United Nations, Rome.

Kahtani, S.H and Adel M. Kaleefah. (2006). Post Harvest Technology Impact on Marketing Loss and Economic Resources losses for important vegetables and fruit crops in Saudi Arabia. Funded project, King Abdul-Aziz for Science and Technology. Riyadh.

Ismaiel M. S. (2011). Dept. of Agricultural Economics. College of Food and Agricultural Sciences. King Saud University. Personal contact.

Ministère de l'Agriculture et de la pêche maritime, 2011. Rapport sur la chaine du froid par Mr Chemsi (2003).

SESSION II.
FISH PRODUCTS

THE STATUS OF THE COLD CHAIN IN THE FISHERY INDUSTRY IN THE MENA REGION

Izzat Feidi , Haydar Alsahtout, and Amar Kaanane

1. Executive summary

For centuries mankind has been aware of the importance of cooling food to delay its deterioration. Natural ice has been used by the Egyptians and Chinese for over 2000 years. Early on ice and salt were used as preservatives and colder countries transported fish to warmer regions. Mechanical ice making developed and the use of refrigerants began around the 19th century with various applications. Beginning of the 20th century refrigerants started to be used worldwide in different modes but with some restrictions due to their effect on the ozone layer.

A general definition of a cold chain is that it is an unbroken chain for perishable products in an uninterrupted series of storage and distribution activities maintaining a given temperature range. Cold chains developed over time into various methods of applications to suit various situations and products including fish and fishery products. These developments have ensured the safety of food and countries made it a priority policy of the highest standards.

Collectively the 21 countries in the Middle East and North Africa (MENA) region have 23,000 km of shorelines, 707,000 sq km of continental area and 16,600 km of rivers and several lakes and other water surface bodies. The region has access to two oceans, several seas, gulfs, lagoons as well as a large expanse into the EEZ. According to FAO the total combined fish landings in 2009 amounted to 3.8 million tons of which 2.5 million tons from capture fisheries and 0.9 million tons from aquaculture. However, in the last few years capture fisheries is showing a declining trend while aquaculture production is on the rise and may surpass capture production in a few years.

The fisheries in the MENA region may be divided into two main sectors: the artisanal, traditional and small-scale sector which produces between 85%-90% of total fish production and operates in poor rural, coastal areas, and the semi-industrial, industrial sector producing the balance and operates in off-shore fishing grounds. Likewise, the current status of the cold chain may also be divided into two: the artisanal one which is very poor or no-existent while the industrial owns a most developed cold chain and runs state-of-the-art infrastructure facilities. The industrial sector has achieved several success stories that allows it to produce high quality products with own trade mark products and export to markets where imports are very strictly regulated such as the E.U. and the U.S.A. markets.

To support the development of safe food including fish and fishery products within a reliable cold chain system, some countries in the region established local organizations

to support production of high quality products and to export to international markets. Also various laboratories were established to ensure the safety of the products for the local markets as well as for export. Internationally there are some tools which were also established to support the production of quality and safe food. The FAO Code contains a specific article on safety of fish and fish products, FAO/GLOBEFISH network provide information on marketing quality fish and fish products worldwide, the European Commission and the U.S.F.D.A. provide support and assistance to fish exporters. Also the HACCP system is used as a useful tool to ensure food safety and quality especially by the semi-industrial, industrial fisheries sector. Many countries now look for traceability certification and verification of the fish products from organizations such as the Marine Stewardship Council.

In spite of all the available support and tools that help to produce good quality and safe fish and fishery products, there are several constraints, mostly in the artisanal, small-scale sector. These constraints stand against better preservation for fish landings and minimize pos-harvest losses. These include lack or shortage of investments in cold chain facilities, poor sanitation on board and on-shore, low hygienic standards, little or no ice on-board or on-shore, lack of cold storage, refrigerated cabinets and transport, specialized human resources, training and awareness on the importance of the cold chain for fish and fishery products and that producing safe and quality food is a prime policy.

The main recommendation suggested to meet the challenge is the establishment of a reliable and efficient integrated cold chain system. Governments in each country needs to collaborate with the private fisheries industry, fishermen's organizations, international organizations and donor agencies to establish, where needed, an integrated cold chain system in fishery based communities. These should include projects with the primary links of proper postharvest handling, processing and packaging, cold storage and distribution, refrigerated transportation and marketing of quality and safe fish and fishery products that meet requisite standards.

2. Acronyms

CFC	Chlorofluorocarbons
Code	Code of Conduct for Responsible Fisheries
EC	European Commission
EEZ	Exclusive Economic Zone
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration
HACCP	Hazard Analysis and Critical Control Point
HCFC	Hydrochlorofluorocarbons
ISO	International Standards Organization
INFOFISH	Intergovernmental Organization providing marketing information and technical advisory services to the fishery industry of the Asia-Pacific region
INFOSAMAK	Centre for Marketing Information and Advisory Services for Fishery Products in the Arab Region
INFOPECHE	Organisation Intergovernmental d'Information et de Coopération pour la Commercialisation des Produits de la Pêche en Afrique
MSC	Marine Stewardship Council
RSW	Refrigerated sea water
ODS	Ozone Depleting Substances
FAO/GLOBEFISH	FAO/International Fish Marketing Information Network
UAE	United Arab Emirates
UK	United Kingdom
USA	United States of America

3. Introduction

Throughout the journey from catch to consumer, the fishing industry is expected to rely on a cold chain to ensure the food safety and commercial viability of its fish and fishery products. The safety of the food, its shelf life, taste and appearance all depend on reliable refrigeration to retard spoilage and minimize postharvest losses. This cold chain may take various forms including use of ice, refrigerated seawater, refrigerated compartments and cold stores, but a common feature in all of these applications has been the traditional use of chlorofluorocarbons (CFC) based refrigeration technology.

The MENA region is among the regions of the world where much of its fish, especially the quantities landed by the artisanal, traditional and small-scale fisheries were its fishing operations are mostly in inshore waters do not have sufficient cold store facilities in order to keep its fish and fishery products in high quality and safe for human consumption and therefore looses much of its value upon sale. One of the main reasons for this anomaly is that a high number of the fishery-based communities in the region are situated in remote, rural coastal areas, around rivers, lakes and fish farms where the general infrastructure facilities are poor and/or nonexistent.

In contrast to this situation, the semi-industrial and industrial fisheries sector, which is mostly owned and operated by large scale fisheries enterprises, is very much more advanced and high proportion of it meets international standards in its fishing operations in off-shore fishing grounds and the high seas operating advanced fishing fleets equipped on-board and on-shore with cold chain facilities and much of its production meets international standards.

This study reviews the historical background of the cold chain, sets the principles of safe food as well as summarizes the current status of the main two fisheries sectors and of their utilization of the cold chain facilities in the region. The study also discusses the main constraints which faces and challenges both sectors to alleviate the current problems in order to raise the standards of quality and reduce post-harvest losses. Finally the study recommends steps to be taken in order to raise the level of the fisheries industry in general for the overall benefit to the fisheries-based communities in the MENA region.

4. Historical background to cold storage of fish

For centuries mankind has been aware of the importance of cooling food to delay its deterioration. Natural ice has been used by Chinese and Egyptians for this purpose for more than 2000 years. Frozen fish in cold winter from northern countries was transported to towns in warmer areas. Ice and salt mixture was successfully used during the mid-nineteenth century. With the advent of mechanical refrigeration during the third quarter of the nineteenth century, artificial ice was produced on commercial scales in North America and the European countries. By the end of the nineteenth century, both vapour compression machines using ammonia and carbon dioxide, and absorption machines using ammonia-water were developed for use in cold stores, ice factories and for quick freezing of fish by direct immersion in brine at –18 °C.

During the first quarter of the twentieth century, the technology of quick freezing of fish by direct immersion in brine found its way on board trawlers and ships in the USA and in Europe. Production of ice by ice plants became common. By the second quarter of the twentieth century large boats, trawlers and ships with on-board refrigerated holds and quick brine freezers were commercialized. However, since the quality of frozen fish was found to be inferior to that of freshly caught fish, the beneficial effects of storage at lower temperatures of –23 to –29 °C were realized by late 1930s. With the advent of CFCs, ozone depleting refrigerants found their way into refrigerated trawlers, ships and cold stores.

Today refrigerants R-12 (CFC-12), R-22 (HCFC-22), R-502 and ammonia are the predominant refrigerants in the fishery cold chain. In the past few decades R-12 has been more commonly used in small cold rooms, refrigerated transport and domestic refrigerators and freezers. R-502 found its way predominantly in the commercial display cabinets and the R-22 in refrigerated warehouses, ships, fishing trawlers and containers. Ammonia has been the refrigerant of choice in large refrigeration plants including ice plants, freezer stores, cold storage, chilled brine and refrigerated sea water (RSW) systems particularly in developing countries with temperate climates like Southern China, India and Indonesia.

Phenomenal developments in biotechnology during the past three decades have resulted in enormous growth, not only in refrigerated fish caught at sea or inland waters but also in aquaculture and other foods. Although some evidence of the existence of aquaculture of food fish in Egypt and China may be traced as far back as 2500 to 4000 BC.

Due to the destructive effect of CFCs, HCFCs and other ozone depleting substances (ODS) on the earth's stratospheric ozone layer, the international community has agreed to reduce and eliminate the production and use of these substances. Under the Montreal Protocol on Substances that deplete the ozone layer, developing countries agreed to a specific phase-out timetable, beginning with the freeze in consumption and production of CFCs in July 1999. This was followed by a 50 per cent reduction by 2005, an 85 per cent reduction by 2007 and total phase out by 2010. HCFCs, another category of refrigerants that deplete the ozone layer, considered 'transitional substances' share the fate of CFCs and will also be phased out eventually.

5. Definition of cold chain in fisheries

A cold chain is a temperature-controlled supply chain. An unbroken cold chain is an uninterrupted series of storage and distribution activities which maintain a given temperature range. It is used to help extend and ensure the shelf life of perishable fresh, chilled and frozen fish and fishery products. As one kind of perishable food, fish product is at risk of suffering various damages during cold chain and temperature is the most important factor to affect the product quality. A cold chain can be managed by a quality management system. It should be analyzed, measured, controlled, documented, and validated.

There has been an increase in cold storage capacity in the last decade. Factors fueling that growth include international trade due to the increased popularity of frozen commodities and retail expansion.

Depending on space, seafood spend anywhere from three days to three months in storage. The varied time in storage can be a result of products that tend to move a little more slowly, since at times buyers will purchase seafood in bulk in an attempt to time the market needs.

6. Principles of food safety

Generally speaking, countries should have as a priority a policy containing the highest standards of food safety. It should have a process that drives the need to guarantee a high level of food safety in all aspects of food that is fit for human consumption whether it is fish, agricultural products, and processed foods as well as imported food commodities.

A food safety policy must be built around high food safety standards, which serve to protect and promote the health of the consumer. The production and consumption of food is central to any society and has economic, social and, in many cases, environmental consequences. Although health protection must always take priority, these issues must also be taken into account in the development of food policy. In addition, the state and quality of the environment, in particular the ecosystems, may affect different stages of the food chain. Environment policy therefore plays an important role in ensuring safe food for the consumer.

The fisheries as well as the agro-food sectors are of major importance for the economy of countries as a whole. The economic importance and the ubiquity of food in the life of citizens suggest that there must be a prime interest in food safety in society as a whole, and in particular by public authorities and producers. The concept of food security thus evolved to rest upon four pillars:

- **Food availability**: ensuring sufficient food supply whether from local production or the international market.
- **Food stability**: ensuring a stable supply of food throughout the year and from one season to the next.
- **Food accessibility**: ensuring that the food is available to the public at affordable prices relative to their income.

- **Food safety**: ensuring that the food consumed is free of any harmful contaminants and safe for human consumption.

The four pillars combined mean that all people in the country should be able to obtain their essential nutritional requirements throughout the year with no risk of deprivation, regardless of whether the food is produced locally or imported.

7. An overview of the fishery industry in the MENA region

Collectively the 21 countries which comprise the MENA region have more than 23,000 km of shoreline and 707,000 sq km of continental shelf area. Furthermore, they also have 16,600 km. of rivers, fresh and brackish water lakes and other water surfaces. These countries have access to two oceans, three major seas, several gulfs, lagoons and a large expanse into the Exclusive Economic Zones (EEZ).

The latest FAO fisheries statistics reported for the three years 2007- 2009 that the countries produced from all sources (capture, aquaculture from fresh, marine and brackish waters) a total of 3.5 million tonnes, 3.6 million tonnes and 3.8 million tonnes respectively (Table 1). The statistics for 2009 show that of this quantity 2.8 million tonnes (76% of total production) were from marine and fresh water capture fisheries and 0.9 million tonnes (24 %) from aquaculture (Table 2). However, statistics for the years 2007-2009 indicate that total production from capture fisheries are declining while aquaculture production is on the rise (Table 3).

The fisheries of the region operate in marine, fresh, brackish waters and in aquaculture in fresh, brackish and marine waters. The major marine capture fisheries resources in the region are concentrated mostly in the fishing grounds of three major fishing areas. These are:

1. Indian Ocean (North-west) and adjacent waters including: Arabian Sea, Red Sea and Gulfs; (FAO Statistical Fishing Area 51);
2. Mediterranean Sea; (Area 37) and
3. East-central Atlantic Ocean (Area 34).

Furthermore, the fresh and brackish water capture fisheries takes place in rivers, lakes, lagoons and other water bodies. As for aquaculture, it takes place in coastal marine areas (mariculture) and also in man-made fish farms as well as in rivers, lakes and other inland water bodies such as reservoirs, dams and other man-made ponds.

FAO latest statistics in 2009 shows that Morocco leads the region in total fish production from all sources with 1.07 million tonnes followed by Egypt with 1.06 Million tonnes, Mauritania with 162,549 tonnes, Oman with 152,111 tonnes and Yemen with 121,101 tonnes (Tables 1 and 2).

Morocco leads the region in fish production from marine capture fisheries with 1.07 million tonnes; followed by Iran with 418,403 tonnes; Egypt with 364,280 tonnes; Mauritania with 162,549 tonnes; Oman with 151,993 tonnes; and Yemen with 121,101 tonnes (Table 2).

Table 1. Fish Production from all Sources in the Region by Country: 2007-2009 (Tonnes)

Country	2007	2008	2009
Algeria	145,383	140,010	128,804
Bahrain	13,032	13,637	12,811
Djibouti	1,229	1,206	1,058
Egypt	999,168	1,057,936	1,069,780F
Iran	560,492	559,468	597,976
Iraq	73,589	53,718	53,237
Jordan	1,015	1,040	1,009
Kuwait	4,721	4,733F	4,733F
Lebanon	4,564F	4,564F	4,564
Libya	31,513	46,847	49,740
Mauritania	208,020	185,758F	162,549F
Morocco	827,909	917,825	1,074,330
Oman	141,007	142,823	152,111
Palestine, (O.T.)	2,639	2,816	1,527
Qatar	15,175	17,666	14,056
S. Arabia	82,861	88,537	92,654
Sudan	67,459	70,595F	73,890
Syria	17,753	15,516	15,214
Tunisia	95,463	92,993	94,542
U.A.E	78,590F	74,956	77,309
Yemen	170,369	121,101	121,101F
Year Total	3,541,951	3,613,745	3,802,995

Source: FAO-Fisheries and Aquaculture Information and Standard Statistics Service.
F=FAO estimate.

Table 2. Capture and Aquaculture Fish Production in the Region: wwBy country 2009 (Tonnes)

Country	Capture	aquaculture	Total
Algeria	126,645	2,159F	128,804
Bahrain	12,809	2	12,811
Djibouti	1,058	--	1,058
Egypt	364,280F	705,500	1,069,780F
Iran	418,403	179,573	597,976
Iraq	34,505	18,732	53,237
Jordan	569	440	1,009
Kuwait	4,373F	360F	4,733F
Lebanon	3,761F	803F	4,564
Libya	49,500	240F	49,740
Mauritania	162,549F	---	162,549F
Morocco	1,073,085	1,245F	1,074,330
Oman	151,993	118	152,111
Palestine, (O.T.)	1,412	115	1,527
Qatar	14,020	36	14,056
S. Arabia	66,536	26,118	92,654
Sudan	71,690	2,200F	73,890
Syria	6,517	8,697	15,214
Tunisia	90,488	4,054	94,542
U.A.E	77,309	0-	77,309
Yemen	121,101F	---	121,101F
Total	2,852,603	950,392	3,802,995

WSource: FAO-Fisheries and Aquaculture Information and Standard Statistics Service. F=FAO estimate; 0= more thn 0 but less than half tonne; - -- = data not available.

Table 3. Total Capture and Aquaculture Fish Production: 2007-2009 (Tonnes)

Fisheries	2007	2008	2009
Capture	2,696,034	2,702,444	2,852,603
Aquaculture	845,917	911,301	950,392F
Total	3,541,951	3,613,745	3,802,995

As for aquaculture production from fresh, marine and brackish waters, Egypt by far is the main producer with 705,500 tonnes and Iran is second with 179,573 tonnes. In comparison, most other countries in the region produce annually small quantities of fish from aquaculture mainly Saudi Arabia with 26,118 tonnes and Iraq with 18,732 tonnes while the other countries hardly exceed 200 tonnes each (Table 2).

Global production in the fisheries sector is projected to increase by 1.3 percent annually to 2020. This is slower than growth over the previous decade, due to reduced or stagnant capture of wild fish stocks and lower growth rates in aquaculture, which underwent a rapid expansion over the 2001-2010 period.

By 2015, aquaculture is projected to surpass capture fisheries as the most important source of fish for human consumption, and by 2020 should represent about 45 percent of total fishery production, including non-food uses.

8. Current status of the cold chain in the MENA region

The fisheries industry in the region is divided into two main sectors: the artisanal, small scale fisheries and the semi-industrial, industrial fisheries. Likewise, generally speaking, the cold chain in the region may also be divided into two: the traditional and poor methods practiced by most of the artisanal fishermen in preserving the quality of their landings by using a cold chain that guarantees fish quality from point of catching the fish until it reaches the consumer and the advanced methods used by the semi-industrial and industrial fisheries sector by using the latest fish preservation technologies throughout the process of landing the fish on board fishing vessels until it reaches the consumer.

1. The artisanal and small-scale fisheries

In the artisanal and small-scale fisheries sector which produces between 85% - 90% of total fish landings of the region, there is a shortage of awareness of and appreciation for cold chain systems at several levels of the industry especially in the more remote and rural areas where artisanal fishermen operate. It should be noted however, that the artisanal or traditional fishermen use various methods of fishing in their marine or fresh water inshore waters using a variety of gear, un-mechanised or mechanized with outboard engines or sail and make a few hours fishing trips without using ice or any means of catch preservation. Most of these fishermen are not aware of the beneficial impact of getting their fish catches into a cold chain system. Coastal markets lack the awareness to utilize cold storage to improve catches quality shelf life, and the basic belief that fish will be consumed within a few hours limits the creative thinking and desire to integrate catches into cold chain systems as soon as the fish is landed.

In this same sector, small scale fishermen, however, use bigger fishing boats with in-board engines and usually make one or three days fishing trips using different fishing gears and use ice in fish holds on board or in insulated boxes to preserve their catches. While the catches of these fishermen are in a better preservation condition, but there is a shortage of refrigerated infrastructure and capacity necessary to support the cold chain in the artisanal, small-scale sector. Value added packing facilities, short term storage, refrigerated transportation, and refrigerated display at the point of sale are all generally inadequate to support the existing fresh fish production base in the region, and are not developing at a rate fast enough to create capacity in the artisanal traditional, small-scale sector.

In several fishing communities of the artisanal sector there are difficulties of access to ice or ice plants and cold stores to preserve fish landings until reaching the markets. Furthermore for onward transportation in a distribution process refrigerated trucks or insulated boxes are not usually available in many of the landing sites. As in most of the countries of the region, fish trade is carried out by the private sector in a free market atmosphere. The availability of the cold chain facilities are usually dependent on individual initiatives on the part of traders or agents of fish processing companies who purchase landings for their trading activities and or for processing into value-added products whether for the local market or for export.

In some areas fishermen cooperatives or organizations and fish traders run their own cold chains such as providing ice on board their fishing boats, on landing sites or during transportation of the fish. Landing and transporting of catches is carried out to the marketing centers to bigger towns and cities or for export. These trading companies which provide these facilities have their priorities directed towards production and processing for direct sales to the market sometimes without strict attention to the quality and shelf life of the product. Some of these organizations receive aid from local governments, regional and or international organizations to compensate for the lack of governmental support for the poor fish landing sites.

Postharvest losses occur most in the artisanal, small-scale fisheries sector. Fish losses caused by spoilage are estimated at 10-12 m. tonnes/year or about 10% of total world catch of about 145 m. tonnes in 2009.Postharvest losses are mainly caused by:

- Inappropriate use of preservation methods,
- Distribution and marketing system cannot cope during glut periods,
- Physical loss from discarding of by-catch,
- Absence or shortage of cold storage facilities,
- About 25% of catch is processed into fish meal or oil.
- Solutions to reduce post-harvest losses include:
- Wiser use of resources by reducing spoilage and discards,
- Converting low-value resources into products for human consumption,
- Improved fish handling on-board and on-land, processing, preservation and transportation,
- With more fish scarcity, discards and by-catch may become more commercially desirable.

2. Semi-industrial and industrial fisheries

In full contrast to the artisanal small-scale sector, the semi-industrial and industrial fisheries sector has developed over the years into various degrees of sophistication by installing and operating the latest in equipment and technologies in cold chain systems for the preservation and good quality of their fish catches, processing, distribution and marketing, as well as importing and exporting fish and fishery products regionally and interregional. In several countries in the region, many successful fisheries enterprises were established over the last three to four decades several of them operating fishing vessels and trawlers of medium to large vessels and motherships that make fishing trips of one week to a month or more.

These fishing craft usually have on-board ice plants, freezers and refrigerated fish holds. On-land they operate efficient cold chain systems to handle fish from landing point until the fish reaches the consumer. These systems include ice plants, cold stores, and various methods of freezing and processing, packaging fish and value-added fishery products. Also they operate fleets of refrigerated trucks for transporting fish from landing sites, to markets and also for export. Also several national and international cargo airlines are equipped to airlift live, fresh, chilled and frozen fish and fishery products to export markets from the region especially to Europe. In their retail fish shops they have the latest in fish display cabinets, freezers, chilling and icing cabinets in sophisticated fish retailing outlets in most major cities and towns.

9. Fishery cold chain success stories in the MENA region

In the semi –industrial and the industrial fisheries sector, there has been significant progress in the installation and running cold chain systems by several small, medium and large fisheries establishment in several countries in the region. Most of these enterprises are private sector entities and engage in a variety of activities within the fisheries industry. These activities include operating advanced, fishing vessels, refrigerated fish storage, fish processing in to value added products, distribution, wholesaling and retailing to the general public. Several of these companies have met international standards in exporting their products to the European Union (EU), United States of America (USA), and Japan where such countries apply very stringent fish preservation regulations on their food imports. Several of these enterprises also use refrigerated air cargo to export or import fish and fishery products. Furthermore, some of these companies established their own logos and brand name products such as, “ASMAK” of International Fish Farming Company of Dubai, “TAQA’ of Oman Fisheries Company and “ALASMAK” of Saudi Fisheries Company.

Most recent and a first such event in the region was the importation recently by air form Germany to Abu Dhabi a consignment of live sturgeon to start what is described as the world’s biggest caviar factory which is being built in the Emirate of Abu Dhabi, U.A.E. The 22 adult sturgeon fish were flown from Frankfurt Hahn Airport to Abu Dhabi and then transported to a new 60,000 sq meter state-of-the-art farm recently commissioned for rearing sturgeons and production of caviar.

Some major examples of cold chain success stories involve the following enterprises:

1. Saudi Fisheries Company, Dammam, Saudi Arabia “ALASMAK”
2. National Prawn Company, El-Lith, Saudi Arabia. Their moto: “Pond to Plate”
3. Arab Fisheries Company, Jeddah, Saudi Arabia
4. Oman Fisheries Company (SAOG), Ruwi, Oman
5. Dhofar Fisheries Industries Company,(SAOG), Salalah, Oman
6. Oman Sea CO (O.S.C), Ruwi, Oman
7. International Fish Farming Company “ASMAK”, Dubai, UAE;
8. East Fish Processing LLC, Ajman, U.A.E
9. United Fisheries of Kuwait, Kuwait,
10. National Fishing Company, K.S.C., Kuwait
11. Burum Fishing and Marketing Co. Ltd., Aden, Yemen
12. Mego Fish International, Cairo, Egypt
13. Iranian Fisheries, (Shilat), Tehran, Iran
14. Mauritanian Fishing Company, (MFC), Nouadihbou, Mauritania
15. Mauritanian Fish Marketing Company, (SMCP), Nouadhibou, Mauritania
16. Negoce-Mauritania SA, Nouakchott, Mauritania
17. Atlantic Sea Products (SA), Agadir, Morocco
18. Le Frigorifiques Bouzargtoun, Casablanca, Morocco
19. Gulf Seafood Company, Dubai, U.A.E.
20. Six Brothers Food Stuff Company LLC, Sharja, U.A.E.

In addition to the establishment of fisheries companies, several fisheries associations were also established in some countries to support the development of the activities of these companies to ensure their advancement and provide assistant in various ways aimed mainly at improving capacity for ensuring the quality and safety of seafood products and to promote national exports of fish and fish products. Some of these associations are:

1. Inter-professional Association of Fishing Products, Tunis, Tunisia
2. Yemen Seafood Exporters Association, Sanaa, Yemen
3. Office National des Peches, Casablanca, Morocco.
4. The National Federation of Seafood Processing and Valorisation Industries, Morocco.

Furthermore, in the last few years various countries in the region started to hold regional and international general food expositions and trade fairs promoting national products and also some dedicated seafood expos most prominent of which is the Dubai Seafood Expo and Processing Expo which held its 5th edition in Dubai, U.A.E. during the period 27-29 September 2011.

10. Constraints for developing cold chain in artisanal fisheries

In the semi-industrial and industrial fisheries, cold chains systems are very well developed and advanced as compared to the artisanal fisheries sector. Therefore, since as noted above, artisanal fisheries produce about 85% to 90% of all fish landed in the region, this sector without a good, efficient and reliable cold chain much of its landings will have low quality and low value and much of the landings would be left for trash. The sector suffers from several constraints and should receive more attention to alleviate these constraints.

The main constraints may be summarized as follows:

- Lack of direct investments in cold chain facilities in remote coastal areas,
- Scant or non-availability of ice at sea or at landing sites,
- Limited presence of institutional, legislative and management capabilities,
- Shortage of scientific and technical know- how on using and running cold chain components,
- Skilled human resource to operate modern equipment and availability of tools,
- Economic limitations of the fishery-based communities, and
- Lack of organized training of local personnel on various machines in the cold chain.
- In addition due to the lack of cold chain infrastructure facilities, the sector suffers from various other constraints which result in low level practices by artisanal fishermen. These may lead to:
- Lack of sanitation practices at the producer level,
- Poor quality products,
- Low hygiene standards of production process and final product,
- Poor cold storage on-shore causing significant post-harvest losses,
- Poor delivery of product to retailer or trader: lack of refrigerated vans and lorries,
- Poor display refrigeration cabinets- leading to a short shelf life,
- Short expiry period in the home of the end user/consumer,
- In turn, there is a poor feed- back of recommendations for the fisherman/producer, and Limited export opportunity for sale of fish and fishery products.

There are several reasons which may prevent artisanal fishermen from using ice when necessary. Despite the knowledge by fishermen on the advantages of fish chilling, ice it is not as widely used as it should be, particularly at artisanal level in tropical areas. Some of the problems are as follows:

- **High power requirements for producing ice mechanically:** In remote, tropical areas there is need for a large power requirement for many locations to produce ice.
- **Cost of ice on fresh fish is high:** In developed countries ice is very cheap and costs only a fraction of the price of fresh fish. In developing countries ice is very often expensive when compared with fresh fish price especially at landing sites,
- **Space on board boats not sufficient:** It is clear that the quantity of ice will increase the space required for storage on board and for distribution in boxes. The use of ice will increase the weight to be handled thus increasing work load for fishermen. The total amount of ice needed per 1 kg of fish, in the complete cycle from the sea to the consumer will be much higher in tropical countries than in cold and temperate regions,
- **Ice is not an additive:** Knowledgeable people (e.g., fish traders) are aware of the fact that ice is not an additive. Therefore, when there is a delay in icing, ice is not usually utilized at point of sale (even if available) because it will not improve fish quality. Consumers could also be intuitively aware of this fact, and they prefer to be presented with the fish as it is rather than in ice, because in this case ice will increase the price of fish but not enhance its quality,
- **Need for appropriate fish handling technologies:** To chill and keep fish with ice is a very simple technique. A more complicated picture emerges when actual fish handling systems are analyzed, including the economic aspect.

11. Importance of cold chain for fish and fishery products

Seafood consumers around the world increased consumption of fish and fish product in recent years due to recognition of their nutritional value. But as one kind of perishable and short shelf-life goods, fishes are easy to deteriorate and the process is accelerated with increasing temperature owing to a number of factors such as microbial metabolism, oxidative reaction and enzymatic activity. Consequently, fish economic value and use value is seriously affected. The cold chain management has become crucial, challenging and important to keep fish product safety due to a high number of product variants, strict traceability requirements from the customer and the need for temperature control in the supply chain.

Furthermore, fish preservation and processing may vary according to species. Each of the many thousands of fish species has its own characteristic composition, size, shape and intrinsic chemistry. Fish is very perishable and several chemical and biological changes take place immediately after capture. Fish requires careful handling and preservation, special facilities such as cold storage and refrigerated transport, and rapid delivery to consumers. Therefore, the research and development of post-harvest systems for handling raw material are important to developing appropriate measures to: (i) increase its shelf- life; (ii) reduce physical, organoleptic (sensory) and nutritional losses; and (iii) preserve the quality and safety of the finished products. This

is important for ecological, social and economic reasons – to safeguard consumer health and food security and to ensure the sustainability of the industry.

A cold chain is one of the most critical requirements to guarantee the quality of the fresh, chilled, frozen or processed. Preservation and fish quality and safety of fish and fishery products from the fishing boat or farm to the points of retail, wholesale or to the processing plant and until it reaches the consumer is a priority. In the Near East region there are a number of obvious breaks and weaknesses in the present cold chain for fish products especially in the artisanal fisheries sector where fishing activities are carried out in remote rural areas where the infrastructure facilities in most countries is poor or non-existent.

Aquaculture is growing fast in most countries of the region and has a bright future as compared to the declining trend in capture fisheries especially in the short and medium run in major fishing areas. The sector has all the natural advantages of inland waters in rivers lakes as well as coastal marine areas where mariculture may be practiced. In anticipation of this growth, a reliable cold chain set-up has to be provided to cater for the increase in production with facilities for icing, chilling, refrigeration and freezing catches as well as a reliable transportation system of products for distribution to marketing outlets or for export are required for the development and expansion of the sector.

Throughout the journey from catch to consumer, the fishing industry relies on a cold chain to ensure the commercial viability of many of these products. The safety of the food, its shelf life, taste and appearance all depend on reliable refrigeration to retard spoilage. This cold chain may take various forms including ice, refrigerated seawater, refrigerated compartments and cold stores, but a common feature in all of these applications has been the traditional use of CFC-based refrigeration technology.

Careful handling, clean hygienic practices and low temperature conditions during processing, storage and transportation can be highly effective in retarding the spoilage of fish. Clean hygienic practices, involving careful processing, washing with clean water and handling of fish, are vital.

To ensure good quality, the fish catch should be cleaned and chilled to 0 °C and frozen, as quickly as possible. Chilling and freezing operations do not improve the fish quality, but slow down the bacterial, enzymatic and chemical actions thus prolonging the shelf life of the fish.

With limited and diminishing conventional wild fish resources, aquaculture has tremendous potential for growth, especially in the temperate climate of many MENA countries, as it involves considerably less stringent refrigeration. Development of aquaculture ponds and farms nearer to the consumption area do not need large freezing, cold storage and refrigerated transport facilities. This provides for a better quality live fish for the consumer and lower costs for the producer. This has also led to the development of fish sperm refrigeration and live fish transport technology involving lower refrigeration requirements. Under the hot and dry climate conditions evaporative cooling technology may be an effective and economic means of maintaining required temperature conditions in aquaculture ponds and during transport to retail outlet. As live fish are far better priced products than frozen fish, more and more efforts are being made to develop aquaculture of food fish and live fish transport. Such developments will have a significant effect on the fishery refrigeration industry.

The fishing industry must ensure that fish handling; processing and transportation facilities meet requisite standards. Adequate training of both industry and control authority staff must be provided by support institutions, and channels for feedback from consumers established. Ensuring high standards for quality and safety is good economics, minimizing losses that result from spoilage, damage to trade and from illness among consumers.

Table 4: Recommended Storage Requirements for Some Fishery Products.

Type of Product	Storage Temperature (°C)	Relative Humidity	Appropriate storage life
Most Demersal species (Breams, Grouper, etc.)	-1 to 1	95 to 100	12 days
Most Pelagic species (Sardine, Mackerel, etc.)	0 to 1	95 to 100	6 to 8 days
Tuna	0 to 2	95 to 100	14 days
Shrimp	-1 to 1	95 to 100	12 to 14 days
Frozen Fish	-28 to -20	90 to 95	to 12 months

12. International instruments in support of fishery cold chain

1 FAO Code of Conduct for Responsible Fisheries

The FAO Code of Conduct for Responsible Fisheries (The Code) set out principles and international standards of behavior for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources. This voluntary Code is directed toward members and non-members of FAO, fishing entities, sub-regional, governmental and non-governmental regional and global organizations, and all persons concerned with the conservation of fishery resources and management and development of fisheries, such as fishermen, those engaged in processing and marketing of fish and fishery products and other users of the aquatic environment in relation to fisheries. The Code was adopted in October 1995 by the FAO Conference. Article 11 of the Code, 'Post-Harvest Practices and Trade', includes several provisions under 11.1 "Responsible fish Utilization" that calls for the adoption of various measures to ensure safety of the fish and fish products from the point of landing until the fish reaches the consumers under conditions of quality assurance and reduction of post-harvest losses.

2 FAO/GLOBEFISH International Fish Marketing Information Network

This network collects information from main market areas and includes it in an electronic databank and distributes the information to various specialized publications worldwide. The databank is supplemented by market information provided by six regional services which form the network. Three of these services operate in the Near East region. These are: INFOSAMAK, INFOFISH and INFOPECHE. The information provided include marketing information, advice on product specifications, processing methods and quality standards and other relevant information to promote fish marketing around the world.

3 European Union and USA fishery trade regulations

Fish and fishery products are currently one of the most heavily traded food commodities worldwide. Most of traded fish products cross international boundaries year round. Fish trading activities cannot profitably survive, develop or grow without being supported by an efficient cold chain system in order to keep the fish and fishery products' quality and safe for human consumption. Most of the fish and fishery products of export quality from countries in the MENA region are traded within the region. However, high value fish and fishery products are also exported to EU countries and to a lesser extent to the USA and to Japan as well as to other countries.

Imports of fish and seafood from outside the EU countries, the USA or to Japan especially from third world countries are very strictly regulated. They demand compliance to requirements for health certification and traceability for all imports and further guarantees in other specific consignments. For example, about 80% of the fish consumed in the United Kingdom (UK) comes from abroad, either from other EU countries or from non-EU countries. Likewise the USA imports about 83% of its fishery products from over 50 countries several of them from third world countries. While movements of fish and fishery products are largely unrestricted within the EU or US, imports of fish and seafood from outside these major importers are very strictly regulated and the cold chain for the proper preservation of the commodities is of major concern to the importers. There are requirements for health certification as well as verification and traceability for all imports and further guarantees on other specific consignments.

Seafood production in third countries has to match EU standards in terms of hygiene and food safety. That means that food produced abroad is covered by the same general principles of food law and food safety as exist in the EU and the USA. These principles are laid out in several EU Commission legislations and the US Food and Drug Administration (FDA). EU legislation that concerns food safety and animal health is properly implemented and enforced. This role includes ensuring compliance with EU food safety and quality standards in third countries exporting to the EU. The FDA is responsible for the food safety aspects of the fish and fishery products entering the US. The EU issues a list of third country fisheries establishments which means that the national authority of that country has approved the listed establishments for export to the EU. And that it is satisfied that the national authority of that country can be relied upon to maintain the required standards of food safety.

Also the FDA regulatory role is to ensure that foreign processors are maintaining standards equivalent to what the US requires for its domestic producers. The FDA uses a variety of approaches to assure the safety of seafood. One way is to conduct assessments on how a country assures seafood shipped to the USA is safe. FDA works with the exporting country regulators and industry to prevent problems before they happen. FDA meets with government officials and visits landing sites, fish farms and fish processing plants, laboratories, etc. to ensure imported products to the USA meets safety standards.

In compliance to EU strict regulations several fisheries establishments in countries in the Near East region has already obtained the approval from the EU Commission to export fishery products for human consumption e.g. EU Commission Decision (2009/951/EU). Currently fisheries enterprises in nine Near East countries obtained

permits to export fish and fishery products to the EU. These are in Egypt; Iran; Morocco; Mauritania; Oman; Saudi Arabia; Tunisia; United Arab Emirates and Yemen. More establishments in more countries in the region are working towards obtaining such permits.

4 Hazard Analysis and Critical Control Point (HACCP)

The food industry uses the process of Hazard Analysis and Critical Control Point (HACCP), as a useful tool. It is a management system in which food safety through the analysis and control of biological, chemical and physical hazards as a means of prevention rather than finished product inspection. The HACCP system of assuring food safety and quality has now gained worldwide recognition as the most cost-effective and reliable system available. It is based on the identification of risks, minimizing those risks through the design and layout of the physical environment in which high standards of hygiene can be assured, sets measurable standards and establishes monitoring systems. HACCP also establishes procedures for verifying that the system is working effectively.

HACCP is a sufficiently flexible system to be successfully applied at all critical stages - from harvesting of fish to reaching the consumer. For such a system to work successfully, all stakeholders must cooperate to increase the national capacity for introducing and maintaining HACCP measures. The system's control authority needs to design and implement the system, ensuring that monitoring and corrective measures are put in place.

In support of the HACCP that ensures safety and quality of fish products, there are other international organizations established to promote sustainable fisheries and fishing practices worldwide. The Marine Stewardship Council (MSC) certifies individual fisheries and offers its logo on certified and traceable fish and fishery products that meets the standards required. Also there is the International Standards Organization (ISO) which provides a framework for organizations, including fisheries, to demonstrate their commitment to environmental responsibility.

13. Recommendations to meet fishery cold chain challenges

In order to meet the challenges to reduce as much as possible the negative effects of the constrains in developing a good and sound fish and fishery products in the MENA region especially in the artisanal, small-scale fisheries sector, various steps needs to be taken that suites the standing situation in each of the countries of the region. In some countries the general infrastructure in fisheries-based communities is more developed than in others. Such a situation would require specific studies regarding the facilities surrounding the fisheries sector some of which may need up-grading or a level of investment that would include a functional cold chain based on the needs of each community. However, in general each community needs to take steps that would eventually ensure an integrated cold chain in the artisanal, small-scale sector to preserve fish and fishery products from landing until it reaches consumers.

Therefore, as a main recommendation, the establishment of an integrated cold chain linked to a supply chain or value chain that transfers perishable foods from the point of harvest to the final point of consumption is urgently required. The primary links of an

efficient and practical integrated cold chain in the fisheries based communities include the following essential five elements:

i. **Postharvest handling**: Postharvest handling involves the procedures or techniques that happen immediately after harvest on-board or on –land. Fish should be immediately iced for direct fresh fish sales, or placed in a cold store awaiting transportation to distribution to markets or frozen for longer periods if required.

ii. **Processing and packaging:** of fish and fish products are means to add value to products, while using the handling process to sort, size, grade and select species for consistency and quality. Processing should preserve inherent product quality and value, while adding value wherever possible through selection or technology that provides consumer appeal or value. It is important to note that products in the cold chain do not normally improve in quality, only maintain the inherent quality of the products produced.

iii. **Cold storage and distribution:** Cold storage and distribution services represent the next basic link in the integrated cold chain. The importance of cold storage and product distribution is often overlooked, yet represents a significant area of emphasis in extending the usable and functional shelf life of perishable foods.

iv. **Refrigerated transportation:** Refrigerated transportation is often overlooked when evaluating the overall efficiency of the integrated cold chain. Once fish and fishery products are placed under refrigeration, it is imperative that they remain refrigerated until consumption in order to preserve the inherent quality and validate the investment in processing, packaging and storage. It is very common in the artisanal fisheries sector to transport refrigerated products in non-refrigerated or insulated transport vehicles, thereby exposing the products, even packaged products, to extreme temperatures and exposure to the elements.

v. **Marketing of fish and fishery products:** Sales to the end user, including retail, wholesale, institutional or food service, represent the ultimate goal of cold chain systems. The mandate is to provide the highest quality products to consumers in the best possible fashion and with the highest perceived value. It is often said that the majority of cold chain damage to products results during the “last 30 meters” of distribution, or at the point of sale to end users.

This overall recommendation, if implemented, would in the medium and long run eliminate to a large degree the constraints that hamper a successful fisheries, raise the standard of the majority of the fisheries in the MENA region, improve quality, raise financial returns to fishermen, reduce substantially post-harvest losses, open new local and export markets, develops local human resources by introducing new appropriate technologies with professional training and would raise the awareness of the community in general on the benefits of running a fishery dependent on an efficient cold chain.

As for the semi-industrial and industrial sector it is believed that most of the fisheries enterprises in this sector are well equipped to keep their high standards in order to stay active and successful in their fishing, processing and trading operations. However, it is in their interest to give full support to the artisanal, small-scale fisheries sector since substantial quantities of their sources of fish is from landings by the artisanal fisheries. Measures should be developed to provide access to infrastructure and access to credit to local artisanal and small-scale processing, trade and marketing initiatives. Such improvements will give greater emphasis on local, national and regional markets.

In order to implement the recommendations above the initiative must come from the fisheries authorities in the governments of each of the countries in the region. Project proposals should be formulated for execution by the local governments in full cooperation and coordination of local semi-industrial and industrial fisheries sector, local non- governmental organizations, fishermen cooperatives and organizations and other related civic bodies. In addition to local efforts, related regional and international development organizations and donors may be called upon to provide expertise in drawing up the project proposals and also to share in the funding of approved projects.

Literature cited

Emirates News Agency; UAE Obtain Accreditation for Export to EU Countries, November 2010.

EU Commission; Commission Decision 2006/766/EC 14 December 2009, Official Journal of the European Union.

FAO, Quality and Changes in Fresh Fish, Fisheries and Aquaculture Department; FAO Technical Paper, 1995. www.fao.org.

FAO: Expert Consultation on International Fish Trade and Food Security, FAO Fisheries

Report No. 708, Casablanca, Morocco, January 2003.

FAO; Fisheries and Aquaculture Information and Statistics Service, May 2011.

FAO: The State of World Fisheries and Aquaculture 2010: Rome, Italy 2010

FDA; Fish Hazards and Controls: More Than a Fish Story; Silver Spring, MD. June 2011. www.fda.gov.

OneWorld: Food Security Guide; www.Oneworld.net.

FIS; Improve Seafood Quality with Good Cold Chain Management, Fish Information Services, February 2011. www.fis.com.

Tingeman, W.; Jian, Z, and Xiaoshuan, Z; Fish Product Quality Evaluation based on Tempreture Monitoring In Cold Chain, African Journal of Biotechnology, Vol., 9 (37), pp 6149-6151), September 2010.

SEAFISH; Import Guidance, Edinburgh, U.K. 2010.

UNEP; Making a Good Catch: Non-CFC Technologies in the Cold Chain, UNEP DTIE, August 2000, Paris, France.

USAID; Cold Chain Assessment for Iraq, Final Report, March 2009.

See also the sub-regional reports included in Annexes II and III.

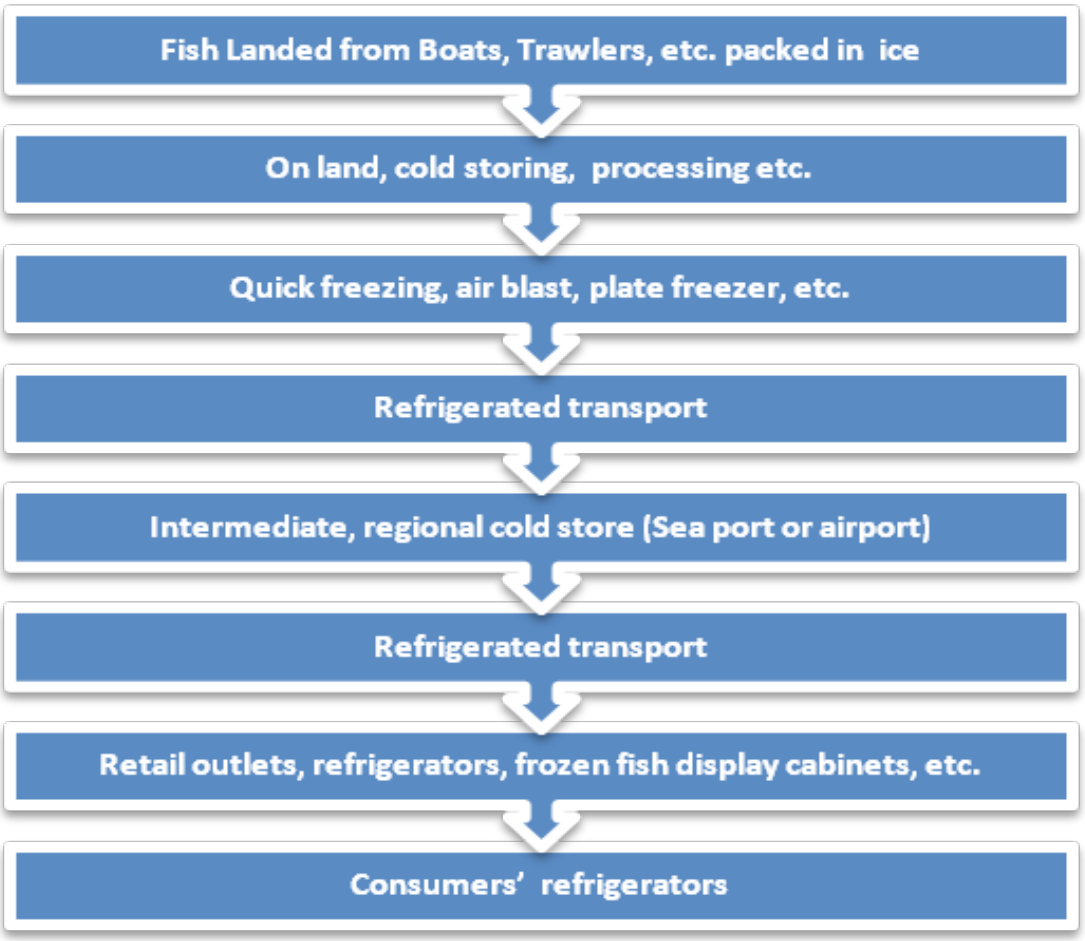
Recommendations of the fishery group

The Fishery Group to the “Expert Consultation Meeting on the Status of the Cold Chain in the Food Sector of the Near East Region” held in Cairo, Egypt 5-7 July 2011, after reviewing the current status of the cold chain in the fishery sector in the Near East, raised several issues that need to be carried out to ensure a better and more sustainable fisheries industries that ensures better quality and safety of fishery products’ for human consumption. In the process the Group suggests one main recommendation as well as other recommendations as follows:

1. Main Recommendation

In order to meet the challenges to reduce as much as possible the negative effects of the constrains in developing a good and sound fish and fishery products in the Near East region especially in the artisanal, small-scale fisheries sector, various steps needs to be taken that suites the standing situation in each of the countries of the region. In some countries the general infrastructure in fisheries-based communities is more developed than in others. However, in general each community needs to take steps that would eventually ensure an integrated cold chain in the artisanal, small-scale sector to preserve fish and fishery products from landing until it reaches consumers.

Therefore, as a main recommendation, the establishment of an integrated cold chain linked to a supply chain or value chain that transfers perishable foods from the point of harvest to the final point of consumption is urgently required. The model below is suggested for an integrated cold chain which may be adjusted according to the standing situation where such a chain is to be established.



1. Other Recommendations

- Identify experts in cold chain in fish industry in each country;
- Survey studies to periodically evaluate the status of cold chain in each country;
- Since the traditional fisheries sector lands majority of seafood, implementation of cold chain management system shall be considered as priority in all the countries.
- Studies and evaluations of cold chain infrastructures requirements should be carried out with the participation of the governments in collaboration of the private sector;
- Identify different partners on cold chain in fish industry such as government organizations, fisheries organizations and professional organizations;
- Develop an adequate management system including appropriate legislations for cold chain system in for each country;
- Organize continuous short courses on the management of cold chain;
- Establish a strategic development for cold chain for each country;

- Encourage the professionals of fish industry to implement the good manufacturing practices and good hygienic practices using HACCP system and other supporting regional and international certification and verification instruments as well as traceability. This can be done by policy making like establishing HACCP certification, ensuring access to credit facilities and duty free import of cold chain tools and equipments.
- Establish documentation and information system of cold chain activities to increase the level of knowledge and establishment of a database as required to maintain a sustainable integrated cold chain.

In order to implement the recommendations above the initiative must come from the fisheries authorities in the governments of each of the countries in the MENA region. Project proposals should be formulated for execution by the local governments in full cooperation and coordination of local semi-industrial and industrial fisheries sector, local non-governmental organizations, fishermen cooperatives and organizations and other related civic bodies. In addition to local efforts, related regional and international development organizations and donors may be called upon to provide expertise in drawing up the project proposals and also to share in the funding of approved projects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SESSION III.
DAIRY PRODUCTS

THE STATUS OF THE COLD CHAIN FOR DAIRY DISTRIBUATION IN THE MIDLE EAST AND NORTH AFRICA (MENA) REGION

Magdy Mohamed Ismail, Bezeid Ould Elmamy, Omrane Ben Jamaa, and Hany Ramadan

1. Executive summary

The purpose of this report is to describe and evaluate the status and challenges of the cold chain for dairy distribution in the Middle East and North Africa (MENA) region. The report tries to identify some of the key constraints to this sector and introduce development instruments to improve it. Following are our main findings:

1. In most cases, cooling milk is in large scale dairy farms, while small farms don't have cooling system.
2. Milk collection centers provide cooling preservation of small farm milk.
3. Sometimes, dairy products factories save the milk in cooling tanks till processing into various products.
4. In many cases especially in North Africa and Levant (Syria, Lebanon, Jordan) countries, milk is transferred from farms to collection centers or plants in vehicles without cooling equipment.
5. Small dairy plants scattered in villages don't contain cooling or freezing chambers which are included only in large plants to cool or freeze the substrates and end products.
6. Dairy products are distributed in vehicles without cooling to nearby towns, while transferred in refrigerated vehicles and trucks across and outside the country.7.
7. Dairy products especially various cheese types are stored in cold storages in summer and when the produced cheese quantities are higher than the market requirements.
8. In retail stores, the fresh raw milk is preserved in a cooler whereas yoghurt, cream and low salt soft cheese is stored in display cabinets.
9. Freezing in the dairy industries is just applied in ice cream production and distribution.

10. Identified constraints to the cold chain for dairy distribution in MENA region include:
    a. Lack of capital
    b. Poor infrastructure
    c. Lack of investments in the cold chain
    d. Absence of official control and supervision on proper use of the cold chain
    e. Shortage of skilled labor
    f. Temperature abuse
11. In order to protect, promote and develop the cold chain for dairy distribution in MENA region, the following recommendations should be considered by all the stake holders in the dairy industry at all levels, i.e. district/regional and national authorities. This includes both local and central governments.
    a. Offering right policies and assistance programs
    b. Provision of cooling equipment at a reasonable cost
    c. Encourage formation of cooperatives or associations of milk producers
    d. Provision of good extension services
    e. Provision of modern cooling systems

2. Introduction

In the majority of developing countries, large amounts of perishable foods, such as vegetables, fruits, meat and milk are annually wasted due to the lack of a proper cold storage, cold chain and frozen food distribution system. Roughly one third of the food produced in the world for human consumption every year, approximately 1.3 billion tonnes, gets lost or wasted, according to an FAO-commissioned study. Industrialized and developing countries dissipate roughly the same quantities of food — respectively 670 and 630 million tonnes (Gustavsson et al., 2011). If there were cold storage systems, efficient cold chain, logistics and distribution companies especially in developing countries, it could be possible to process these primary products into newer, secondary products that can be sold to consumers locally and internationally. A strategy needs to be developed for the growth of this industry and a lot of investments must be made.

The refrigerated movement of temperature sensitive foods is a practice that dates back to 1797 when British fishermen used natural ice to preserve their fish stock piles. This process was also seen in the late 1800s for the movement of food, namely dairy products, from rural areas to urban consumption markets.

Refrigerated foods are one of the fastest growing sectors of the grocery and foodservice industries. Continued success relies upon effective management of the ‘cold chain’, a term used to describe the series of interdependent operations in the production, distribution, storage and retailing of chilled and frozen foods. Control of the cold chain is vital to preserve the safety and quality of refrigerated foods and comply with legislative directives and industry ‘codes of practice’.

Freezing preserves the storage life of foods by making them more inert and slowing down the detrimental reactions that promote food spoilage and limit quality shelf life. However, it should be recognized that a number of physical and biochemical reactions can still occur and many of these will be accentuated when recommended conditions of handling, production and storage are not maintained.

On the other hand, milk is one of the most important products for human consumption. It is also the perfect growing medium for micro-organisms. Milk quality relates to its chemical, microbiological, physical, and organoleptic properties, as well as to its safety. To protect milk quality, it should be handled under rigid sanitary conditions, resulting in low bacterial count, good flavor and appearance, satisfactory keeping quality, high nutritive value, and free from disease-producing organisms and foreign constituents.

Milk storage on the farm, and the time taken to bridge the gap between producer and consumer gave bacteria the chance to acclimatize and grow in this nutritious liquid. It became a problem to keep milk quality at the same level as just after milking. A safe and effective system of raw milk preservation is therefore required by the dairy sector. Preservation should not adversely affect the nutritional characteristics of raw milk. Refrigeration is currently recognized as the preferred milk preservation method. At low temperature chemical processes and microbiological growth will slow down, delaying the reduction in the quality of stored milk. Refrigerating milk on the farm has two main aims, firstly to inhibit bacterial spoilage and secondly to extend storage on the farm so as to decrease milk transport costs.

Most farmers in the world especially in the developed countries have a requirement that their milk must be cooled to 4 °C within 3½ hrs from the start of milking, so cooling milk quickly for storage is an integral part of every farm's quality assurance / food safety plan. In contrast, using cooling for milk preservation is adopted slowly in developing countries because of the high coasts of equipment; however in the last two decades refrigerating milk was applied particularly in large farms.

Cooling is used for milk preservation and for preservation of the quality and safety of dairy products. In Egypt, after three months of ripening period of Ras cheese, it is stored in cold rooms at 10-12°C till consumption. Other products like butter and cream are also preserved in these cold rooms.

Several constraints face use of refrigeration for milk or dairy products preservation in the Middle East and North Africa (MENA) region. The largest two problems are lack of capital and weakness of infrastructure.

This report will sketch the status and challenges of the cold chain for dairy distribution in the MENA countries. Moreover, some recommendations for government policies are formulated aimed at strengthening the sector's ability to face current and future challenges.

3. Cold chain of food

1. What is the Cold Chain?

A cold chain is basically a logistics system, which helps in maintaining and providing a series of facilities for ensuring ideal storage conditions for the perishables from the point of origin to the point of sale. A well developed and efficiently organized cold chain reduces wastage, spoilage and helps keeps the perishables intact thereby helping to maintain the quality of the harvested food products ultimately making the whole system cost effective to the farmers and that which ensures top-notch quality to the end user.

Also, the cold chain is the part of the food industry which deals with the transport, storage, distribution and selling of chilled or frozen food. It includes equipment and the operation of that equipment to maintain frozen food in a fully frozen condition at the correct temperature (Fuller 1998).

Dairy products cold chain is a logistic system that provides a series of facilities for maintaining ideal storage and handling conditions for milk and dairy products from the point of origin (“Farm”) to the point of consumption (“Fork”) or home refrigerators.

2. What is chilled food?

The perishable foods which are maintained at temperatures in the range –1°C to +8°C, to retain their quality shelf life, wholesomeness and safety.

3. What is frozen food?

A Food which has been subjected to a freezing process (at temperatures below -18°C) specially designed to preserve their quality, shelf life, wholesomeness and safety of the product.

4. Cold chain of milk and dairy products distribution

1. Cooling of milk on the farm

The rate at which milk is cooled has a major influence on the bacterial content of raw milk. After having followed the right milking and hygienic procedures, milk should be cooled to 4°C or below as soon as possible after it leaves the udder. It should be cooled to this temperature within 3½ hours from the start of milking. However, any reduction in cooling time will increase milk quality and reduce energy costs. It is also very important for the milk to be stored at below 4°C between milking. Bacteria counts rise rapidly once milk temperatures rise above 4°C. Refrigeration is the single most important factor in maintaining quality after the milk leaves the udder. However, it is vital to recognize that cooling is a compliment, not a substitute, for hygienic working conditions. Avoiding infections through good hygiene practices, and cooling the milk as soon as possible after milking, combine to ensure high milk quality. Also, effective milk cooling is essential to ensure the quality of the end product.

Cold chain of milk starts from the farm. After lactating, milk is preserved in the cooling tanks to reduce its temperature to 4°C and the chilled milk is transferred to the processing plant or to market. The cold milk amounts carried from farm to the processing plant or market depend on the produced quantity and the size of the farm and its contents of the animals and also on the distance between the farm and places of processing and consumption of milk. When the amount of produced milk is less

than 500 kg / day with the long distance to the factory, milk is saved two or three days in the cooling tank on the farm. After collection of the milk amount that reduces transport costs to a minimum, it is transferred to the processing plant or retail. On the contrary, when farm production increases up to 2 tons milk / day or more, the milk is kept in cooling tanks to reach a temperature of 4°C then transferred directly to the processing plant in the same day.

In most developing countries, dairy farming is generally carried out at the smallholder level. About 75-80% of dairy producers have less than 8 cows (Ismail and El-Haisha 2005). Because of shortage of capital and poor infrastructure such as lack of electricity needed for the refrigeration equipment, milk of small-scale farms usually is not cooled, but it is sold in nearby markets in the form of raw or sour milk or collected by dairies and transferred to small cheese or yoghurt factories scattered through the villages. So, we can say that milk is only chilled in large scale dairy farms which have cooling systems. Milk cooling is often linked by animal auto lactating which based on providing of large numbers of them and such numbers are only found in large scale dairy farms.

The cooling equipment differs in size and capacity depending on the productivity of the farm, ranging between 500 to 5000 kg milk or more. The price of cold milk is higher than that of raw milk; many of the factories pay premiums to farmers to care for cleanliness and quality of milk.

In the new villages of Nubaria area in the north of Egypt, one of the new reclaimed lands which owned by graduates or settlers who have only 1-2 cows, milk collection centers are not available since graduates are scattered over the big dessert area. Through extension services, the graduates gained the experience of cheese-making, mainly Domiati cheese. But processing of 7-14 kg of milk daily was neither reasonable nor economic for them. Some of the graduates cooled the milk at their refrigerators for 48 hours, while others freeze it, then the collected milk produced within three or four days (30-60 kg) is processed into Domiati cheese once or twice a week instead of daily processing.

2. Cooling of milk in the collection centers

In some cases, instead of milk cooling on the farm, especially with small quantities, the farmers or dairies transfer milk to the milk collection centers. These centers have cooling tanks, so they provide good chance for milk preservation by refrigeration. Collection centers sell the cold milk to the factories or groceries.

The most important advantage of milk collection centers is improving milk quality because they are forcing farmers to produce clean and fresh milk. The capacity of cooling tanks at collection centers is usually higher than that on farm, according to the large milk amounts delivered to them.

3. Cooling of milk in the processing plants

Sometimes, milk is collected from farms and moved directly to processing plants where it is saved in cooling tanks till manufacture on the same or next day according to plant capacity. Milk may be pasteurized before cooling or chilled as raw milk. Generally, receiving milk in plants immediately from farmers also helps to improve the quality of milk.

4. Cooling of milk during transportation

The transport and distribution sections of the chill chain are particularly important to control in order to ensure both safety and quality. To preserve safety in chilled milk, there are prescribed maximum temperatures. Currently, the Agreement on the International Carriage of Perishable Foodstuffs (ATP Agreement) specifies the following maxima for transportation: 6°C for butter; 4°C for milk and dairy products. These temperatures are also a good guideline to be followed throughout all stages of production, including distribution, storage and retail display.

It is observed in the North Africa region that milk is usually transferred from farms to collection centers or plants by a cart, bike, motorcycle or vehicles without cooling equipment because of the high cost of refrigerated vehicles. Therefore, the transfer of cold milk is in the morning or evening with low temperature. In Gulf area, high cooling technology vehicles are used for milk transferring.

5. Cooling of dairy products in the processing plants

The majority of small dairy processing plants scattered in villages which just produce soft and Ras cheese don't contain cooling chambers due to lack of money. In contrast, medium and large dairy plants produce several products such as pasteurized and UHT milk, soft, hard and processed cheese, yoghurt, cream, butter and ice cream which need cooling or freezing immediately after manufacture, so cooling or freezing chambers are included. The substrates and end products are preserved in refrigerators or freezer till manufacturing or distribution.

6. Cooling of dairy products during distribution

Dairy products are distributed to retails in the towns surrounding the plant or in the country or the products are exported to other countries. Mostly, refrigerated vehicles are not used to transport dairy products to the areas near the plant to reduce the cost of transport but they are used for the distribution across the country. It is observed that not all dairy products are carried by refrigerated vehicles, just some products, such as yoghurt are moved in refrigerated vehicles to maintain their quality and increase shelf life. Pasteurized, UHT milk and cheese are often distributed in non-refrigerated vehicles. Of course, ice cream is transferred in freezing vehicles. In general, using of refrigerated vehicles to transport dairy products depends on the plant capital, the standards and their application.

The exported dairy products are transferred in refrigerated trucks or ships equipped with cooling chambers. For example, Egypt exports white and Ras cheeses to Gulf countries, the cheeses are transferred in refrigerated trucks by road with a small part in the Red Sea, crossed by ships.

Temperature control in the shipment of dairy foods is a component of the industry that has continued to rise in necessity with international trade. As a growing number of countries focus their export economy around food and produce production, the need to keep these products fresh for extended periods of time has gained in importance.

7. Cooling of dairy products in cold storages

Dairy products especially various cheese types are stored in cold storages in summer and when the produced cheese quantities are higher than the market requirements. At the end of cheese ripening period (3-6 months), it is preserved in cold warehouses till distribution to groceries. Also, the exported cheese is stored in large cold storages

in the importing state and during transport to retailers. Generally, cheese is stored in the cold storages for a period not exceeding six months to reduce the production costs.

In many cases, cold storages are not owned by the factory, but rather are separate and scattered throughout the country, and most have followed the private sector and domestic investments. Public sector has a few of them. All Arab countries save vegetables, fruits, dairy products, meat and fish in cold warehouses of different capacities. However, the ratios of these properly handled products differ from one country to another. In Lebanon, three-quarters of the storage capacity of cold storages are dedicated to store apples and citrus for export. The remaining quarter of these capacities is allocated to store milk, cheese, meat, poultry and imported and domestic frozen fish.

In the Gulf states, the vast majority of cold storages are used to store vegetables and fruits such as apples, grapes, oranges and bananas at 0 to 5°C according to the type of vegetables and fruit. About 30% of the total storage capacities are dedicated to preserve dairy products, meat, fish and frozen poultry at -18 to -20°C. In Egypt, the largest numbers of cooling and freezing storages are used to store some fruits and vegetables like pear and potatoes and some of them are used to preserve meat, poultry, fish, white cheese and Ras cheese.

8. Cold storage of dairy products in retail stores

After lactation, the fresh milk is directly transferred from farm to groceries which contain coolers with different size (100-500kg) to preserve the raw milk during the selling period. The pasteurized and UHT milk are stored at ambient temperature. Sometimes the pasteurized milk is stored in display cabinets with yoghurt, cream and low salt soft cheese.

Display cabinets are the link in the cold chain where cold and frozen dairy products are displayed to the consumer. They are intended to be used for displaying and selling frozen foods and not for lowering product temperature. The refrigeration unit fitted in each cabinet is required to match the heat gain, mostly due to radiated heat transferred from the store and air infiltration. Several types of cabinets are used, the most common being:

- Vertical multi deck with or without glass doors, using refrigerated air circulated by fans throughout the cabinet.
- Open top cabinets, which cool the food compartment using forced air circulation and/or natural convection.

9. Freezing of dairy products

Freezing can preserve the taste, texture and nutritional value of foods better than most other preservation methods. However, such qualities depend upon the careful choice of food materials, use of appropriate pre-treatments, the choice of freezer and frozen storage options and the use of appropriate packaging. The major considerations for optimum quality of frozen foods can be described under pre-freezing, freezing and post-freezing stages of manufacture. Freezing in dairy industries is just applied in ice cream production and distribution.

10. Temperature ranges for dairy products

There are several temperature levels to suit the different types of dairy products and the stage of processing for each type that requires cold conditions in general; there are three ranges of recommended temperatures for preserving dairy products:

- Frozen Stores temperature: -18C to -20C
- Chilled stores temperature: +0 C to +5 C.
- Ambient stores temperature: +20C to +25°C

Shelf-lives of dairy products vary from 4 days up to 24 months based on product natures and characteristics.

5. General characteristics of the cooling sector of milk and dairy products in gulf cooperation council (GCC) countries

- Large farms for milk productions usually owned by the dairy producers, i.e Almarai, Alsafi, Nadec, Nada dairy, Alin dairy , Albeheria ,…etc the farms having selective herds for milk production with advanced veterinary and feeding systems care.
- Pre-cooling facilities available in farms having medium and large capacities.
- Strict preventive maintenances schedules for the cooling facilities / equipments and always contingency plan there.
- Refrigerated trucks to transfer milk to plants usually once or twice a day up to 500 km distances.
- Well maintained fleets / vehicles and associated for dairy only.
- Advanced technology in plants for milk recipient and storage in silos provided with filtration and de-aerator units.
- Good stores and warehouses with enough spaces / racks / loading facilities i.e. forklift or hand lifts for products and ingredients based on the stages of processing, with temperatures control and monitoring systems.
- Loading / unloading procedures always under hygienic and good housekeeping (GHK) procedures to avoid cross contaminations and to maintain the cold chain.
- Separate stores for dairy products or separate partitions in stores not mixed with any other food stuffs.
- Implemented procedures of the “First In-First Out” (FIFO) or “First Expiry First Out” (FEFO)/First Production First out (FPFO) issuance system in stores and inbounds.
- Continuous self audit by milk producers, manufacturers and retailers.
- Formal audits by local and international authorities.
- Educate the consumers on handling and storages of chilled and frozen products on package materials declarations.

- Support and provide the small shops with cooling facilities like small show refrigerators and freezers.
- Climate and geographical natures for the gulf region force the necessity for strong cold chain for dairy products due to centralizing the manufacturing in some countries or some parts of the country.
- Information Management systems (Traceability and Tracking etc).
- Good transportation infrastructures and low fuel prices.
- Low prices for trucks and refrigerators carriers the vehicles equipped with temperature recorders and control panels to set and maintain the product at the correct temperature.
- Media and awareness playing great role so dairy companies as well as governmental health authorities educate customers and consumers on the proper care and handling of dairy products.
- Strict adherence to the governmental health law, municipality roles and the international health organizations requirements for food safety standards.

6. Some characteristics of the cooling sector of milk and dairy products in Morocco and Tunisia

1. Morocco

1. General characteristics of the cooling sector

The total storage volume is valued at 1,700,000 m³ cold rooms which correspond to 370,000 tons split on 495 units. At the national level, the average capacity of a refrigeration unit is around 750 tons (3,500 m³). There is a total of 1,980 cold storage rooms with a unit capacity of 189 tons (850 m³).

2. Distribution of capacity by product

Fruits and vegetables	2400000 T	(66%)
Dairy Products	62000 T	(17%)
Seafood	53000 T	(14%)
Meat	7000 T	(02%)
Miscellaneous	4000 T	(01%)

3. Needs in refrigeration storage capacity

Refrigeration storage capacity is small and represents only 4% of total perishable goods production which is valued at around 9.4 million tons. The valuation of the additional refrigeration storage capacity needed is at 504,000 tons.

2. Tunisia

The storage volume of 1,310,011 m³ is dispatched as follows:

Fruits and vegetables	923661 m³	(70%)
Dairy products	68025 m³	(05%)
Seafood	175042 m³	(14%)
Meat	73282 m³	(06%)
Miscellaneous	70001 m³	(05%)

The dairy sector seems therefore well equipped and the majority of operators are certified. The utilization rate is around 70%.

7. Manufactures of cooling and freezing equipments

In most cases, cooling and freezing apparatuses in North Africa region are locally made because of weak economic situation. The holders of large cooling enterprises import the used tools from Europe and USA. Now, China is selling cooling equipments cheaper than Europe and USA. In contrast, in Gulf countries, modern refrigeration apparatuses are used.

8.The role of food packaging in the cold chain

Packaging plays a key role in protecting the product from contamination by external sources and from damage during its passage from the food producer to the consumer. The choice of packaging is dictated primarily by economic, technical and legislative factors. Also, a well-designed and consumer-appealing package will help to portray an image of high quality and responsible food production to the consumer.

9. Challenges of the cold chain for dairy distribution in the MENA region

9.1. Lack of capital

Many farmers don't have money to buy small cooling tanks for saving milk on the farm. Therefore, the milk is produced with very bad quality especially in summer with hot climate. Low price is paid for bad quality milk which decreases the final profit of farmers. Also, several of small milk factories which processes about 75% of the produced milk in the majority of developing countries, can't attach cooling chamber with the plant because of shortage of money. As a consequence, part of the product suffers from qualitative and quantitative losses. Some of the factories' owners use unauthorized preservatives for keeping their products. These preservatives are very dangerous to health.

2. Poor infrastructure

The lack of electricity or clean water and proper roads in the villages of developing countries represents very important constraint facing the cold chain. This is more pronounced in the countries of North Africa and Levant (Syria, Lebanon, Jordan).

3. Lack of investments in the cold chain

The investment in the cold chain in the developing countries of MENA region is domestic and inadequate vs the high cost of establishing and maintaining the modern cold chain. Foreign investment in the cold chain of the mentioned states is absent for many reasons that may be political and/or economic. As mentioned, weakness of infrastructure reduces investment opportunities in any field.

4. Absence of official control and supervision on cold chain

The absence or insufficient government inspection of cooling systems leads to bad management that cause deterioration of the chilled foods.

5. Shortage of skilled labor

Inadequate experience of workers in cold chain allows terrible mistakes including cooling system failure or food spoilage. Sometimes, large companies utilize foreign experts to face this problem which increases the production costs.

6. Temperature abuse

Temperature control during handling of chilled foods is most important from a food safety perspective. Abuse of temperature is likely to lead to increased occurrence and growth of pathogenic bacteria.

Transfer points are well known problem areas for temperature abuse and refer to points in the cold chain where products are transferred from one cold area to another, e.g. blast freezer to cold store, factory cold store to truck, truck to supermarket, supermarket cold store to display cabinets, and display cabinets to home. Frequent or prolonged door opening in vehicles during distribution and delivery is a major cause of temperature abuse. The transfer points normally involve a change of personnel and there can be periods when nobody has responsibility for the product, i.e. it may be left standing in a non-refrigerated area for considerable periods.

It should be noted that chilled foods are easily temperature abused in comparison with frozen foods as the temperature of the former can rise quickly. The ice in the latter 'protects' them in safety terms, and from quality loss for brief periods at less-than-ideal temperatures. Awareness of the need for temperature control at all stages in the chill chain and for a low initial bacteria count (e.g. less than 103 per gram) is of paramount importance to all involved with the handling of chilled foods – including the consumer.

10. Improvement of the cold chain for dairy distribution in the MENA region

1. Offering right policies and assistance programs

If policies must be implemented to promote cooling systems then institutions must be present to determine the most helpful policies and develop the best strategies for their implementation. At this juncture, it is clear that cold chain development needs to be accomplished through policies that can attract various stakeholders to invest in this sector. The initial step will be seeking the right policies. Nevertheless, seeking the right policies is not enough for cold chain development, but also having supportive institutions and services for stakeholders. The governorates should provide a good infrastructure. It is very important factor in attracting investment.

2. Provision of suitable cost cooling equipments

High quality and reasonably-priced cooling equipment should be provided to small dairy farms and plants. Also, it is important to provide buying by installments to help farmers who can not pay the total cost in one installment.

3. Encourage formation of cooperatives

The formation of farmer groups and dairy cooperatives could be helpful in three ways: firstly a group has better access to formal credits than individual farmers and secondly, external support or training from the public and private sectors is easier in groups, finally credit schemes could be easily organized within the group.

4. Provision of good extension services

Extension services can provide good opportunities for education and training of cold chain workers. As mentioned before, transfer points are known problem areas. A useful concept is that of the 'relay system', where the baton (the food product) is transferred safely from one responsible person to another, and where a signing-over system includes information on product temperature and history. Such a system

necessitates thorough education and training of staff likely to come into contact with the food product.

5. Provision of modern cooling systems

The apparatuses and vehicle must be provided with a good refrigerated system that remains operating at all times during production and transportation to keep the product temperature at the required values. During transportation, it is important to keep doors closed, otherwise large quantities of warm air will enter the cold area. Warm air carries moisture that can badly affect the cooling performance.

11. Some pointers for success of the cold chain

There are major attractions with the freshness, quality, safety and convenience of chilled foods. Two principles dominate control of quality and safety in chilled foods: PPP (product-process-package) and TTT (time-temperature- tolerance).

PPP factors need to be considered at an early stage in the production of chilled foods, as they dictate the likely commercial success of the product. In this category, a useful 'rule of thumb' is to consider that any processing or handling step will take away some of the food material's inherent natural characteristics and qualities. Generally, quality cannot be gained from processing, but it certainly can be lost. High quality chilled foods require high quality raw materials and ingredients. The product development team needs to consider the interaction between ingredients and components of formulated foods.

The PPP factors are:

- Product
- Raw material quality.
- Quality and suitability of ingredients, including additives/enhancers.
- Product formulation – how the component parts integrate to form the final chilled food product.
- Process
- The speed and effectiveness of the chilling operation.
- The use of additional processes, e.g. heating, pasteurization.
- Package
- 'ordinary' packaging, offering physical, chemical and barriers.
- 'advanced packaging', including Modified Atmosphere Packaging.

In cold chain applications, temperature is the most important hurdle. Control of temperature is, therefore, essential.

TTT factors maintain quality and safety during storage and offer guidance on how to deliver foods with long quality shelf life. TTT concepts refer to the relationship between storage temperature and storage life. TTT relationships are also able to predict the effects of changing or fluctuating temperatures on quality shelf life. As a guide to food manufacturers, the International Institute of Refrigeration (IIR) has published 'Recommendations for the processing and handling of frozen foods (1986)'

(commonly known as the 'Red Book'), which gives indications of recommended storage life for different foods. The following factors are important in relation to achieving the necessary temperature control for chilled foods:

In chilled food production and storage:

- Use product temperatures as 'critical control points' in the HACCP plan.

In chilled food distribution:

- Prior cooling of the distribution vehicle is necessary to achieve the appropriate temperature during the entire distribution process.
- Product and environment temperatures should be closely monitored and recorded during the distribution process. Systems available include data loggers (both in-situ and portable).
- Time-temperature indicators (TTIs) are an emerging technology for food product monitoring: a British Standards Document has been compiled (BS7908, 1999).

In chilled food retail display:

- Introducing warm products into chilled food cabinets can cause a general temperature increase: it should be noted that cabinets are intended only for holding and are not designed for cooling foods.
- Poor cabinet stocking and stacking arrangements and inadequate servicing can cause significant problems with maintaining low temperatures.
- Iced-up cooling coils in cabinets indicate the need for proper defrosting regimes and correct setting of thermostats.
- Interference with cabinet design can disrupt the flow of cool air through the cabinet and cause a rise in temperature.

Increasingly good temperature control is being achieved throughout the cold food chains as a result of improved equipment design, quality control and heightened awareness of issues surrounding food safety and quality. However, it is important to avoid complacency and to integrate temperature monitoring as a part of the Total Quality Management programme.

12. Recommendations

There is significant potential to improve the cold chain for dairy distribution in the MENA region by increasing the economic viability of the dairy enterprise, provision of reasonably-priced cooling equipment and encourage of cooperatives formation. Finally, the list below contains some of the most important 'do's and don'ts' for both the chilled and frozen food producer:

- Maintain high levels of hygiene at all stages of the product's life.
- Chill or freeze products quickly and adequately after preparation and manufacture.
- Rigidly maintain chill (<5°C) or frozen (<-18°C) temperatures, wherever possible, during storage, distribution, holding stores and display cabinets.
- Ensure that chilled or frozen products are transferred in a continuous operation (no stopping or delays) between temperature-controlled areas, e.g. delivery trucks to holding stores; storage areas to retail display units.
- Segregate cooked and uncooked chilled or frozen products in storage and retail display cabinets.
- Conduct frequent and systematic temperature checks on chilled and frozen food product temperatures, using appropriate and calibrated instrumentation.
- Do not overload chilled or frozen retail cabinets with product: refer to cabinet manufacturer's recommended capacity and loading patterns.
- Train and educate all personnel (including consumers) in the correct handling and storage of chilled and frozen foods. Re-educate when new practices are adopted.

References

Gustavsson, J., Cederberg, C., Sonesson, U., Otterdijk, R. and Meybeck, A. 2011. Global Food Losses and Food Waste. Study conducted for the International Congress, SAVE FOOD! At Interpack2011 Düsseldorf, Germany. FAO.

Fuller, R.L. 1998. A Practical Guide to the Cold Chain from Factory to Consumer. Concerted Action CT96-1180. Report 1.

Ismail, M.M. and El-Haisha, M. 2005. Production and Processing of Dairy in the Arab World. 1st ed., Scientific Home, Cairo, Egypt.


The story of extension in the cold chain
First: Extension professionals
There is a new piece of knowledge available
The extension professionals are now aware of this knowledge (received, digested , and assimilated) from the knowledge generating source (universities, research centres, or R&D)
Professionals may participate in the generation of such knowledge

SESSION IV.
MEAT PRODUCTS

THE STATUS OF THE COLD CHAIN FOR RED MEAT AND POULTRY IN THE MENA REGION

Salah Elsafty, Adnan Alfaris, and El-Shahat Moghazy

1. Executive summary

Unquestionably, agricultural production and productivity need to be increased in developed and/or developing countries, and particularly in low-income food-deficit countries, and not only to strengthen the resilience of their production systems by boosting investment in rural infrastructure, water schemes, rural roads, storage facilities, cold chains, slaughterhouses, communication networks and so forth, but also by using modern production and handling practices. The cold chain remains one of the most important ways to preserve perishables and deliver them to market in healthy and good condition. The various requirements for success in the cold chain are identified, and examples of what can go wrong are given. Environmental issues are considered. Solutions for the future relating to produce, equipment, storage and handling, and logistics are identified. The main requirements are for education and training and for provision of good operating systems. Nowadays, there are approximately 1,300 specialized refrigerated cargo ships, 80,000 refrigerated railcars, 650,000 refrigerated containers and 1.2 million refrigerated trucks in operation use worldwide. They carry vast amounts of foodstuffs and other perishables and mostly do so very successfully. **It is important to state that the breakdown of cold chain of meat will definitely increase the microbial growth and in turn decrease the storage period of that meat and cause a risk from pathogenic microorganisms.** Practically, the cold chain in the MENA region for red meat and poultry suffer a lot of problems, which may be due to the lack of sufficient awareness of the importance of cold chain and its role in maintaining the integrity and quality of the product until they reach the consumer. It is worth mentioning that the occurrence of any malfunction during the cold chain of meat will undoubtedly increase the amount of waste in the meat, which negatively affects both the producer and consumer. We will display through this report the current status of cold chain for meat as a case study in some countries in the MENA region and the challenges facing this industry and also the most important recommendations to address those challenges.

2. Introduction

Cold chain is a logistic system that needs a series of facilities for maintaining ideal storage conditions for perishables from the point of origin to the point of consumption in the food supply chain. Logistic is the management of the flow of goods and services between the point of origin and the point of consumption in order to meet the requirements of customers. Logistics involves the integration of information,

transportation, inventory, warehousing, material handling, and packaging, and often security. Likewise, a cold chain is a temperature-controlled supply chain network. Cold chains are common in the food and pharmaceutical industries and also some chemical shipments. The specific temperature (and time at temperature) tolerances depend on the actual product being shipped, where in chilled poultry carcasses, the optimum temperature is the nearest to the freezing point i.e. -1 to -1.5 °C.

A cold chain can be managed by a quality management system (QMS). It should be analyzed, measured, controlled, documented, and validated. A quality management system can be expressed as the organizational structure, procedures, processes and resources needed to implement quality management. A well organized cold chain reduces spoilage, retains the quality of the harvested products and guarantees a cost efficient delivery to the consumer given adequate attention for customer service. The main feature of the chain is that if any of the links is missing or is weak, the whole system fails.

The food industry uses the process of Hazard Analysis and Critical Control Point, HACCP, as a useful tool. Hazard Analysis Critical Control Point or HACCP is a systematic preventive approach to food safety and pharmaceutical safety that addresses physical, chemical, and biological hazards as a means of prevention rather than finished product inspection (shaded boxes in figure, IV.1 are critical control points during the processing of poultry in slaughterhouses). The cold chain logistics infrastructure generally consists of: pre-cooling facilities, cold storages, refrigerated carriers, packaging, warehousing and information management systems (Traceability and Tracking etc.). Well maintained cold chain helps to; Reduce costs, improve product integrity, increase customer satisfaction, and reduce wastage and returns of expired stock.

In an overview of the current and expected situations in the production of red meat and poultry worldwide, recent report published by FAO (2010) revealed that the total world production of beef was 27 million tons in 2010 and is expected by 2019 to be 28 million tons. The average per capita consumption is 15 kg per year. Concerning poultry meat, about 38 million tons produced in 2010 and is expected to grow to 43 million tons by 2019. The average per capita consumption is more than 25 kg to about 28 kg. Regarding sheep meat, about 2.7 million tons produced in 2010 and will decrease to 2.6 million tons by 2019. The average per capita consumption is 1.6 to 1.4 kg. Generally, total consumption of meat (red and poultry meat) per capita per year was about 65 kilograms (2010) and will increase to 68.5 kg (2019).

There is no doubt that meat and poultry, as well as their products, must be kept within safe and optimum temperatures during transport, processing and storage. So that, monitoring environmental and processing conditions of meat and poultry all the way from its source to the moments prior to its consumption is very important and also is a great challenge reduction. Monitoring, recording, and analyzing the data of these conditions are essential to maintaining the safety and quality of meat products. It is well known that safety, quality and shelf life play an important role in the food industry.

3. Red meat

1. Chilling of red meat

Immediately after slaughtering, the pre-cooling (0- 4 °C) of carcasses is very important for the following reasons: (1) To decrease carcasses temperature from 40°C to almost

zero, that definitely may increase preservation age to 3 weeks if good sanitation is maintained during slaughtering and processing of meat, (2) Retardation of bacterial growth, (3) Increasing storage period, (4) Providing or giving time for rigor mortis process, (5) Improving the meat flavor and other quality properties. It is important to state that the temperature at the deepest point of the meat is the challenge; it depends on the efficiency of chiller, carcasses weight and fattening. In cattle carcasses, the temperature of the deep muscle should be between 6- 7°C within 28 to 36 hour, while in sheep carcasses temperature should be reduced within 24 to 30 hour. Data presented in Table 1 shows the expected preservation age for different red meat under chilling temperature (-1°C).

2. Freezing of red meat

The main purpose of the freezing of red meat is increasing the preservation age from weeks to several months. The bacterial growth is inhibited at -12°C, so that it is recommended to keep temperature below this point, because the enzymes of meat will be activated and the rancidity will occur at higher temperatures. The maximum preservation age at -18°C is 10 months for cattle meat and 8 months for sheep meat.

Table 1. Expected preservation age for different kinds of red meat and rabbits meat under chilling temperature (-1°C).

Meat type	Expected preservation age at – 1°C
Cattle	3 week
Calf	3 week
Mutton	10- 15 day
Rabbits	5 day

4. Poultry meat

1. Chilling of Poultry

The primary objective of chilling of poultry is reduction of microbial growth to level that will maximize both food safety and time available for marketing. Generally, a carcasses temperature of 4°C or less is recommended as soon as possible after evisceration (1 to 2 hours postmortem). The most common methods of chilling of poultry are in water (in USA) and in air (in Europe). The chilling in water operation is divided into two stages: (1) Pre-chilling, the carcasses temperature decrease from 38°C to about 30 or 35°C within 10 to 15 min. (2) Chilling, the carcasses put in the main chilling tank and its temperature decrease to 4°C rapidly within 45 to 60 min. Concerning the air chilling method, it involves passing the shackle lines of carcasses through large rooms having forced cold air (-7 to 2°C) for 1 to 3 hours.

2. Packaging and storage of chilled poultry

The chilled poultry is packaging in plastic package made from polyethylene material. When the chilled carcasses temperature is in between -1 to 4 °C, the storage period should not be more than 96 hour after slaughter. Whereas, in case of the chilled

temperature is in between -1 to zero, the storage period will be increased reaching till 4 to 10 days. It is important to state that the higher scalding temperature and the time of scalding led to shortening storage period as a result of deterioration of the carcasses skin (peeling of skin).

3. Preservation of poultry meat by freezing

We have to cool the carcasses just after slaughter to 10°C before start the freezing process, because the freezing directly after the slaughter led to pronounced deterioration in meat tenderness. There are presently many methods we can use to freeze the poultry carcasses which include: air blast freezing, liquid contact freezing and immersion freezing spray. In general, the inside carcasses temperature should reach around -9.5 °C after about one hour and half from the beginning of the operation (for broilers), while in turkey carcasses the period will increase up to 5- 7 hours according to the carcasses weight.

4. Storage of frozen poultry

The frozen poultry is placed in cardboard boxes or wood boxes, and the optimum economic storage temperature should be in between -18 to -20°C, hence the storage period may be increased reaching to 12- 24 month. According to the food laws, the storage period should not be more than 6 months when temperature is -12°C, also should not be more than 9 months when temperature is -18°C.

*Shaded boxes represent critical control points (CCP) throughout the processing of poultry carcasses in the slaughterhouse.

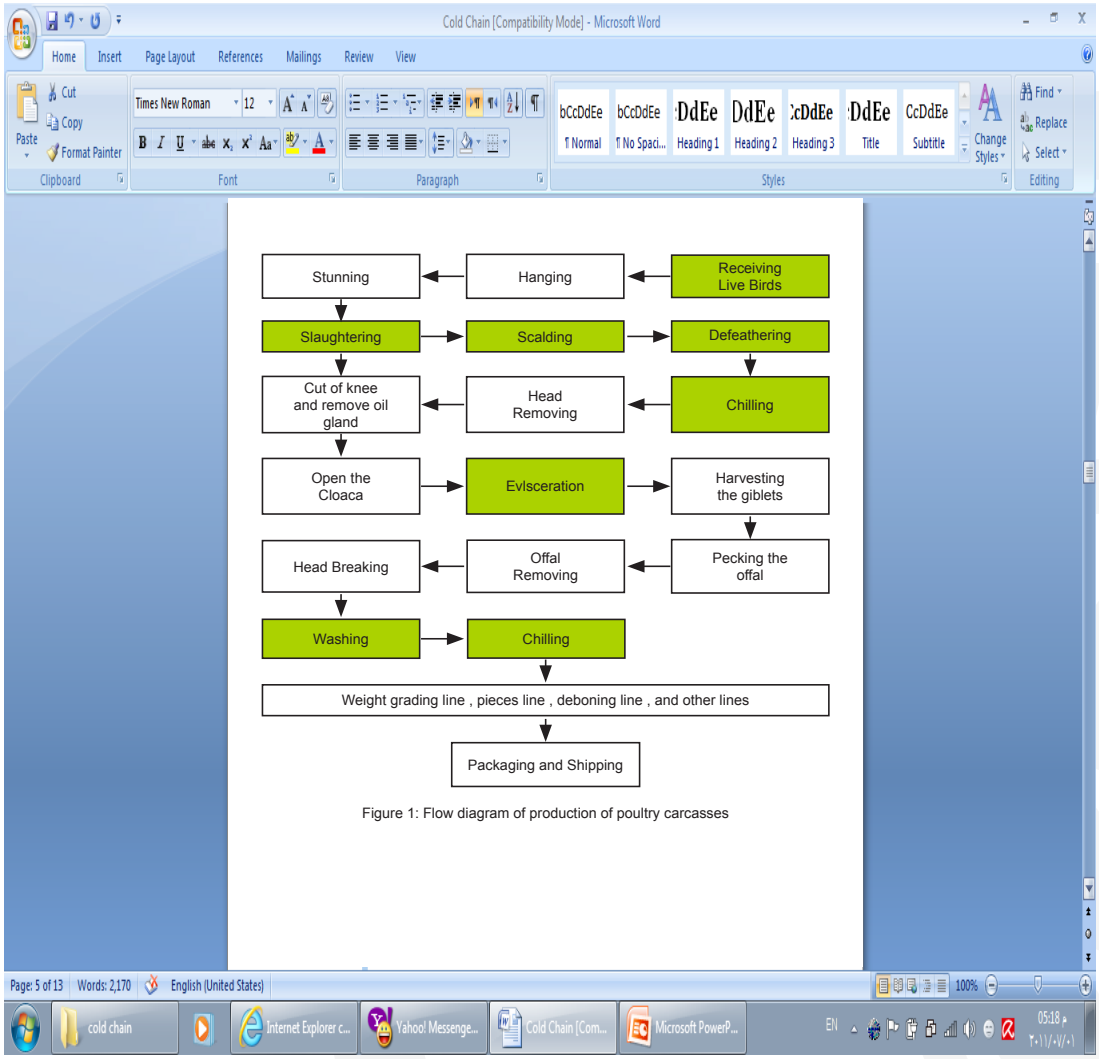

Figure 1: Flow diagram of production of poultry carcasses

5. Case study: the current status of red meat and poultry in Egypt

There are currently (2011) no cold storage rooms in all cattle slaughterhouses (beef, buffalo, mutton, sheep and camel) in Egypt; therefore, immediately after slaughtering, the pre-cooling is not used. Moreover, the refrigerated transport of cattle carcasses is not practiced. Likewise, most cattle carcasses are not displayed under refrigerated conditions. Accordingly, the cold chain of local cattle carcasses is actually absent; therefore, significant qualitative and quantitative losses occur. Regarding poultry meat, the marketing of live poultry in Egypt represents the most common pattern, like many countries of the region, despite the issuance of a lot of legislation that criminalize it. At the level of refrigerated or frozen marketing, the automatic slaughterhouses follow up the procedures of cooling and freezing in good manner and transport in refrigerated vehicles until the stores which display it in chilled or frozen pattern.

Table 2. The red meat and poultry meat production in Egypt

Meat type	Production in 2009 (1000) ton
Cattle	393
Buffalo	369
Sheep	85
Goat	60
Camel	4.9
Poultry	7.7 million ton

6. Case study: the current status of red meat and poultry in Saudi Arabia

In Saudi Arabia, cattle, calves, camels and sheep are slaughtered in slaughterhouses only and will be transfered directly after that by two methods: firstly, the owner of the carcass receives his carcass to preserve it in the refrigerator. Secondly, the carcasses transfer to the refrigerator of the shops directly. In general, the carcasses transfer from the slaughterhouses to selling centers by refrigerated trucks or cars. During the pilgrimage season, the losses of the sacrificed carcasses are in large amounts annually as a result of inadequate cold chain facilities. Nowadays, the kingdom solved this problem via freezing and distributing that meat to Islamic world as a funding from Islamic Development Bank. Slaughterhouses and refrigerators with 300,000 tons capacity are implemented by Amikka company in Makka.

Regarding the poultry industry, the poultry enterprises have been adjusted through committees of preventive security to follow up the projects in all phases including cold chain. The authorities banned the marketing of live birds and support the implementation of slaughterhouses projects which have refrigerated stores and chilled cars. In 2009, the self sufficiency percent in the Kingdom from both red meat and poultry meat was 38 and 47.8%, respectively.

Table 3. The red meat and poultry meat production in Saudi Arabia, (1000) ton

	Year	
Meat type	2008	2009
Red meat	170	171
Poultry meat	446	494

Table 4. Red and white meat (1) production in the MENA region*

	Year			
Production (1000 M.T.)	Average 2000-2004	2005	2006	2007
Red Meat	2121.31	2290.43	2331.29	2283.4
White Meat	2671.98	3061.3	2544.57	2780.24
Total Meat	4793.29	5351.73	14775.86*	15663.64*

(1) Does not include fish production * Add livestock production from Iran

Table 5. The red meat and poultry meat production in Iran, in 2010

Meat type	Quantity, (1000) ton.
Red meat	950
Poultry meat	1600

Table 6. Production of different red meat sources and poultry meat in Arab nations (except Sudan, Djibouti and Somalia)

	Year			
Production (1000 M.T.)	Average 2000-2004	2005	2006	2007
Production of cattle and buffalo meat				
	1006.84	1059.25	1168.18	1089.18
Production of sheep and goat meat				
	963.87	1069.16	1013.96	1042.26
Production of camel meat				
	149.45	133.3	122.16	125.07
Production of poultry meat				
	2671.98	3061.3	2544.57	2780.24

Table 7. Total imports from different sources of red meat and poultry meat (fresh, chilled and frozen) in Arab nations (except Sudan, Djibouti and Somalia).

	Average 2000-2004		2005		2006		2007	
	Q.	V.	Q.	V.	Q.	V.	Q.	V.
Cattle meat (fresh, chilled and frozen)								
	309.47	542.28	462.49	871.45	467.28	903.89	529.93	1161.15
Sheep and goat meat (fresh, chilled and frozen)								
	128.64	282.61	158.88	409.48	152.97	393.67	156.19	416.69
Other meat (fresh, chilled and frozen)								
	18.95	26.79	10.52	14.02	15.51	21.56	14.91	21.82
Chicken meat (fresh, chilled and frozen)								
	695.11	758.74	1024.85	1284.51	921.54	1189.16	993.3	1345.64

Value (V): Million U.S. Dollars Quantity (Q): 1000 M.T.

7. Current status and challenges of the cold chain of meat in the MENA region

The key challenges to the growth of the sector are:

- In some countries, there is a lack of a reliable cold chain due to electricity constraints (high energy costs); a fundamental prerequisite for the development of integrated poultry industry with centralized slaughterhouses**.**
- Extreme climatic conditions with extremely hot summer in most region countries had a negative effect on the efficiency of cold chain application.
- Some MENA countries still lack the basic conditions for the development of a sustainable fresh chicken industry: a functional cold chain system and affordable as well as uninterrupted energy (electricity).
- Lack of cold storage rooms or adequate systems in the all cattle slaughterhouses.
- Lack of data on consumer demand and preference for fresh chicken.
- Lack of a functional cold chain in order to sell fresh chicken meat rather than live chickens.
- Lack of the food awareness for both consumer and decision maker, regarding the importance of cold chain to obtain safe and healthy food.
- Lack of financial support for cold chain infrastructure in most region countries, except Gulf countries.
- Lack of competitiveness with frozen imports from Brazil and USA (low price).
- Arabian consumers have a strong preference for live or fresh chicken and are willing to pay a price premium of over 30 percent over the frozen or chilled equivalent.

- A fresh chicken market does not practically exist in some countries today due to the lack of cold storage capacity. So that, the choice for consumers is between frozen or live chicken.
- Implementing a cold chain strategy for a new market or climate zone can have many challenges, such as, adapting the cold chain to meet new regulations, geographic distance and varying validation processes. In some cases, just identifying the risks for your cold chain can be extremely challenging. With Government appointed health agencies seeking the best global practices at all stages of the supply chain, companies must overcome these challenges to ensure success.
- Poor infrastructure particularly in cold storage, warehousing and transportation.
- Inadequate quality control and testing infrastructure.
- Inefficient supply chain, marketing facilities (network) and over involvement of middlemen.
- High transportation and inventory carrying cost.
- High taxation.
- High packaging cost.
- Meeting the global standard of quality is very difficult and challengeable.
- Sub-standard product and unscrupulous practices in the unorganized sector.
- Heavy policy intervention.
- Presence of too many intermediaries.

8. Recommendations

The key recommendations to improve the cold chain of meat and poultry industry are:

- **Shift towards chilled poultry rather than live poultry**: As a result of increasing the risks of pandemic diseases such as avian flu, so that both private and public sectors are moving towards chilled poultry vs. live birds in some countries. These carcasses need refrigerated storage, and hence are expected to encourage the development of cold storages.
- Government initiatives: the Governments should encourage the cold chain industry by incentivizing investment into the development of cold chain infrastructure, especially the loans which is oriented to the cold stores.
- Development of processed food sector will develop the cold chain of meat and poultry industry in the region countries.
- **Development of organized retail**: Organized retail is the strongest driver for the development of cold chain of meat and poultry in the region. Introducing the technical support to cold chain of poultry and meat users to increase their awareness.
- Developing efficient supply chain networks, pre-cooling facilities, refrigerated vehicles, cold stores, warehouses, pack houses and traceability systems.
- Investment in improving and introducing new marketing infrastructure techniques.
- Establishment of cold storage rooms in all slaughterhouses all over the MENA region (to achieve the pre-cooling of carcasses, which is a very important challenge because these rooms are not found in most slaughterhouses).
- Pre-cooling of carcasses should be one of the slaughterhouses responsibilities.
- Carcasses owners should be obliged to transfer carcasses under adequate cooling conditions either to refrigerated storage or for the retail display.
- Training, education and traceability as well as following the new era of food quality control systems should take it into our consideration.

Literature Cited

Alan R. Sams (2001). *Poultry Meat Processing*. CRC Press, USA.

Arab Organization for Agricultural Development (AOAD), 2007. Livestock, Poultry and Fish Production, Part 4; Imports, Part 6.

FAO (2010). OECD-FAO, Agriculture Outlook 2010-2019.

Gyesley, S. W. (1991). *Total Sysstems Approach to Predict Shelf Life of Packaged Foods*. ASTM STP 1113-EB.

Lawrie, R. A. (1985). Meat science (17th ed.), Pergamon press.

Meyers, T (June 2007). "RFID Shelf-life Monitoring Helps Resolve Disputes". *RFID Journal*.

Osheba, A.S and Abdel -Bar, N.M. (2007). Effect of different marinating solutions on microbial growth inhibition and quality characteristics improvement of beef slices during cold storage. Egypt. J. Agric. Res., 85 (2): 629 – 646.

Osheba, A.S.; Mervat, M. A. and Nagy, Kh. S. (2008). Effect of irradiation and packaging materials type on shelf life and quality attributes of minced meat during cold storage. ISOTOPE & RAD. RES., 40 (3), 593 – 612.

Price, J. F. and Schweigert, B. S. (1971). The science of meat and meat products, W. H. freeman and company, San Francisco.

Riva, Marco; Piergiovanni, Schiraldi, Luciano; Schiraldi, Alberto (January 2001). "Performances of time-temperature indicators in the study of temperature exposure of packaged fresh foods". *Packaging Technology and Science* 14 (1): 1–39.

Singh, S. P.; Burgess, Singh (January 2008). "Performance comparison of thermal insulated packaging boxes, bags and refrigerants for single-parcel shipments". *Packaging Technology and Science* 21 (1): 25–35.

Sutherland, J.P.; Varnam, A.H. and Evans, M.G. (1986). *A colour Atlas of Food Quality Control*. Wolfe Publishing Ltd, Netherlands.

Svendsen, F.U. and Caspersen, C. (1981). Factors decreasing shelf life in production of fresh broilers, Proceeding of 5th European symposium on the quality of poultry meat, Apeldoorn, The Netherlands, May 17-23, 1981, (eds R.W.A.W. Mulder, C.W. Scheele and C.H. Veerkamp), pp. 459-67.

منظمة الأغذية والزراعة للأمم المتحدة- دليل تطبيقي، ممارسات جيدة لصناعة اللحوم (2006) القاهرة، مصر.

التقرير السادس لوزارة الصناعة المصرية- حالة الصناعات الغذائية في مصر (2009).

تقرير وزارة الزراعة السعودية – إنتاج اللحوم الحمراء والدواجن (2010).

http://presstv.com/Program/176959.html

http://www.iran-daily.com/1387/3292/html/index.htm

SESSION V.

EXTENSION AND TECHNOLOGY TRANSFER

Awad Hussein, Sultan Althagafi, and Hala Chahine

Extension and technology transfer activities can be effective in informing food producers and handlers about the importance of the cold chain in maintaining food quality and safety.

Importance of Cooling

By far the most important part of maintaining the quality of harvested fresh produce and increasing their shelf life is:

- ensuring that they are cooled as soon as possible after harvest and that
- optimum temperatures are maintained during distribution.

It has been noted that in many cases in different MENA countries the actors in the field of postharvest have little knowledge on the possibility of cooling their fresh items and the importance of doing it to increase their shelf life.

Technology transfer

The right technologies to be used are being studied at university and research centers level however extension of the information is rarely done at the right time and to the right actors. Every country and every produce has its own specificities in terms of harvest, physiology and requirements to increase its shelf life whether it is fish, meat, chicken, eggs, dairy or fresh produce.

Assessment of the existent is crucial to determine the problems to be solved.

Assessment

In order to transfer knowledge it is essential to

- Understand the existent
- Determine extension needs
- Determine Postharvest training needs assessment

There is a Commodity Systems Assessment Methodology (CSAM) necessary to collect data that will be shared with the stakeholder and will be the base of information transfer.

Information transfer

Information collected by the CSAM should be shared with all stakeholders of the cold chain to keep the chain well connected.

The stakeholders and the extension agents will agree on the information needed. The extension agents should gather the information needed to solve the specific cold chain problems.

- The extension agents on cold chain will meet with the producers, harvesters / collectors / transporters, cold storage owners and workers, distributors and all stakeholders and inform them of the importance of cooling. Other extension officers related to harvest and postharvest should also be involved.
- Capacity building should be done on all causes of postharvest losses to avoid them. The extension agent should stay close to producers and farmer organizations during harvesting and inform them in a timely manner.
- Stakeholders need to be assisted into harvesting at the proper season and the proper time of the day.
- Make sure producers and harvesters understand the importance of harvesting at the proper maturity stage in relation with the destination market (local or export, short or long distance).
- Explain to the harvesters the importance of sorting the produce and removing the injured ones in order to speed the cooling process and make it more efficient.
- Address the Collector/Harvester/Middleperson/ Transporter and insist on putting the produce in the shade and Cover trucks to reduce water loss as a result of delays in transportation.
- Also to avoid delays assist them in having a good schedule of collection and deliver to packinghouses ASAP.
- Always check produce initial quality and temperature in order to sort them and calculate speed of water loss and the time needed to cool them to the appropriate temperature and relative humidity
- Training on how to avoid injuries, mixed loads and diseases is a must.

Planning and Management

Extension is not only in information transfer but also in assisting stakeholder in understanding the Produce Cool Transport Management System and Planning for best quality. Questions such as those below, need to be answered before starting a business in cold chain:

- What will be the transport equipment?
- How to prepare the load? Inform the actor of the loading methods to be adapted to specific conditions
- How to prepare the trailer? What is the frequency of cleaning, maintenance of the truck/trailer?
- What is the importance of precooling the vehicle and how to avoid its re-warming?
- What are the handling procedures at destination and during retailing?
- Stakeholders involved in transportation and cooling facility need to be informed of the internal, external and residual heat loads. Extension agent will train them on the different methods to remove the heat.

Extension Methods and Tools

Extension Methods

- Presentations
- Demonstrations of tools and practices
- Field visits and discussions
- Written training materials
- Illustrations and diagrams
- Audio-visuals
- Cell phone sms
- Commodity Systems Assessment Methodology
- Cost/benefit examples
- Demonstrations
- Field visits to convince stakeholders in using new and adaptable practices.
- Field visits could be also to visit other packing facilities, cold storages & assess problems.
- Take farmers on study tours and provide facilities' managers with specific technical assistance.
- Exchange visits between farmers/associations from developing countries to farmers/associations in developed countries

- Assisting traders in organizing meetings among stake holders to attend trade fairs.
- Arrange meetings or workshops for stakeholders along the chain.
- Assist producers and buyers in interacting for better produce quality

Extension Tools

- Digital thermometers to check the product and air temperature
- Vented and not vented plastic bags to show the effect of RH and ventilation during cooling
- Refractometer to measure the solids soluble contents or sugars
- Sizing Rings for grading
- Penetrometer to measure the firmness in selected fruits as an indicator for maturity and ripeness
- Color charts as an indicator for maturity and ripeness to decide on the timing of cooling.
- Pictures and slides to familiarize the stakeholders with diseases, tools and others
- Exercises and examples on cost/benefit analysis
- Questionnaires

Example of demonstration

- The demonstrations are direct visual evidence of the effects of:
- Temperature and temperature management for stakeholders to be aware of the produce temperature and how to manage its cooling.
- Improving humidity / ventilation (plastic bags / vented) on cooling
- Simple packaging / liners on produce
- Sorting and cooling
- Measuring soluble solids or sugars to assess maturity
- Sizing Rings for grading purposes
- Measuring firmness in selected fruits

Needed information is also available on the Internet

- The Information Network on Post-harvest Operations, http://www.fao.org/inpho
- Postharvest Fresh http://www.postharvest.com.au
- The postharvest research and extension programs http://postharvest.ucdavis.edu
- Postharvest program at University of Florida http://irrec.ifas.ufl.edu/postharvest/
- Training in postharvest technology http://www.postharvest.org

References for small scale postharvest handling operations

- Kitinoja and Thompson. 2010. Pre-cooling systems for small□scale producers. Stewart Postharvest Review 2:2.
- Kitinoja et al. 2011. Postharvest technology for developing countries: challenges and opportunities in research, outreach and advocacy. J. Sci. Food Agric. 91: 597–603.
- Kitinoja and Kader. 2003. Small-scale postharvest handling practices: A manual for horticultural crops (4th edition). http://postharvest.ucdavis.edu/datastorefiles/234-1450.pdf

Choices + Information = Decision

- A stakeholder needs to have the needed information and a choice of tools and methodologies in order to make his own decision. This is applicable in terms of Pre-cooling ways and instruments, different packing methods and packaging materials
- Choices of pre-cooling method
- Choices of packages
- Posters / Results of Research /Pictures
- Dos and Don’ts
- Videos

Cost/benefit calculations

- Before spending any money on new practices, tools, packages, etc., you can determine whether it will be profitable
- C/B calculations allow you to compare using two or more different practices in the context of your own operation.
- Calculate the Return On Investment (ROI) for current and new practice

Lessons learned from past projects in different developing countries

- In an assessment project organized by WFLO and Bill and Melinda Gates Foundation and led by Dr. Lisa Kitinoja 6 major lessons , 12 projects that were revisited by our WFLO/UC Davis postharvest teams.

1) Focus on the Beneficiaries

- Address the entire value chain, understand needs of buyers
- Lessons Learned from past projects in different developing countries

2) Work through Groups when possible

- groups are the key to:
  a. Assessing local needs
  b. Strengthen marketing capacity & linkages
- Lessons Learned from past projects in different developing countries

3) Postharvest best practices should be incorporated early on in projects.

- Sorting, grading, packing, cooling, storage topics should be addressed
- Lessons Learned from past projects in different developing countries

4) Invest wisely in PH infrastructure

- Training without postharvest infrastructure = frustration.
- Similarly, no infrastructure without training
- Lessons Learned from past projects in different developing countries

5) Build local capacity

Training for local trainers to support service

- Lessons Learned from past projects in different developing countries

6) Projects should have a longer term focus

- For sustainable results
- Infrastructural Problems
- Lack of a cold chain
- Poor access roads
- Inappropriate vehicles
- Lack of proper packing sheds
- Need to Provide subsidy in the cooling system

Case study: Cold Chain in GCC

Challenges facing the cold-chain in GCC

Saudi Arabia has the highest population in GCC with more than 26 million people and a growth rate of 1.5% annually. This imposes greater pressure on improving the status of post-harvest technologies including its cold chain. However, the concentration on agricultural operations in order to increase production remains the focal point, while the ways to reduce post-harvest loss through the application of appropriate technologies do not meet the same importance.

In addition, there does not exist published data that evaluate these losses for any product or source its causes and how to minimize it. It is estimated that loss in vegetables and fruits, reaches about 20% with and it is concentrated during harvesting, transport, storage and marketing.

Based on the above, the following cold chain challenges emerged

1. Lack of sufficient electricity sources with right requirements in many areas of production
2. Lack of funding necessary to establish such projects, which requires loans from various destinations and guarantees difficult to repay.
3. Absence of technical, well-trained staff to provide support and design the appropriate choice of equipment, and provide effective maintenance and operation services
4. Prevailing culture, traditions and customs prevent the spread of the concept of maximizing postharvest effectiveness by adopting to basic concept in this felid
5. The process of establishing an effective cold chain in a country is one of the slow processes that take between 30 to 40 years (Billiard, 2003) or other words that requires time for circulation is the beginning of that process and the survival of the faith is most important.
6. High postharvest losses and poor produce quality at destination.
7. Contractual marketing, absence of market information system, and lower returns to growers Lack of technical labor
8. Lack of modern packing grading and storage facilities.
9. Compliance issues (Quality standards, Sanitary & Phytosanitary issues, Food safety, Pesticide residues, Traceability
10. Non-availability of independent Food Testing Laboratories
11. Poor transportation means and absence of cold chain infrastructure.
12. Absence of any standard R&D facility for postharvest and cold chain.
13. Lack of integration between research, academia and extension

Accordingly, it is necessary to adopt a comprehensive strategy that aims towards transferring expertise from many neighboring countries to Saudi Arabia, plus enhancing awareness and general knowledge of postharvest latest techniques among producers, logistic companies and retailers.

High-Rise Automated Warehouses

In the GCC there is a new high technology initiative for cold storage warehouses: the High-Rise Automated Warehouses.

What is it?

In high-rise automated warehouses there are two cranes working in the same aisle, putting and picking pallets so quickly in around a minute (fig V.1). Some automated cranes can hold two pallets at a time. Conveyers in the middle of the building normally feed cranes so that the cranes need not travel the entire length of the aisle. Buildings with 30,000 pallets often have only two aisles and two cranes.

The net consequence of this technology is:

1. Large saving of manpower
2. Much smaller buildings
3. More thermally efficient facility
4. Much smaller footprint
5. Significantly lower construction and land costs
6. Unmatched speed and efficiency in handling pallets movement and maximizing storage space utilization.

Based on a recent study conducted by Samara Refrigeration Company in Saudi Arabia, it was found feasible to apply the high-rise automated warehouses concept.

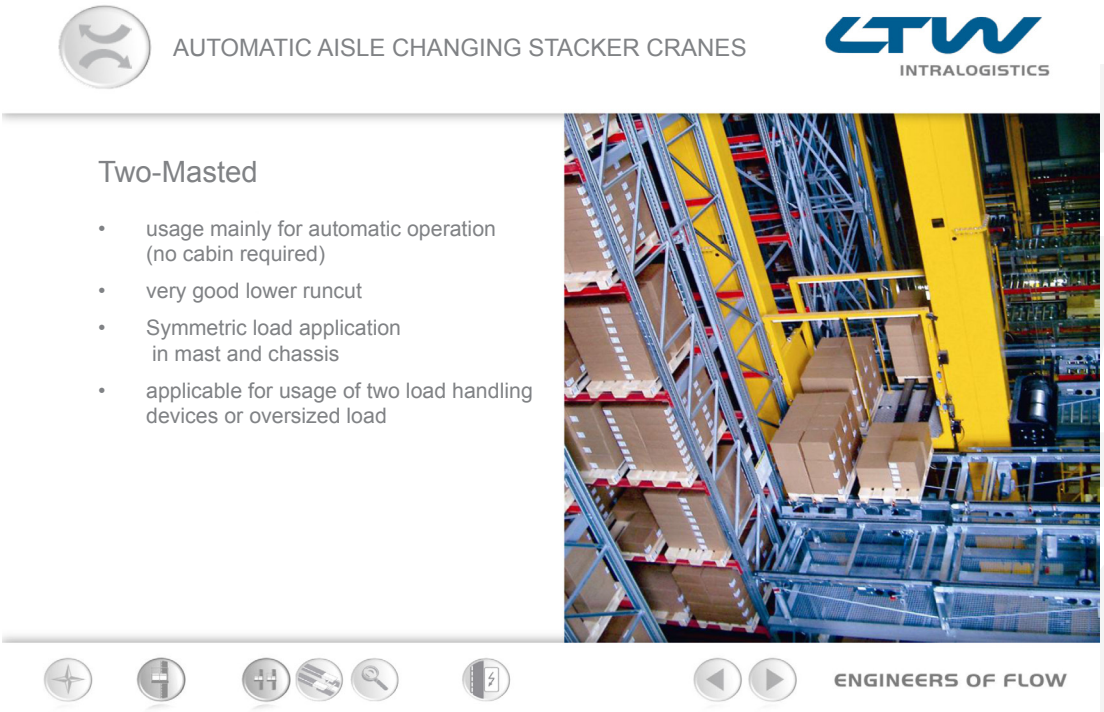

Figure 1. High-rise automated warehouses with robotic cranes.

The concept

High-rise automated warehouses change the role of the refrigeration design engineer considerably:

1. Refrigeration loads and the system size, are significantly reduced. The buildings are very tall and gravity helps distribute refrigeration in the building.
2. The internally generated loads during operations are much lower, allowing off-peak operations, saving the cost difference between on-peak rates and off-peak rates. The system must be designed to capitalize on the off-peak opportunities in warehouses.
3. The design process of an automated building is significantly different from the conventional building shown in figure 2.

Figure 2. Conventional warehouse, Tabuk Agricultural Co. Saudi Arabia

4. Rack-supported buildings distribute loads relatively evenly on the floor plate, changing the design of the floor plate particularly when pilings are used. The engineer designing the floor structures needs to coordinate with the manufacturer of the rack-supported building. Again, this gives an advantage to the rack manufacturer for coordinating the entire project.

5. As shown in figure V.1, Automated cranes and the pallet license plate readers are very moisture-sensitive; they do not tolerate any frost or ice coating.

6. Product might be stored in bulk on docks for long periods of time. The dock itself is kept around –15°F (–23°C) for ice cream. The entire dock, door-design and dehumidification system requirements and design are affected by these material-handling decisions.

Figure 3. Dates factory, UAE

Suggestions to improve cold-chain awareness in the region

1. To establish cold chain associations
2. Document current practices
3. Creation of some media, educational tools and programs
4. Establishing a cold chain resource directory
5. Establishing a regional center of Excellency of cold store R&D
6. Promoting green cold-chain technology
7. Obtaining support from international organization such as FAO, IIAR, WFLO, GCCA and IARW.
8. Organizing the first cold chain conference in the region
9. Solutions to existing problems in the postharvest handling system require:
    - Use of available information and
    - Application of available technologies at the appropriate scale rather than conducting new research, or developing new technologies.

Recommendations

In general

- Training at stakeholders at all levels of the value chain to on all aspects that will affect the cold chain.
- Continuously support stakeholders during operation not only as flash training. Always share information
- FAO to assist MOA in facilitating activities of the Private sector through regulations and strategies implementing.

Large scale - Cold-chain Challenges

It is necessary to:

1. Adopt a comprehensive strategy that aims towards transferring expertise from many neighboring countries
2. Enhance awareness and general knowledge of postharvest latest techniques among large producers, logistics companies and retailers.
3. Improve cold-chain awareness in the region

The cold chain starts from the grower

- Raise awareness on maintaining low temperature during handling of the crop to keep product quality close to its quality at harvest
- Promote the use of shade to protect harvested produce while waiting for transportation
- Encourage cover transportation vehicles to prevent rewarming of produce

At the facilities

- Address sorting before cooling will improve cooling efficiency
- Encourage the use of precooling. Training of operators will help efficient use of the technology.
- Special care should be taken for stacking and ventilation in the cold room.
- Raise the awareness on the basis of mixing produce in a cold room

Commodity Groups compatibility :

chilling sensitive/ non chilling sensitive

ethylene sensitive / non ethylene sensitive

on the actual temperature of the product:

Already cooled / still warm produce

In Transportation

- Promote cooling and cleaning of vehicles before loading for efficient cooling.
- Promote temperature recording during transportation and at every stage is crucial to solve problems.

During display

- Training on the protection of produce from elevated temperatures and from possible injuries during display is recommended

At the consumer level

- Raise the awareness of the consumer on reduction of losses
- And on how to cool and use leftovers

At the organizational level

- Use of available information
- Application of available technologies at the appropriate scale No need to conduct new research, or develop new technologies.
- Train and follow up with trainees until they adopt and make it a routine.
- Organizational

Conclusion

- Postharvest horticulturists need to coordinate their efforts with those of:
- Production horticulturists,
- Agricultural marketing economists,
- Engineers, food technologists,
- Others in various aspects of the production and marketing system.

References

Postharvest Handling and Transportation Training of Trainers Workshop Report August 25-September 5, 2002 , La Palm Hotel Accra, Ghana Submitted to: Market Access Working Group , U.S.–Ghana CCARD Submitted by: U.S. Postharvest Training Team Dr. Adel Kader, University of California, Davis Dr. Lisa Kitinoja, Extension Systems International Mr. Brian McGregor, U.S. Department of Agriculture Mrs. Heidi Reichert, U.S. Department of Agriculture.

Grocery Store Display Storage Adel A. Kader, Department of Pomology, and Jim Thompson, Department of Biological & Agricultural Engineering , UC Davis, August 2001, Issue No. 107 Perishables Handling Quarterly.

Increasing Food Availability by Reducing Postharvest Losses of Fresh Produce A.A. Kader, Department of Pomology, University of California, Davis, CA 95616, USA. Proc. 5th Int. Postharvest Symp., Eds. F. Mencarelli and P. Tonutti, Acta Hort. 682, ISHS 2005

HANDLING OF CUT FLOWERS FOR AIR, TRANSPORT, M.S. Reid University of California, Davis, CA, 95616, U.S.A., msreid@ucdavis.edu, IATA perishable cargo manual – flowers (234-1373)

WFLO Grant Final Report Part 1: Past Project Assessments Identification of Appropriate Postharvest Technologies for Improving Market Access and Incomes for Small Horticultural Farmers in Sub-Saharan Africa and South Asia, Dr. Lisa Kitinoja, Project Director, Senior Technical Advisor – Horticulture and Food Security World Food Logistics Organization March 31, 2010 Funding provided by the Bill & Melinda Gates Foundation (Grant Number 52198)

- IIAR 2011 technical paper, high-rise automated warehouse by Gerlad Dohlen

- Samara Refrigeration Company, Saudi cold stores market study 2011

- LTW Company for automated warehouses technology, Austria

- CIA world factbook 2011, Saudi Arabia factbook, www.cia.com

ANNEX I.

THE STATUS OF THE COLD CHAIN IN THE FISH INDUSTRY IN NORTH AFRICA

Amar KAANANE

Acronyms

Bn :	Billion
FAO:	Food and Agriculture Organisation of the United Nation
GDP:	Gross Domestic Product
GMPs:	Good Manufacturing Practices
GHPs:	Good Hygienic Practices
HACCP:	Hazard Analysis and Critical Control Point
MADREF :	Ministère de l'Agriculture, du Développement Rural et des Eaux et Forets
SNTL :	Société Nationales des Transports et de Logistique
SDTM :	Société Marocaine de Distribution et Transport de Marchandises
USTDA:	United States Trade and Development Agency

Introduction

Fisheries and aquaculture are an important source of food and a provider of livelihoods and economic benefits for many countries engaged in harvesting, culturing, processing and trading of fish. For example, fisheries and aquaculture supply over 1.5 billion people with almost 20 percent of their average animal protein intake and 3 billion people with at least 15 percent of their average animal protein intake. In addition, around 45 million people were directly engaged, full time or part time, in fisheries and aquaculture and an additional 135 million people work in subsequent activities (FAO, 2010).

Fish is a highly perishable food, which needs proper handling and preservation if it is to have a long shelf life and retain a desirable quality and nutritional value.

After capture, several chemical and biological changes take place in fish that can ultimately lead to rejection for human consumption because of spoilage. Improper fish post-harvest technologies can lead to significant losses, especially in developing countries. They are estimated at 10 to 12 million tonnes and account for around 10 percent of global capture and cultured fish but can reach over 30% in some developing countries (Ababouch 2009; Ward 2007). Reducing spoilage requires improved fish handling on board, during landing, processing, preservation, and transportation.

The methods used to preserve fish and fish products include:

- The control of temperature using ice, refrigeration or freezing;
- Heat treatment (canning);
- The control of water activity by drying, salting, smoking or freeze-drying;
- The physical control of microbial loads through microwave heating or ionizing irradiation;
- The chemical control of microbial loads by adding acids.

The key point to reduce these losses throughout the supply chain of fresh or processed fish lays on temperature management practices. A continuous and appropriate temperature management of cold chain in fish industry from capture to consumption have many advantages:

- Assure a safe fish product for the consumer;
- Assure a high commercial and nutritional quality of the fish product;
- Reduce losses;
- Increase shelf life of the product;
- Allows the producers to reach more profitable markets,
- Increase the availability of fish and fish products in the markets that are far from the production zones.

1. Importance of fish industry in North Africa

In Morocco, the fishing industry is a leading foreign exchange earner, accounting for 56% of agricultural and 16% of total exports. For a long time the industry has been an economic pillar for the country. The Kingdom is considered the largest fish producer in Africa, with an estimated total catch of 1,074,330 Tonnes in 2009.

The fisheries sector accounts for 3% of GDP. The government estimates the number of direct and indirect jobs at 400,000 (including 104,000 fishermen). The small-scale fisheries sector (100,000 people), however, lags far behind other branches of the fisheries sector owing to the lack of infrastructure and of harbour facilities.

Morocco's wide-reaching agricultural reform drive has been extended to the fishing industry. At the end of September 2009, the Ministry of Agriculture, Rural Development and Maritime Fishing unveiled Plan Halieutis. This aims to increase exports from US$ 0.9bn in 2007 to US$ 2.58bn by 2020. In the same time, the sector's contribution to GDP is expected to rise from US$ 1.91bn to US$ 2.81bn. Direct jobs in the fishing industry, a key employer, are also anticipated to nearly double, rising from 61,650 to 115,000 2.

In Mauritania, The fisheries sector contributes significantly to revenues and earnings, and its impact could further rise. The industry is distinguished by four characteristics. The country disposes of important halieutic resources, including a large number of species, of which two are underexploited (Cephalopods and small pelagic species). Over 95% of fish in Mauritanian waters are sold in foreign markets. Foreign fleets

catch most of Mauritanian fish. The fishing industry accounts for more than 25% of the national budget, 50 % of foreign exchange earnings and about 7% of GDP. In 2009, the estimated fish production is about 162,549 tonnes (FAO 2010).

Algeria's fishing industry is not well developed even it has a large Mediterranean coast, in part because fishing is generally done by small artisanal boats. In 2009, the estimated fish production is about 128,804 tonnes (FAO 2010).

In Tunisia, the fishing industry employs 25,000 people and catches an average of 93,000 tonnes of fish a year. However, coastal fishing has declined dramatically since 1995 due to pollution and the depletion of fish stocks. Fish is Tunisia's second most important food export after olive oil, and the government has made strong efforts to improve processing and storage facilities in order to match European standards. In 2009, the estimated fish production is about 94,542 tonnes (FAO 2010).

In Libya, all catches of fish are sold and consumed fresh on large urban market areas except for a part of the small pelagic which goes to canning for domestic market or as a fishmeal, during high peak production. Although the fisheries authorities has devoted substantial resources to improving the harvest and post-harvest sectors, particularly in the areas of landing site and harbour development and processing plants, national fisheries still perform well below their real potential. Employment in the fisheries sector provides for a small fraction - around 1% - of the total national labour force. It is estimated, that the contribution of fisheries to the Agricultural GDP is around 9 %. In 2009, the estimated fish production is about 49,740 tonnes (FAO 2010).

Egypt has a long coastline, extending for about 2 500 km, together with a continuous continental shelf of about 53 000 km2 bordering the country on the north along the Mediterranean Sea coast and to the east along the Red Sea, with the Suez and Aqaba Gulfs. Moreover, Egypt has various inland resources, include the Nile. The fishing industry has a relatively minor direct role in the economy of Egypt, but domestic fish production makes a valuable contribution to the national food supply and to the traditional way of life, in which fish eating plays an important part. In addition, it is a significant source of food for the tourist industry. In some cases, fishermen (especially in the Red Sea) sell their catch directly to restaurants or hotels. Fishing industry is also important for the livelihood of over 65 000 fishermen and other people employed full time in related activities (estimated at some 300 000 men). The fishing industry in Egypt comprises sea fisheries (Mediterranean and Red Sea fisheries), which account for 24% of total production, inland fisheries 61,5%, and aquaculture 14.5%. In 2009, the estimated fish production is about 1,069,780 tonnes (FAO 2010).

2. The importance of cold chain in maintaining quality

The success of cold chain lies in its capacity to prolong the period during which perishable foodstuffs remain in an acceptable state, by slowing down decay or physiological changes. It makes it possible to market safe foodstuffs, while maintaining their nutritional and organoleptic characteristics for some time, depending on the method used (chilling or freezing). It also makes it possible to supply foodstuffs to non-producing regions and to provide high-quality products to importing countries.

Cold chain plays a dual role: it guarantees steady supplies to the domestic market and makes it possible to meet the quantity and quality requirements of foreign markets. An efficient cold chain is an absolute prerequisite to the expansion of production.

This cold chain should comprise

- Fixed industrial equipment, cold rooms, cold stores comprising several cold rooms and specialized systems (industrial freezers, tunnels, order picking stations), and ice production plants;
- Mobile equipment, i.e. road, rail or sea transport equipment designed to maintain the same temperature conditions as those present in industrial cold rooms;
- Commercial equipment for preserving and displaying perishable foodstuffs (small cold rooms annexed to stores, horizontal and vertical open and closed display cabinets for chilled, frozen or quick-frozen products);
- Domestic refrigerators and freezers.

3. Cold chain in fish industry in North Africa

This study will highlight the importance of fish industry and the status and constraints of cold chain in Morocco. The status of cold chain in fish industry in Algeria, Mauritania, Tunisia, Egypt and Libya will not be discusses because of lack of information.

1 Morocco

Cold chain is relatively recent in Morocco. The first industrial cold storage facility was built in Fès in 1945. Few other facilities were set up until 1970 and most of them were state-funded. In 1975, the private sector started to show interest in cold chain facilities because of government incentives. From then on, the private sector and government authorities combined forces to drive the sector toward exponential growth.

The fishing industry is comprised of two distinct sectors: the artisanal, costal fishery and the high seas fisheries (Industrial fisheries).

1 The artisanal and coastal fisheries

The artisanal fishery is made up of about 12,000 smaller, wooden boats (MADREF, 2002). These boats catch mainly low-priced fish including sardines, mackerel and anchovies. They are older, poorly managed and lack technical equipment such cooling equipments. Therefore, the boats engaged in this fishing only stay out at sea for up to three days. Due to their lack of technical accoutrement, specifically coolers, they often times bring back damaged catches.

The coastal fleet consists of approximately 2,500 vessels, of which some trawlers are equipped with mechanisms that assist with catching deep dwelling fish such as octopus and squid. They lack cooling equipments but they use ice to cool down their capture.

2 The high sea fisheries (industrial fisheries)

Morocco's high seas fishing is somewhat more modern and consists of mainly steel boats equipped with freezing facilities, which allow them to stay out at sea longer. These boats are usually between 100 and 150 feet long and make about 5 trips, lasting 60 days, each year. There are currently 280 Moroccan registered high sea cephalopod operating trawlers. Catches by Morocco's high sea fishing fleet is smaller in tonnage than its coastal fishing fleet, but they account for the largest return in value since their catches are comprised mostly of high-priced cephalopods and white fish.

3 Destination of fish production

Catches by Morocco's high sea are usually exported immediately after arriving at Moroccan ports. Japan is the number one importer from Morocco of these catches. For these products, the cold chain is maintained and the temperature is will managed throughout handling on board, during landing, processing, preservation, and transportation (MADREF, 2002).

Catches by artisanal and coastal fisheries are intended for domestic markets and for export and are used in different ways

- By domestic Fresh consumption (33% of the captures);
- By canning industries. There are about 40 units mainly located at Agadir , Safi and Tantan (17%);
- By Cured fish units, mainly anchovies. There are about 40 units. They processed about 40,000 tonnes in 2000.
- By freezing plants. There are about 130 plants mainly located at Agadir and Dakhla. The amount processed in 2000 is about 56,000 tonnes;
- By fishmeal and fish oil plants production (42% of captures);
- By packinghouses of fresh fish oriented mainly for exportation.

4 General characteristics of cold chain facilities in Moroccan fish industry

1 Cold storage facilities

The overall industrial and commercial cold storage capacity was estimated as being 1,700,000 m3 that is equivalent to 370,000 tonnes and accounting for 495 units (MADREF, 2002), excluding refrigerated display cabinets because of lack of data on the subject.

The average capacity of cold storage facility is 750 tonnes, equivalent to of storage volume of 3,500 m3. There are 1,980 cold rooms with an average unit capacity of 189 tonnes and an average net volume of 850 m3.

In the industrial sectors, the average storage capacity ranges from 10,000 m3 to 12,000 m3 (2,000 to 24,000 tonnes) and in the commercial sector from 600 to 800 m3 (120 to 160 tonnes).

The industrial sector also has a freezing or quick freezing capacity of approximately 2,200 tonnes day and a water ice making capacity of 2,000 t per day.

Table 1 shows the distribution of cold storage capacities according to the type of the product. Fish and fish products represents only 14% of the total capacity corresponding to 53,000 tonnes.

Table1: Distribution of cold storage capacities as a function of product type in Morocco

Product	Capacity in tonnes
Fruits and vegetables Dairy products Fish Meat Ice production	244,000 (66%) 62,000 (17%) 53,000 (14%) 7,000 (2%) 4,000 (1%)

Source: MADREF, 2002

Morocco's cold storage capacity covers only 4% of the overall production of perishable foodstuffs, which is estimated as being 9,4 million tonnes. In addition, Morocco's cold storage compared with that of other countries is relatively low: Morocco: less than 60 litres per inhabitant, Argentina 120 litres, and Spain 250 litres.

The needs in terms of cold storage capacity for fish and fish products were estimated to 62,000 tonnes using an average turnover of 8 (MADREF, 2002).

2 Transport

For domestic commercialisation, large parts of fish and fish products are transported in refrigerated trucks or vans. These vehicles are owned by either private companies or national companies such as SNTL and SDTM. For export, refrigerated trucks and containers are used. In this case, some of the refrigerated trucks are leased from foreign companies in Spain, France, Italy and Germany. In 1999, about 100,000 tonnes of fish and fish products were exported via refrigerated trucks, data are not available regarding the volume exported by boats or air.

3 Ice production in Fish industry

The main mean used to preserve the fish quality on board, during storage and during domestic transport. The number of ice production is about 43 units located in ports and in fish sites landing. The theoretical production capacity is estimated to 2,000 tonnes/day equivalent to 4,000 tonne/day of storage. Table 2 shows the location and production capacities of Moroccan ice production units.

Table 2: Ice production units repartition as a function of location zones

Location	Unit number	Production capacity (T/day)	Storage capacity (T/day)	Production (T/day)
Mediterranean coast	12	408	788	290
North Atlantic	15	598	1,195	292
Atlantic centre	10	590	1,198	284
South Atlantic	6	402	805	310
Total	43	1,997	3,986	1,176

Source: MADREF, 2002.

The estimated needs of ice during different steps of fish production chain are:

- During handling fish on board: 448,000 tonnes/year;
- During landing point (Fish Halls and commercial industrial fish counter:30,000 tonnes/year;
- During transportation: 260,000 tonnes/year;
- During display: 89,000 tonnes/ year.

The total needs in ice is around 827,000 tonnes/year compared to the actual production capacity (430,000 tonnes/year), big effort has to be done to overcame the lacks in ice production.

5 Main Facts about cold chain in fish industry in Morocco

The cold chain in fish industry in Morocco is characterized by the following handicaps:

- The needs in terms of cold storage capacity for fish and fish products were estimated to 62,000 tonnes compared the available cold storage capacity of 53,000 tonnes, the required capacity to meet the needs is 10,000tonnes;
- Existence of discrepancy between fish oriented to export and the ones destined to domestic market in term of quality levels as well as on the efficiency of cold chain implementation;
- Insufficient refrigerated trucks for fish transportation and display equipments for domestic commercialisation.
- The total needs in ice is around 827,000 tonnes/year compared to the actual production capacity (430,000 tonnes/year), big effort has to be done to overcame the lacks in ice production;
- The cold chain is not continuous throughout the country.

6 Main constraints

Some of the main constraints are listed below:

- The artisanal and coastal fishery fishermen do not have means to invest in cold storage;
- Lack or insufficient refrigeration cabinet in the main domestic markets;
- High cost of energy;
- High credit cost;
- Poor management of cold chain in fish industry sector;
- Lack of spare parts for cold chain equipments in local market;

- High taxes.
- Lack of high-qualified personnel in the cold chain field.

7 Examples of success cases

In the last teen years, many Moroccan semi industrial and industrial fisheries have succeeded in the implementation of good cold chain. These plants have a good quality management and all certified with HACCP system:

- SOCIETE NOUVELLE AVEIRO, canned fish Agadir;
- SOCIETE ATLANTIC CONSERVES, canned fish,Agadir;
- SOCIETE LES CONSERVES MAROCAINES DOHA, canned fish, Agadir;
- SOCIETE BELMA, canned fish, Agadir;
- SOCIETE ESPADON, canned fish, Agadir;
- SOCIETE AMANDINE INTERNATIONAL, Frozen fish, Agadir;
- Les Frigorifiques Bouzargtoun, Casablanca;
- CONSERVE TEAM, Frozen fish, Mohammedia;
- Delta fish, Seafood for export; Casablanca.

8 Government actions

The country suffers from low cold storage capacity and shortage of equipment. These insufficiencies result in break in the cold chain.

To alleviate these handicaps, the government of Morocco has implemented incentive measures to foster investment in the cold sector.

In the area of taxation, the government offers guaranteed subsidies, which vary between 10% and 15% per cold storage unit and may amount to 200,000 EUR per unit.

Further investment assistance consists of a 15 EUR/m3 subsidy.

Furthermore, USTDA is funding a US$ 462,970 grant to the Office National des Pêches. The program is underway for the period of 2009-2014.This technical assistance includes a comprehensive study to identify the specific needs for cold storage infrastructure and facilities for the fishing industry to help reduce post-catch losses. The assistance also provides a training component targeting producers and producer associations on the role of cold storage in preserving the quality of production and therefore improving the value of the catch.

Conclusions

This study on the status of cold chain in fish industry in North Africa showed that:

The total fish production for the North African countries is about 2,442,000 tonnes in 2009.

The Kingdom of Morocco is the largest fish producer in North Africa, with an estimated total catch of 1,074,330 Tonnes in 2009. The fisheries sector accounts for 3% of GDP.

The fishing industry in Egypt comprises sea fisheries (Mediterranean and Red Sea fisheries), which account for 24% of total production, inland fisheries 61,5%, and aquaculture 14.5%. In 2009, the estimated fish production is about 1,069,780 tonnes (FAO 2010).

In Mauritania, the fishing industry accounts for more than 25% of the national budget, 50 % of foreign exchange earnings and about 7% of GDP. In 2009, the estimated fish production is about 162,549 tonnes (FAO 2010).

Algeria's fishing industry is not well developed even it has a large Mediterranean coast, in part because fishing is generally done by small artisan boats. In 2009, the estimated fish production is about 128,804 tonnes (FAO 2010).

In Tunisia, the fishing industry employs 25,000 people and catches an average of 94,542 tonnes of fish a year. However, coastal fishing has declined dramatically since 1995 due to pollution and the depletion of fish stocks.

In Libya, all catches of fish is sold and consumed fresh on large urban market areas except for a part of the small pelagic which goes to canning for domestic market or as a fishmeal, during high peak production. The estimated fish production is about 49,740 tonnes.

Data on cold chain in fish industry are scarce except Morocco where some old data exist (MADREF, 2002).

The main constraints for all North African countries are:

- The artisanal and coastal fishery fishermen do not have means to invest in cold storage;
- Lack or insufficient refrigeration cabinet in the main domestic markets;
- High cost of energy;
- High credit cost;
- Poor management of cold chain in fish industry sector;
- Lack of spare parts for cold chain equipments in local market;
- High taxes.
- Lack of high-qualified personnel in the cold chain field.

Recommendations

- Survey studies to evaluation the status of cold chain in fish industry in north Africa;
- Studies and evaluation of cold chain infrastructures in fish industries;
- Identify different partners on cold chain in fish industry;
- Develop an adequate management system for cold chain in fish industry for each country;
- Organize continuous short courses on the management of cold chain;
- Establish a strategic development for cold chain in fish industry for each country
- Encourage the professionals of fish industry to implement the good manufacturing practises and good hygienic practices using HACCP system. This can be done by policy making like subsidizing HACCP certification, ensuring credit facilities and duty free import of cold chain equipments.

References

Ababouch, L. 2009. Fish utilization and trade. In “Anthology on fisheries, trade and development”. Royal Swedish Academy of agriculture and forestry. Pp 363-384. Stockholm. Sweden.

FAO, 2010. The state of Fisheries and Aquaculture. Rome.197 pp.

FAO, 2010, Fishery and aquaculture Statistics.

MADREF, 2002. Etude de faisabilité des entrepôts frigorifiques. Rabat, Maroc.

Ward A.R, 2007. Post harvest loss assessment in PP3 zones of Cameron, Chad, Gambia and Senegal: key learning. FAO/DFID Sustainable Fisheries Livelihoods Programme – Post harvest Fisheries Livelihoods Pilot Project. SFLP-FAO, Cotonou, Benin. 60p.

MEDISCO, 2006. Report on food and agro industries characterisation in Tunisia, Morocco and Egypt. Egyptian Environmental Affaire AGENCY (EEAA).

1. http://ec.europa.eu/world/enp/pdf/country/enpi_csp_morocco_en.pdf
2. http://www.oxfordbusinessgroup.com/weekly01.asp?id=4675#english

ANNEX II.

THE STATUS OF THE FISHERY INDUSTRY IN THE GULF REGION

Haydar Hasan Alsahtout

Executive summary

Seafood is becoming integral part of balanced diet for health conscious people all over the world. Since it is highly perishable in nature, preserving the quality and nutritive values from the point of catch till reaches the consumer is very challenging in many countries in the world. Apart from employing GMP's, SSOP's and HACCP's, maintaining uninterrupted cold chain throughout the supply chain is crucial for ensuring the quality and safety of seafoods. This paper has inputs from the practical experiences of Saudi Fisheries Company in the field of capture fisheries and Aquaculture for the past 30 years.

A cold chain management system could be defined as a logistic system that provides series of interdependent operations in the production, distribution and retailing of chilled and frozen Seafoods. Various kinds of cold chains developed over the years to suit various situations and products. These developments have ensured quality and safety of seafoods in many countries and became basis for evolving international quality standards.

The Gulf region constitutes mainly of 9 countries having enormous potential for both capture fisheries and coastal aquaculture. The capture fishery in some countries in this region is not well organized. Moreover, declining trend of total catch year after year in many of these countries is the matter of concern for food security in the long run. On the contrary, aquaculture is growing in most of these countries and there is vast scope for further growth in the near future. Lack of cold chain infrastructural facilities for handling, processing, storing, distribution and marketing is one of the major hurdles for growth of capture fisheries in most of these countries.

The capture fisheries in this region could be categorized as traditional, semi industrial and industrial. On an average 75-85% of the total catch is contributed by traditional fisheries and the remaining 15-25% from modern vessels being operated by fisheries industries. There is a need to revive the capture fisheries in this region as some of the major species reached the state of extinction due to over exploitation. Lack of cold chain management especially in the traditional fisheries is not only resulting in loss of products due to quality deterioration but also fetches lower price in the local and international markets. Some of the industrial establishments in the sectors having state of the art infrastructural facilities and operate with good cold chain management systems. They are able to get the international recognition and approval for exporting to EU, USA and Japan, etc.

The governments and various fisheries related institutions in this region need to make comprehensive studies on the strength, weaknesses and opportunities for development in cold chain in the fisheries sector. It should be considered as a priority for the fishery sector to ensure food security and reliability in the long run. Investment from the private sectors, proper training and education to the fishermen communities, infrastructural development in the rural areas, implementation of integrated cold chain management system, restructuring of marketing system, export promotion and adequate support from the government/private institutions are critical for overall growth of fisheries sector in this part of the world.

1. Introduction

In view of increased market shares of fast foods, ready meals and frozen products in recent years, temperature controlled supply chain or cold chains plays an important role in ensuring quality and safety of the products being marketed all over the world. With the growing demands to keep and distribute temperature sensitive products in potent condition, organizations are seeking better solutions to maintain and monitor cold chains. This paper emphasizes the importance of cold chains based on the practical experience of Saudi Fisheries Company in the field of capture fisheries and aquaculture for the past 30 years. The success of implementing cold chain management involves continued monitoring of product's temperature throughout the distribution process and having appropriate corrective action plans in place. A streamlined and well-maintained cold chain helps to:

- Reduce product loss or wastage
- Improves wholesomeness of the product.
- Enhance customer's satisfaction
- Reduce costs.
- Maintain product Quality.

In the Gulf countries, much of the fish landed by the traditional and small-scale fisheries are consumed locally. Lack of infrastructural facilities to maintain cold chains from the point of catch to the point of consumption very often results in loss of products and revenue to the country in general and fishermen communities in particular.

On the contrary, semi-industrial and industrial fishing sectors in the Gulf region are fairly well organized with modernized fishing vessels and structured cold chain facilities to meet the international quality standards.

Aquaculture in this part of the world is developing rapidly. Most of the countries (except fresh water aquaculture in Iran) have large-scale fully integrated farms. The processing industry in general is well organized and cold chain management system also well established in most of these countries.

This paper gives an overview of existing cold chain management system in both capture and aquaculture sectors in the Gulf region. This paper also discusses the main constraints for proper implementation of cold chain management system in the fisheries sectors for improving product's quality, ensuring safety and minimizing postharvest losses.

2. Definition of seafood cold chains

Seafood cold chain is a temperature controlled supply chain. It helps in maintaining quality and ensures safety from the point of catch/ harvest till it reaches the final consumer. It is also described as the series of interdependent operations in the production, distribution and retailing of chilled and frozen Seafoods. Control of the cold chain is vital to preserve the safety and quality of refrigerated seafoods and comply with industry “codes of practices”.

A well organized seafood cold chain reduces spoilage, retains the quality of the catch and harvested products and guarantees a cost efficient, safe delivery and quality to the consumer. This requires knowledge of post harvest handling, processing, storage, shipping environment, package design, duration of the shipment (s) and critical control points throughout the process. The main feature of the seafood cold chain is that if any of the links is missing or weak, the whole system fails.

3. Importance of cold chain in seafoods handling processing, distribution and marketing

Seafood considered as one of the healthy diet of high nutritional value. However, considering its perishable nature, preserving the wholesomeness is difficult without having cold chain management in place. They are highly susceptible for quality deterioration by bacterial, enzymatic and oxidative reaction when exposed to increased temperature. Therefore, cold chain management has become crucial, challenging and important to keep the product not only safe for human consumption but also to avoid economic loss.

A cold chain is one of the most critical requirements to ensure the quality & safety of fresh, chilled, processed and frozen products in the supply chain. At chilled temperatures, the growth of microorganisms occurs slowly, food spoilage and deterioration reactions are inhibited to such as extent that food safety and quality is preserved for extended periods when compared with fresh fish. Implementation of HACCP principle in addition to cold chain management system is critical in extending shelf life of seafoods (Table 1).

Table 1. Predicted shelflife of fish products stored at different temperatures.

Shelf life in days of product stored in ice (0°C)	Shelf life at chill temperatures (days)		
	5°C	10°C	15°C
6	2.7	1.5	1
10	4.4	2.5	1.6
14	6.2	3.5	2.2
18	8	4.5	2.9

In this region there are some weak links in present cold chain especially in the traditional fisheries sector. Whereas it is adequately addressed, implemented and monitored in the industrial and aquaculture sectors.

The fishing industry relies on commercial viability and its operation on cold chain management from the point of catch to the consumer. The quality, safety, shelf life, organoleptic and sensory parameters depends on the reliable refrigeration to retard spoilage. The cold chain may take various forms including ice, refrigerated seawater, freezers and cold stores, but a common feature in all these applications has been the traditional use of CFC- based refrigeration technology.

Cold chain management alone will not ensure food quality and safety unless otherwise properly handled under hygienic & sanitary conditions, controlled work environment (includes GMP & SSOP's), processing, freezing and storage conditions. Chilling and freezing activities do not improve the fish quality but definitely extend the shelf life by retarding bacterial, enzymatic and chemical actions.

The chilled and frozen products to be transported in clean and refrigerated truck maintained at 0-5°C and -18°C respectively. If the products are not transported at an appropriated temperature, overall quality and shelf life will be affected negatively. Therefore monitoring of reefer truck temperature by using continuous temperature logger or any such measuring units is crucial to avoid possible temperature abuse till it reaches the final destination. In addition to this, proper temperature also needs to be maintained while storing in the intermediate cold store before distributing to wholesale or retail outlets.

Cold chain control in seafood retailing

As appropriate, both safety and quality aspects should be considered for each operation of the cold chain. With respect to food safety, a HACCP plan should be developed, as appropriate, for each operation in the cold chain especially retailing.

Display cabinets should:

- Be equipped with an appropriate temperature measuring device;
- Be located so that the open display area is not subject to draft or abnormal radiant heat (e.g. direct sunlight, strong artificial light or in direct line with heat sources); and
- The retail establishment should have appropriate back-up storage in case of emergency.

2 Temperature management in the seafood cold chain

Inadequate food temperature control is one of the most common causes of food borne illness. Inadequate food temperature control may also result in an adverse effect on product quality, including food spoilage.

Temperature management systems should be in place to ensure that the temperature along the cold chain is controlled and monitored effectively.

1 Temperature monitoring and equipment

The cold chain technologies utilize various temperature monitoring systems and equipment during handling, processing, transportation and distribution. The major components are,

- **Air Temperature Monitoring:** In air temperature monitoring, fixed temperature sensors are used to monitor the air temperature in the refrigerated system. The sensors are normally protected from damage during commercial activity.
- **Product Temperature Monitoring:** Product temperature may be measured directly or indirectly. Direct measurements of product temperature may be undertaken destructively or non-destructively.
- **Temperature monitoring equipment**
- **The selection of temperature monitoring equipment should take into account:**
- Appropriate accuracy and resolution (depends on the construction of the equipment and its use);
- Ability to withstand vibrations, shocks or movement (for mobile system);
- Coverage of adequate temperature range and be calibrated to ensure proper functioning.

4. An outline on capture fisheries and aquaculture in the gulf region

The Gulf region covers mainly 9 countries. These are Bahrain, Iraq, Iran, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates and Yemen. These countries comprise a total area of more than 5, 020, 975 km² and continental shelf area of 451,540 km². These countries have access to three major marine bodies in the Near East region: Arabian Sea, Red Sea and several Gulfs. In addition, Iran and Iraq have several inland fish resources from rivers and other small to medium size fresh water bodies. However, most fisheries in the region operate mainly in marine and to much lesser extent in fresh water fisheries.

Iran leads in both capture fisheries and aquaculture in the region followed by Oman in capture fisheries and Saudi Arabia in Aquaculture

According to FAO fisheries statistics reported for the year 2009, total production for the nine countries was 1,128,488 m.t. in the Gulf region. This total constitutes 901,049 m.t. from capture fisheries and 227,439 m.t. from aquaculture (Table 2).

Table 2. Quantitative Analysis of Capture Fisheries and Aquaculture Production in the Gulf Countries – 2009 (m.t.)

Country	Capture Fisheries	Aquaculture	Total
Bahrain	12,809	2	12,811
Iran	418,403	179,573	597,976
Iraq	34,505	18,732	53,237
Kuwait	4,373	360	4,733
Oman	151,993	118	152,111
Qatar	14,020	36	14,056
Saudi Arabia	66,536	26,118	92,654
United Arab Emirates	77,309	2000 E	79,309
Yemen	121,101	500 E	121,601
Total	**901,049**	**227,439**	**1,128,488**

5. Importance of fish industry in the gulf countries

1 Saudi Arabia

Saudi Arabia occupies 80% of the Arabian Peninsula land surface with coastal belt exceeding 2,400 k.m. The fishery industry is divided into three sectors: The traditional, semi industrial/industrial and aquaculture. The total production from the capture fisheries was 66,536 m.t. and Aquaculture 26,118 m.t as per FAO statistics for 2009.

Aquaculture is growing rapidly and most of the aquaculture activities are conducted in large integrated shrimp and fish farms.

Majority of the locally caught seafoods are consumed locally (per capita consumption: 8 kgs/annum as per 2003 statistics). Farmed shrimps are generally exported to various countries worldwide.

1 Oman

Fisheries sector along with Agriculture is the highest non-oil revenue. The fishery sector is growing 3% and the export volume increase by 5% annually.

The fishery sector is dominated by traditional fishing which constitutes 85% of the total landings (151,993 m.t.) and remaining 15% by semi industrial or industrial sector as per FAO statistics 2009.

Aquaculture is developing and 3 major projects under taken recently are – Abalone culture, Finfish hatchery development and Sea cucumber culture. Apart from them, Shrimp culture, cage culture, integrated farming system for Tilapia and Tuna fattening are also being practiced on a commercial scale. However, when compared to capture fisheries, the contribution of aquaculture is insignificant.

3 Bahrain

Aquaculture is in preliminary stage although there is scope for culturing finfishes, Groupers, Sobaity and Rabbit fish, etc. Shrimp farming is not feasible due to limited resources. Inland fisheries can't be developed on a commercial scale due to scarcity of fresh water.

On the contrary, capture fisheries by traditional fishing contributes major fishery landings (12,809 m.t.) as per FAO statistics for 2009. The per capital fish consumption is 9.1 kgs/annum as per FAO data of 2007.

4 Qatar

Aquaculture is in its early stage and 98% of the landings come from the traditional fishing. In addition to the local fish landings, fisheries products imported from other countries to meet the market requirements.

The contribution of fishery industry to the national economy is insignificant (< 0.1% GDP). There is limited scope for aquaculture development due to non-availability of suitable coastal or land based sites.

5 United Arab Emirates

It is one of the pioneers in aquaculture among the GCC countries. Major species cultured are Groupers, Sea breams and Mullets, etc. Finfish cage culture is widely practiced.

Fresh water aquaculture is limited but likely to be expanded in near future.

Capture fisheries is the major source of seafood supply (77,309 m.t. in the year 2009). On an average 20,649 people are engaged in fishing related activities.

6 Kuwait

Aquaculture projects are relatively new and could be a potential source of fish production in the country. Major species being cultured are – Tilapia, Sea bream and Sea bass etc. There is wide scope for aquaculture development in due course.

Capture fisheries are mainly managed by traditional and/or semi industrial fishing constitutes major chunks of the landings (4,373 m.t. as per FAO - 2009) although it is insignificant to the country's economy.

The capture fishery is under pressure due to over fishing and declining trend in the landings in recent years.

7 Yemen

Fishery sector represents most important non-oil production. The capture fisheries are dominated mainly by the traditional fishing (121,101 m.t as per FAO-2009). Almost 70% of the landings consumed locally and the remaining 30% exported (Mainly Cuttle fish).

Given below are the details of infrastructural facilities as per FAO statistics 2004.

Total number of processing plants - 36

Total number of people employed - 1471

Ice production capacity - 251 m.t /day

Cold store capacity - 18,140 m.t.

Aquaculture is not growing rapidly mainly due to lack of experience, finance and investment.

8 Iran

Iran is leading aquaculture producers in the Gulf region. Different types of aquaculture could be practiced due to varying weather condition across the country. Fish farming mainly dominated by Carps, Trout's and shrimps. Total aquaculture production during the year 2009 was 207,353 m.t., and the industry is employing 37,649 people. The major species includes Carps (48%), Trout's (36%) and shrimps (2.5%). Among the harvest 85% consumed locally and remaining 15% (Mainly shrimps & Caviar) are exported.

Iran also is a leading producer in capture fisheries. The total quantity produced in the years 2009 was 418, 403 m.t. and the capture fisheries industry is employing 181,381 peoples. The per capital consumption of seafood in Iran is 7.6 kgs/annum as per FAO statistics of 2009.

9 Iraq

Aquaculture is not developed much mainly due to limited coastline and other constraints. Therefore, mainly depends on inland fishery production and marine fisheries. Fresh water aquaculture production mainly carps – 16,000 (FAO- 2007) and the total aquaculture production in the year 2009 was 18,732 m.t.

Capture fisheries landings in the year 2009 was 34,505 m.t. Number of people employed in this sector was 6,023 (FAO 2007) which would have increased in the past few years.

Due to limited landings, all production is consumed locally and other quantities are imported from other countries to meet the market requirements. Some of the developmental projects undertaken in the year 2004 were,

- Upgrading of fish hatchery
- Setting up of a specialized Laboratory
- Re-habilitating of some fish farming sites
- Start of experiments on closed circulating system & pilot cages.

6. Outline on the existing status of the seafood cold chain in the gulf region

All the Gulf countries are geographically considered as tropical regions with higher temperature especially during summer season (except some parts in Iran). The fishing season in most of these countries coincides with the summer season. Therefore, there is extra need for proper cold chain management system in this part of the world.

The Fishery industry in the region could be categorized in to mainly three sectors: The traditional or small-scale capture fisheries, Medium or large-scale capture fisheries and Aquaculture. Accordingly, three different kind of cold chain management practices are adopted by these three sectors in all the 9 countries. Traditional or small-scale fisheries sector adopt generally poor or inadequate temperature control methods which might maintain the product's quality good enough to reach the consumer from

the point of landing. On the contrary, the medium or large scale capture fisheries and aquaculture sectors uses latest cold chain management technologies throughout the supply chain till it reaches the consumer.

Exporting or importing of fresh and frozen seafoods within or from abroad is one of the major trading activities in most of these countries. The cold chain management system of frozen products is well organized and monitored. However, it is quite weak in the supply chain of imported fresh fish.

The flow charts in the subsequent sections would explain the current status of cold chain management systems for all these sectors in general and not specific to any Gulf country.

1 The traditional or small scale fishing sector

The traditional or small-scale fisheries sector produces almost 75-85% of total catch in the region. The infrastructural facilities in this sector vary from country to country and within the countries at different places. Governmental organizations and / or fishermen associations in some of these countries provide infrastructural and logistic support to this sector. However, the cold chain management system in traditional and small-scale fisheries generally weak in the Gulf region. Some of the small scale fishing boats do carry insulated boxes and ice for preserving the fishes. Whereas only insulated boxes are used for storing when the fishing trip is limited to few hours. Given below is the flow chart of cold chain system generally followed by the traditional and small scale fishermen not specific to any country but to the whole region in general. (See Figure 1.)

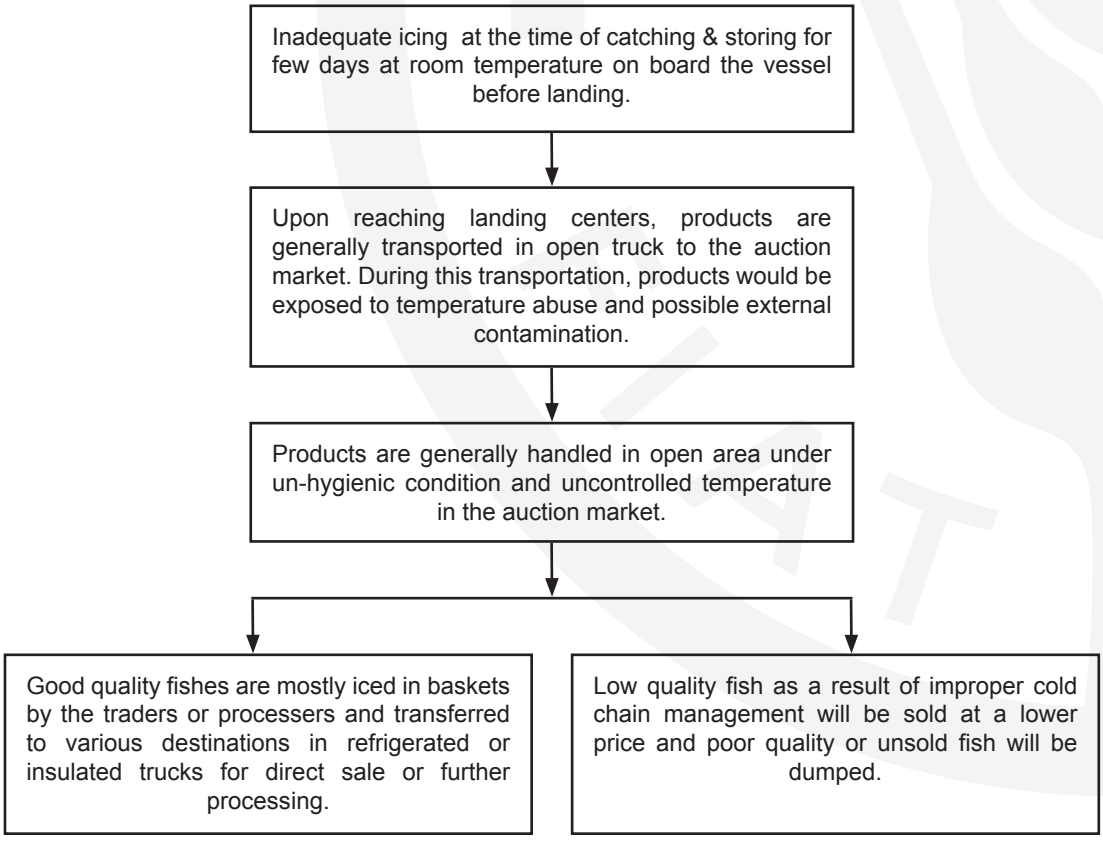

Figure 1. Cold Chain Followed by the Traditional Fishing Sector

2 Medium and / or large scale fishing sector

The medium and large-scale fisheries sector has developed over the years and implemented standard cold chain management system from the point of catch to the consumer. Several seafood processing companies with their own modernized fishing fleets were established over the years in this region to meet the local and international market requirements. These medium to large fishing vessels usually have on board ice plants, freezers and refrigerated fish holds. On shore they operate efficient cold chain systems to handle fish from landing centers till they reach the processing plants or the end user. Given below is the process flow diagram of cold chain management at the semi industrial/ industrial level (See Figure 2).

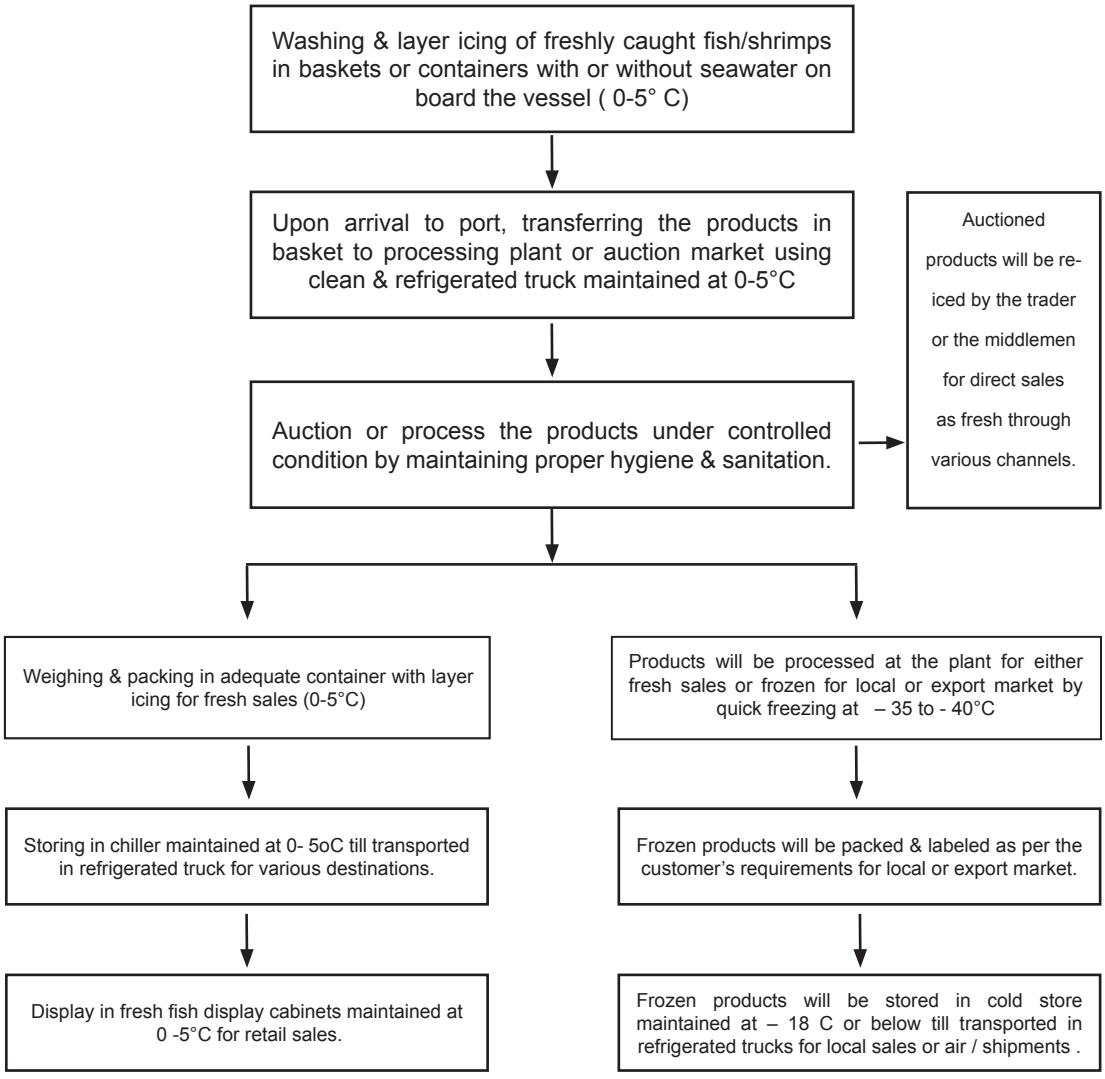

Figure 2. Cold Chain Followed by the Medium or Large Scale Fishing Sector

3 Aquaculture

When compared to capture fisheries, aquaculture is a well-organized sector in this region. Many countries diversified its fisheries to fresh and marine fish /shrimp aquaculture in the recent years to meet the growing demands of both local and international markets. Most of the governments and other organizations are promoting aquaculture in view of the declining marine catches due to depleted or over exploited stocks in some of these countries (See Figure 3).

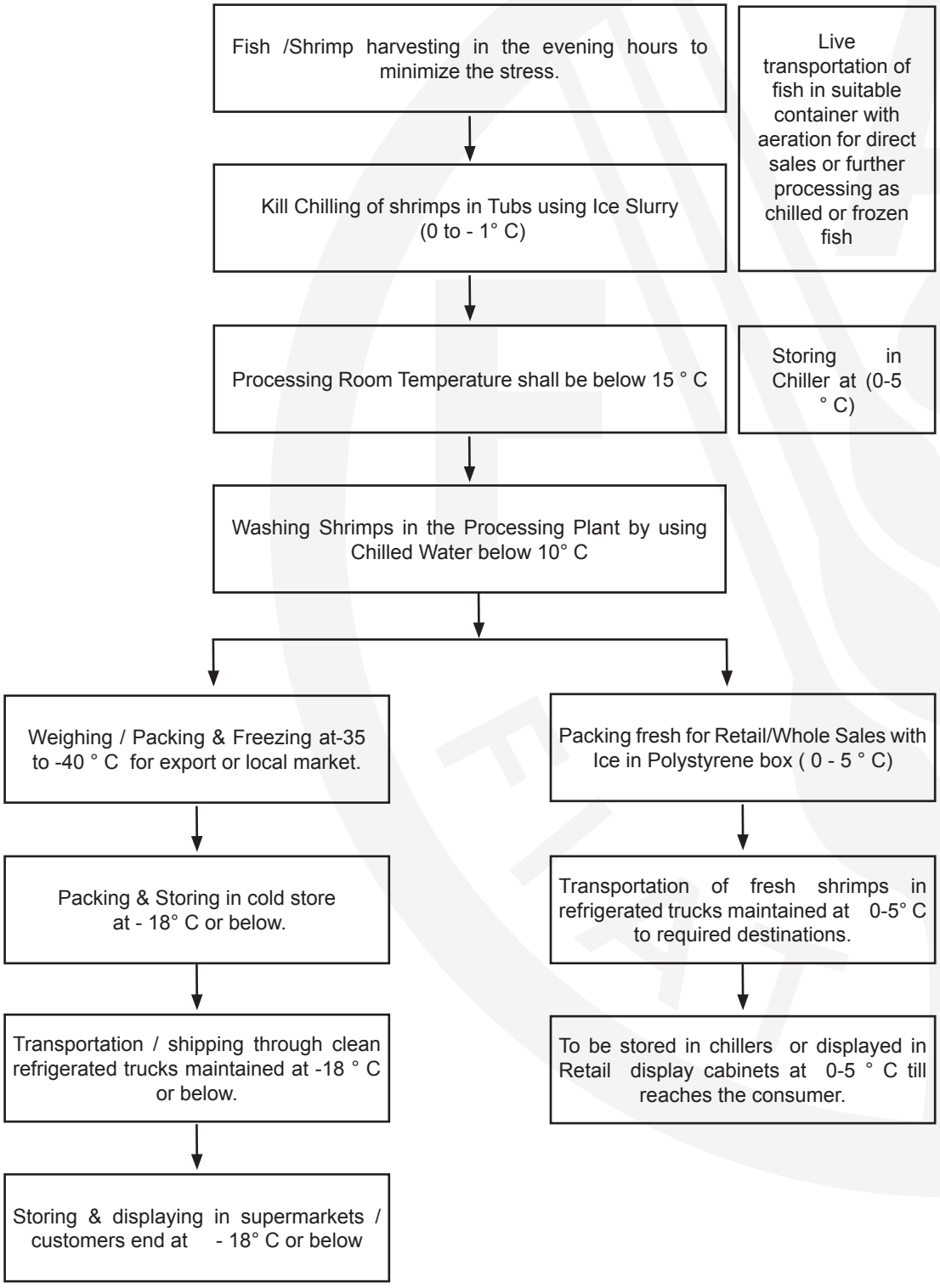

Figure 3. Flow Diagram of Cold Chain System Followed in the Aquaculture Sector

4 Imported Fresh and Frozen Seafood Products:

In addition to local production from capture marine and aquculture, almost all countries in the region import various fresh and frozen quantities of seafood products from various countries in the region or from outside the region. The imported seafod products also have to go through a cold chain system to ensure quality and safety of the products. (See Figure 4).

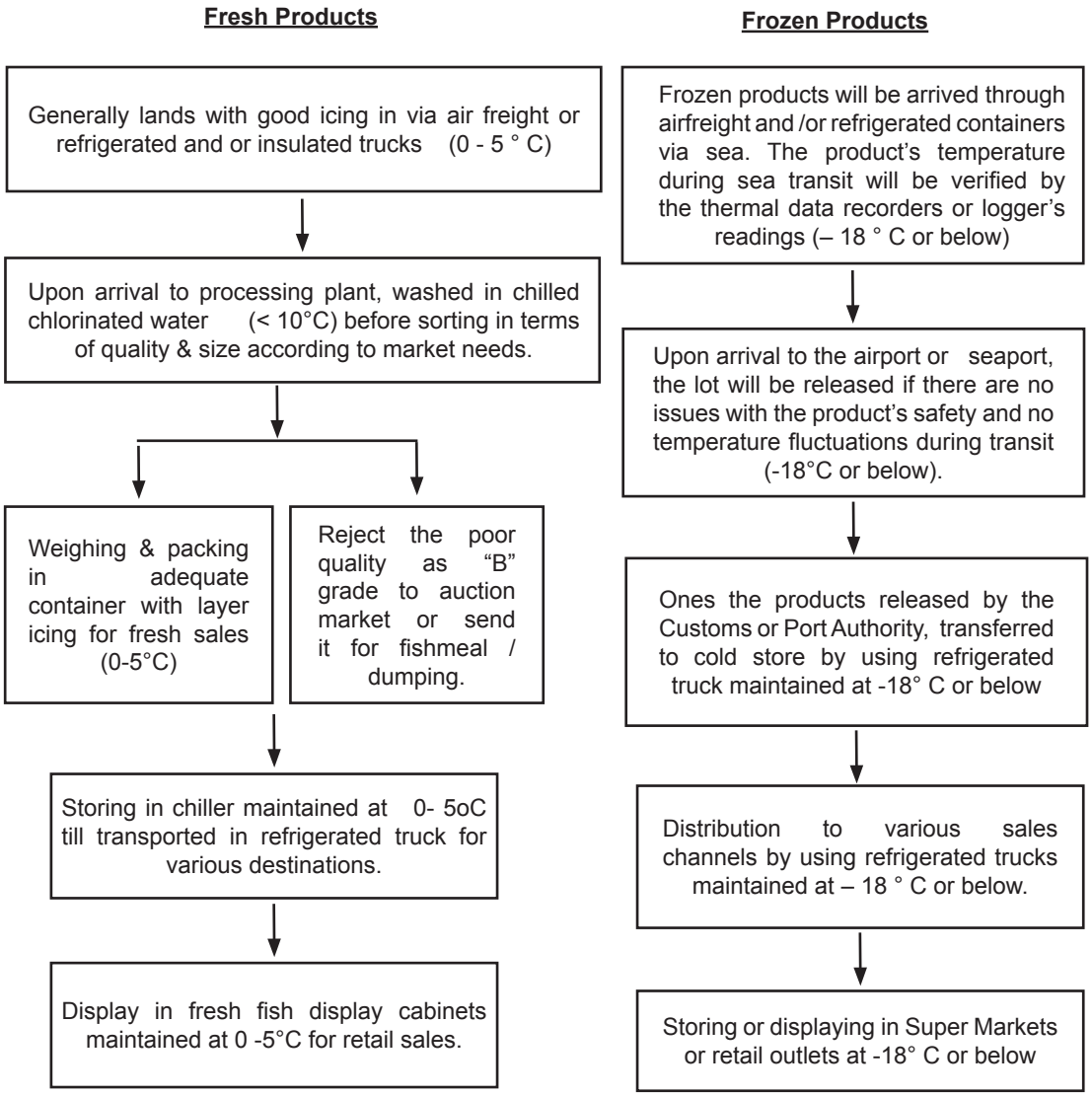

Figure 4. Cold Chain Followed for Imported Fresh and Frozen Seafoods in the Gulf Countries

7. Shortcomings in developing seafood cold chain management system in the gulf region

Since 75-85% of the total fish landings in this region contributed by the traditional fisheries, implementation of cold chain management system is vital for ensuring overall development of fisheries sector. The main constraints in this area are as follows;

- Private or public entities are not keen in investing on cold chain facilities in most of these countries considering the declining trend in capture fisheries.
- Logistic problems in arranging ice at sea or landing centers.
- Inadequate legislations to enforce the implementation of cold chain management system by the government authorities.
- Lack of technical know- how and management of cold chain components by the traditional fishermen communities.
- Limitation in upgrading the small sized vessels, higher ice cost and local tradition in preferring the fresh fish to chilled fish discouraging the traditional fishermen to implement cold chain management system.
- Non-existence of organized training of fishermen on proper utilization of cold chain mechanism.

8. Strengths, weaknesses and opportunities for improvements in seafoods cold chain management in the region

Strengths

- Cold chain in aquaculture is well established and implemented by all the leading producers in the region.
- Governments in most of these countries are capable of providing all the required infrastructural facilities for maintaining and managing cold chain in seafood post harvest handling, processing, storage, distribution and marketing, etc.

Weaknesses

- The capture fisheries sector is not well organized and probably not encouraging private investments due to declining trend in sea catch in the recent years.
- Shortcomings in organizing logistic services for maintaining cold chain right from the point of catch till it reaches the final consumer in remote areas.
- Lack of education or training to the fishermen, middlemen and or traders on the benefits and drawbacks of not maintaining proper cold chain management system.
- Poor handling in fish catching sector leads to reduced quality & safety
- Lack of suitable landing, handling and marketing facilities for artisanal fishermen
- Wholesale market facilities does not comply with international sanitary regulations
- Lack of existing training facilities on cold chain components including fish handling.

Opportunities for improvements

- The cold chain management could be improved if the concerned government authorities enforce proper implementation of national and / or international standards at all levels.
- The new technologies such as continuous temperature monitoring loggers or GPS system for trucks tracking, etc. could be utilized for cold chain management.
- Awareness on importance of cold chain management from **"farm to fork"** needs to be imparted to the fishermen, processors, traders, wholesalers and others involved in seafood business.

Conclusions

1. Cold chain management system is very well established and implemented in Aquaculture sector of this region.
2. Among capture fisheries, it's fairly well established in both the semi-industrial and industrial sectors.
3. Whereas small scale industries in most of these countries still has weak links of cold chain management systems. The logistic problem in remote areas, small size of vessels and cost of ice results in breaking of cold chain.
4. Lack of infrastructural facilities in the rural areas for effective implementation of cold chain management system. Non availability of ice plants and refrigerated vehicles at the landing center in rural area are the major problems.
5. Within the same country, we would observe the existence of excellent facilities while other part of the same country suffers from lack / non-existence of any kind of modern infrastructure. The fishermen society or local organizations shall take up the issue at a government level for providing uniform facilities.
6. Good government's support, but not organized and not subjected to clear strategies.
7. The government is supportive in most of these countries but lacks of technical expertise or commitment in execution of the strategies are the matter of concern.
8. Unrelated / lack of co-ordination between monitoring and control agencies along the cold chain components. Qualified and trained personnel shall be assigned to monitor the cold chain components in the supply chain.
9. High storage capacity, but located in main industrial / commercial centers. Needs to provide infrastructural facilities near the landing centers for maintaining better seafood cold chain instead of concentrating in the urban areas.
10. Imported products enjoy better cold chain management system. Imported products are brought in refrigerated container with continuous temperature monitoring loggers and then transported to the cold stores by using refrigerated trucks.
11. Therefore it is more organized. High losses / wastage especially at the first components of the cold chain in the traditional fishing sector - no data available.

12. Co-operatives are heavily dependent on government support and subsidy.
13. Unlike other agriculture sectors, cold chain technology for the fishery sector is well established, but infrastructure is weak. Basic infrastructural facilities shall be provided by either the government or private companies to accomplish this task.
14. Sufficient regulations, but lack of enforcement of existing regulation. Lack of qualified personnel is one of the reasons. Needs to be given practical training on cold chain components for effective monitoring and implementation at various levels.
15. Consumers still prefer to buy fisheries products from traditional fish markets. Needs to be educated on the possible effects of fishes handling in unhygienic conditions and also effect of temperature on its quality, safety and nutritional value.
16. Strong inter trade of fisheries products within the region. Both the fresh and frozen products are being traded within the Gulf countries depending on the season and market demands.
17. Export oriented industry is more organized and have excellent cold chain system. Products meant for export has to undergo strict quality control process in the importing country as well as host country. Therefore, the processer maintains a good cold chain management system right from the landing center till it is processed and shipped.
18. Lack of data on every aspect of the cold chain in most of the countries within the region. The data's on infrastructural facilities like the number of ice plants, processing plants, cold stores & their capacities etc. are not available in most of these countries. Such information's helps to plan the strategies for development of fishery infrastructures

Recommendations

- Status of seafood cold chain in all these Gulf countries needs to be evaluated periodically.
- Infrastructure requirements to implement cold chain management system throughout the supply chain needs to be studied in all these countries.
- Since the traditional fisheries sector lands majority of seafood, implementation of cold chain management system shall be considered as priority in all the Gulf countries.
- Education and / or training in the field of cold chain management shall be the minimum requirement for those responsible for implementing at various levels.
- Government/private partnership in improving the infrastructural facilities for cold chain management in the rural areas.
- Subsidize the equipments, spare parts, refrigerants, electricity and fuel etc. apart from providing incentive for those investing on the seafood cold chain infrastructural facilities especially in the rural areas.

References

Emirates News Agency; UAE Obtain Accreditation for Export to EU Countries, November 2010.

FAO, Quality and Changes in Fresh Fish, Fisheries and Aquaculture Department; www.fao.org.

FAO; Country profile fact sheets.

FIS; Improve Seafood Quality with Good Cold Chain Management, Fish Information Services, February 2011. www.fis.com.

USAID; Cold Chain Assessment for Iraq, Final Report, March 2009.

Wikipedia; Cold Chain, www.wikipedia.org.

Seafoods – The Codex Alimentarius.

SASO- Standards – Saudi Arabian standards on Seafoods

ANNEX III.

PROGRAM

Tuesday, 5 July, 2011

8:30 – 9:00 am: Registration
9:00 – 9:30 am: Opening Remarks and Introduction of Participants---Dr. Elhadi Yahia
9:30 – 10:00 am: Importance of the Cold Chain in Food Distribution---Dr. Adel Kader
10:00 – 10:30 am: Tea/Coffee Break
10:30 am – noon: Session I: Horticultural Perishables
Dr. Ahmed Ait-Oubahou (Session Moderator)
Dr. Abdullah Alhamdan
Dr. Atef Elansary

Noon – 2:00 pm Lunch Break

2:00 – 3:30 pm Session I: Horticultural Perishables (continued)
3:30 – 4:00 pm Tea/Coffee Break
4:00 – 5:30 pm Session II: Meat Products
Dr. Salah Elsafty

Wednesday, 6 July, 2011

8:30 – 10:00 am Session III: Dairy Products
Dr. Magdy Mohamed Ismail (Session Moderator)
Dr. Bezeid Ould Elmamy
Mr. Omrane Ben Jamaa
Mr. Hany Ramadan
10:00 – 10:30 am Tea/Coffee Break
10:30 – noon Session III: Dairy Products (continued)

Noon – 2:00 pm Lunch Break

2:00 – 3:30 pm Session IV: Fish Products
Mr. Izzat Feidi
Mr. Haydar Alsahtout
Dr. Amar Kaanane
3:30 – 4:00 pm Tea/Coffee Break
4:00 – 5:30 pm Session IV: Fish Products (continued)

Thursday, 7 July, 2011

8:30 – 10:00 am Session V: Extension and Technology Transfer

Dr. Awad Hussein (Session Moderator)

Eng. Sultan Althagafi

Dr. Hala Chahine

10:00 am – 10:30 am Tea/Coffee Break

10:30 am – noon Session V: Extension and Technology Transfer (continued)

Noon – 2:00 pm Lunch Break

2:00 – 3:30 pm Session VI: Conclusions and Recommendations for Actions to Improve and Expand the Cold Chain for Food Distribution in the

MENA Region

Dr. Adel Kader and Dr. Elhadi Yahia (Session Moderators)

ANNEX IV.

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