

Cold Chain Development and Challenges in the Developing World

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Abstract

The cold chain (pre-cooling, cold storage, refrigerated transport, and refrigerated display during marketing) is a requirement for a successful postharvest industry in any country. Major developments have been observed in the last decade in the cold chain industry in the world, including in some developing regions. World total cold chain capacity in the last decade has increased. In the developing world (DW) it more than doubled in India and increased 66% in Brazil, and 20% in China, but still very little or none in many regions of the DW. The increasing capacity is driven by greater reliance on the cold chain to meet growing trade and consumption of better quality perishable foods, needs to meet international standards of quality and food safety, the retail boom and a growing middle class in these countries. In general, the cold chain in the DW is still not developed adequately, and still needs major improvements, with challenges facing the industries. Building and/or owning cold chain facilities is very expensive for most businesses in the DW, and there is inadequate support from companies that specialize in renting cold chain spaces and instruments. Therefore, companies that need cold storages become involved in construction and/or buying, with very little opportunities for renting the service. Erratic (or even lack) of power supply in many regions of the DW, especially in regions with warm climate or during the warm season is a serious problem. In some regions of the DW the cold chain industry is characterized by poor return on investment compared with other businesses. In addition to the lack of adequate cold chain application and cold chain infrastructure in many regions of the DW, the overall knowledge of proper cold chain practices is very weak in most regions of the DW, and the number of adequate and properly trained technicians is very limited, especially among small companies.

INTRODUCTION

The cold chain (pre-cooling, refrigerated storage, refrigerated display) is a small, but an important part of the whole postharvest handling chain. All the components of the postharvest chain are very important. However, the cold chain is the backbone of any postharvest industry (developed or developing). No technology or technique can substitute the cold chain, but all complement it.

The establishment of an adequate cold chain requires adequate infrastructure (certain amount of investment depending on the operation), and an adequate adaptation, technology transfer, maintenance, and adequate applications.

The cold chain is weak almost everywhere, but weaker in the developing regions of the world. The situation of the cold chain in the developing world (DW) is very diverse and complex; it is underdeveloped in some regions and very developed in others. In some parts of the DW the cold chain does not even exist, and it is not adequately maintained in many regions.

It is very difficult to collect and find accurate data on the cold chain, especially in the DW. In 1998, the International Association of Refrigerated Warehouses (IARW) started collecting data from developed and developing countries. In 2008, data were collected from 45 countries (Table 1). Some of the data are real, others are estimates from experts, and some data include infrastructure used for frozen foods. In general, global

cold chain infrastructure has increased significantly (Fig. 1). This global increase is due to many reasons such as increased consumer demand for higher quality, safe produce, major increase in trade of perishable foods, major increase in concerns about health and health related problems that can be prevented or reduced by refrigeration, and increases in supermarkets. In the countries where IARW has collected information, cold chain capacity increased in 17 and remained the same in 6 countries. Data in other areas were insufficient to draw any conclusions. Countries that showed the greatest increases were France, Germany, Netherlands, Spain and Brazil. China showed a 20% increase, and India's capacity has more than doubled since 1998. Total global capacity in 2008 for those countries where data were collected for the last report was 180 million cubic meters, which represents a 15% increase from 2006. This growth suggests a worldwide trend towards increasing 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 248 million cubic meters.

Even in many regions or sites where adequate infrastructure is available, overall knowledge of proper cold chain practices, maintenance (including availability of spare parts), and applications are weak in most of the DW, and it is generally worst in facilities owned or operated by government than in facilities owned or operated privately.

SOME EXAMPLES FROM DIFFERENT REGIONS OF THE DW

Latin America

Over the last two decades cold chain capacity and applications have increased significantly in some countries in Latin America. This has been due to several reasons, such as booming production of horticultural commodities especially for export, increased demand for these in local markets, increased supermarkets which improved postharvest handling as compared with local open markets, and particularly due to a large number of important free trade agreements (such as NAFTA, the Caribbean initiative, Mercusur, etc.), which increased horticultural commodity trade and therefore expectations to meet international standards.

The most important countries in Latin America with respect to cold chain capacity include Brazil, Mexico, Argentina, Venezuela, Chile, Colombia, Costa Rica, Peru and Guatemala (Table 1). There is still room for major improvements both in capacity and application of the cold chain in all countries of Latin America, but especially in most countries of Central America (such as Salvador, Honduras, Nicaragua, Guatemala, Panama), and some South American countries such as Colombia, Peru, Paraguay, and Bolivia. The cold storage industry in Brazil started to develop in the 1950's when the Brazilian government began investing in infrastructure for large fresh food distribution centers. In 1970's the total cold chain capacity was about 100,000 cubic meters with about 70% of refrigerated warehouse space under the control of the Brazilian government, and currently there are an estimated 155 cold storage facilities and about 90% are managed by the private industry.

Mexican cold chain infrastructure and applications have improved very significantly in the last 2-3 decades, although there is still need for growth. The cold chain in Mexico started to expand in the 1950's, but the major growth started to increase in the 1990's, especially due to the NAFTA trade agreement and the booming supermarket industry. It will certainly increase further over the next few years.

The cold chain infrastructure and applications in Chile have seen very significant development in the last 4 decades, and although not very big (see Table 1), but is considered as one of the best in Latin America. The cold storage industry in Chile is made mostly of medium-sized companies primarily for export. Chile currently supplies more than 150 countries with fresh horticultural commodities (apples, grapes, stone fruits, kiwifruit, etc.), and this success was possible due to excellent developments in infrastructure and in applications of the cold chain (pre-cooling, refrigerated storage and

transport). One of the challenges that faces the cold chain infrastructure in Chile is that Return-on-Investment (ROI) for this industry is not as high as other investment projects.

Total cold storage capacity in Costa Rica is estimated as 573,000 cubic meters. However, increasing export and import of perishable foods and Costa Rica's tentative entry into the Central American Free Trade Agreement with the US, will for sure increase the cold chain capacity and improve applications over the next few years.

The cold chain industry in Guatemala, with a total capacity of about 473,000 cubic meters, is growing very slowly, although there is a very significant need.

Asia

The total capacity of refrigerated warehouses in China is estimated by the IARW study to 9 million tons (more than 30 million cubic meters), about 20% increase in capacity since 1998. As it is the case in almost all regions of the DW, the overall knowledge of proper cold chain practices is weak, especially amongst small companies and operators. China is still in great demand for a bigger and better cold chain capacity and application, since its perishable food production is very big (about 700 million tons), and consumption (about 240 million tons) and imports (about 30 million tons) are very significant and require a much bigger and better cold chain.

Cold chain capacity, especially for cold storage, is expanding very rapidly, although it is still very far from what is needed. Cold storage capacity is estimated as 76 million cubic meters, which is mostly for potatoes. Currently, India is the top producer of fruits and the second producer of vegetables in the world, and these very significant quantities require major cold chain infrastructure. In addition to the need for a much more developed infrastructure, there is obvious need for more capable technicians and better applications.

In Bangladesh there are about 7.8 million cubic meters (MCT) of cold capacity. There are about 350 cold storage facilities; most of them are for potato. Some of the challenges that face the cold storage industry in Bangladesh include erratic power supply, design problems of the cold storage room (most of them are two story buildings, making it very difficult to adequately handle the crop, and causing major losses), and a strong need for capacity building to develop better knowledgeable technicians.

Demand for more infrastructure and better applications of the cold chain in all Asian countries, especially those, such as Indonesia, where developments have been slow, is expected to increase in the next few years.

Africa

South Africa has the most developed infrastructure and development of cold chain in Africa, with excellent cold storage warehouses, excellent pre-cooling facility, and refrigerated port facilities. There has been reasonable growth in cold chain infrastructure in Morocco, Egypt and Kenya, and lately in Libya, but in all African countries there is still major room for growth and much great efforts to improve capacity training to form better technicians and to improve applications.

SOME POSTHARVEST TECHNIQUES THAT AFFECT THE COLD CHAIN APPLICATION

In addition to problems directly related to the cold chain infrastructure and applications, there are several other problems related to the cold chain, which result in worsening the problem. For example, the inadequate packing and packaging systems in the DW result in a rather inefficient cold chain even in regions of the DW where adequate cold chain infrastructure has been developed. Inadequate packages (such as inadequate materials used, inadequate sizes and designs) make it difficult for an adequate application of the cold chain even in regions of the DW where the cold chain infrastructure development is adequate. Other examples of inadequate postharvest handling practices that can negatively affect the application of adequate cold chain include transport and marketing. The lack of adequate market infrastructure in almost all regions of the DW

causes major difficulties in adapting adequate cold chain infrastructure in these markets, especially in wholesale markets, and especially in the adequate application of the cold chain. Great losses of perishable foods in the DW are caused by the inadequate transport system used. Transport of perishable foods in the DW is still mostly non-refrigerated and in bulk. Refrigerated transport units in most regions of the DW are not adequately maintained, incompatible loads are often transported together, and optimum conditions are usually not known by users and/or not adequately applied. In addition to all these problems, roads in most regions of the DW are commonly in poor condition, and adding this to poorly maintained transport vehicles, results in major losses including those caused by mechanical damage. There is still very little sea transport used to ship perishable commodities from many regions of the DW. Most airports and sea ports in the DW still lack any cold chain facilities for perishable foods.

SOME SUGGESTED SOLUTIONS

There have been some improvements, especially in the last 2 decades, in postharvest in general and in the cold chain in particular in the DW. However, these improvements are still inadequate, and major efforts are still needed to improve the postharvest chain in general and the cold chain in particular. Needed improvements include increased infrastructure, but also there is a significant need for improved knowledge about maintenance and adequate applications. Education, extension and training in most regions of the DW are still extremely weak, and major, adequately planned efforts, are in desperate needs. There have been major failures in adapting the use of cold chain facilities and infrastructure in many regions of the DW because of lack of adequate technology transfer programs. Adequate infrastructures are still lacking in almost every region of the DW, and not enough everywhere.

CONCLUSIONS

Some improvements in cold chain infrastructure and applications have occurred in some regions of the DW, but they are still inadequate and far from what is needed. Major improvements are needed to establish better technology transfer techniques, which require major efforts in adequately planned education, training and extension.

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Tables

Table 1. Cold chain capacity in some countries from developed and developing world (from the International Association of Refrigerated Warehouses, IARW).

Country	2004		2006		2008	
	Million cubic meters	Million cubic feet	Million cubic meters	Million cubic feet	Million cubic meters	Million cubic feet
Argentina	*	*	*	*	0.50	17.66
Australia	5.30	187.05	6.00	211.89	6.00	211.89
Austria	0.65	22.95	0.80	28.25	0.80	28.25
Bangladesh	*	*	*	*	7.76	274.04
Belgium	1.60	56.50	1.60	56.50	2.00	70.63
Brazil	2.20	77.69	2.70	95.35	4.50	158.92
Canada	6.34	223.89	6.79	239.79	6.89	243.32
Chile	*	*	*	*	0.17	6.00
China	*	*	*	*	15.00	529.72
Colombia	*	*	*	*	0.12	4.24
Costa Rica	*	*	*	*	0.09	3.18
Denmark	1.80	63.57	1.80	63.57	1.90	67.10
Eastern Europe	1.00	35.31	1.00	35.31	1.00	35.31
Finland	0.40	14.13	1.80	63.57	1.80	63.57
France	5.40	190.70	5.40	190.70	8.50	300.17
Germany	6.50	229.55	8.70	307.24	13.40	473.22
Great Britain	4.40	155.38	4.40	155.38	5.60	197.76
Greece	0.90	31.78	0.90	31.78	0.90	31.78
Guatemala	*	*	*	*	0.07	2.50
India	*	*	*	*	18.58	656.15
Ireland	1.30	45.91	1.30	45.91	1.70	60.03
Italy	3.00	105.94	3.00	105.94	3.50	123.60
Japan	27.46	969.74	27.69	977.86	27.69	977.86
Malaysia	*	*	*	*	0.01	0.46
Mauritius	*	*	*	*	0.03	1.06
Mexico	*	*	*	*	1.35	47.67
Middle East	*	*	*	*	0.40	14.10
Namibia	*	*	*	*	0.04	1.41
Netherlands	1.20	42.38	9.00	317.83	12.60	444.96
Norway	1.50	52.97	1.50	52.97	1.50	52.97
Peru	*	*	*	*	0.08	2.83
Poland	0.30	10.59	0.30	10.59	0.30	10.59
Portugal	0.60	21.19	0.60	21.19	0.80	28.25
Russia	*	*	*	*	16.00	565.03
Spain	2.50	88.29	2.90	102.41	8.20	289.58
Sweden	0.90	31.78	0.90	31.78	0.90	31.78
Switzerland	0.50	17.66	0.50	17.66	1.00	35.31
Trinidad & Tobago	*	*	*	*	0.06	2.00
Turkey	0.30	10.59	0.30	10.59	0.30	10.59
USA	66.75	2,357.10	68.97	2,435.80	70.74	2,498.20
Venezuela					0.35	12.36

Figures

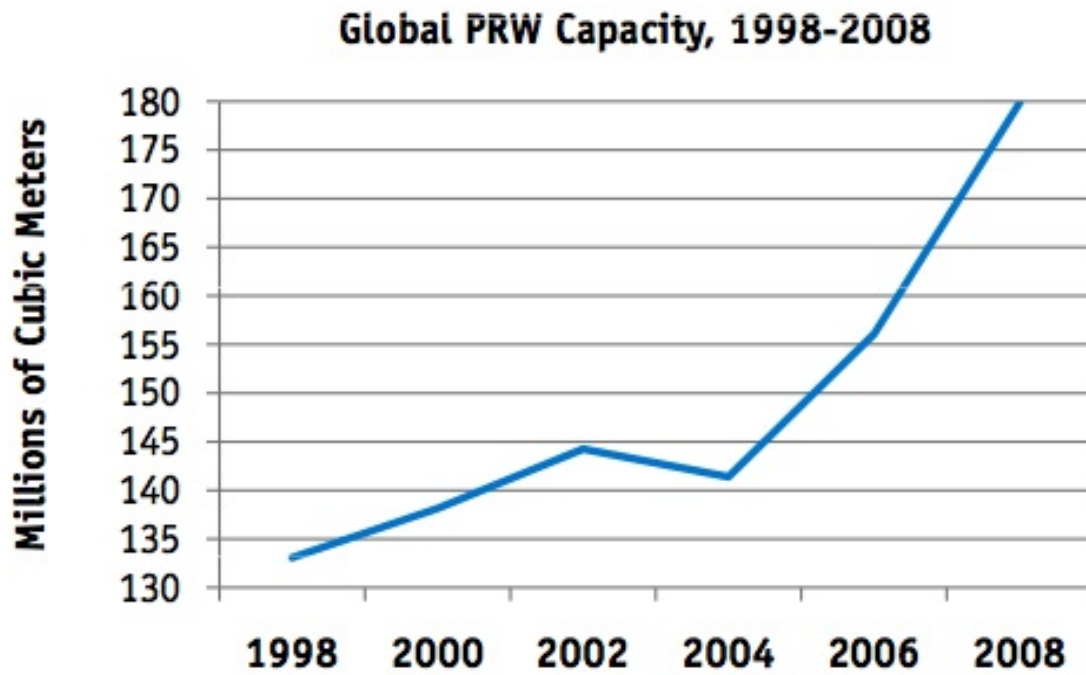


Fig. 1. Global cold chain capacity development in the last decade (from the International Association of Refrigerated Warehouses, IARW).