Entrepreneur Development & Skill Training for Ripening Chamber

Organized by:

ICE
CENTRE OF EXCELLENCE

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National Centre for Cold-chain Development

(Department of Agriculture, Cooperation and Farmers Welfare, Govt. of India)

The Task Force on cold chain development in India had suggested in its report to establish a National Centre for Cold Chain Development (NCCD) in India as an autonomous centre for excellence to be established as a registered society to work in close collaboration with industry and other stake holders to promote and develop integrated cold chain in India for perishable F&V and other perishable allied agri – commodities to reduce wastages and improve the gains to farmers and consumers substantially.

As recommended by the Task Force on Cold Chain a National Centre for Cold Chain Development (NCCD) has been established to promote and develop integrated cold chain in India for perishable agriculture and horticulture produce including perishable from allied sectors. The main objectives of the centre are to recommend standards and protocols for cold chain infrastructure, suggest guidelines for human resource development and to recommend appropriate policy frame-work for development of cold chain.

NCCD was registered as a society under Registration of Societies Act 1860 on 27.01.2011. Cabinet Committee gave post facto approval on 09.02.2012.

NCCD is representative in nature and as such, it has representation of stake-holders such as- Government Departments from various Ministries responsible for implementation of the schemes relating to cold chain development in the Country, Industries, Associations of CII and FICCI, Service Providers, Expert Organizations, Growers Associations etc.

In conformity with the vision of the Task Force on Cold Chain Development in India, set up by Ministry of Agriculture, the NCCD is mandated to recommend technical standards for cold chain infrastructures for perishable food items including fresh fruits & vegetables and undertake their periodic revision keeping pace with technological advancements. It is also going to undertake consultancy work, certification of cold storages and their ratings, Applied R & D and Human Resource Development Programmes for meeting requirement of skilled man-power of the cold chain sector in the Country. It is also going to advise Government in the matters relating to development of integrated cold chain infrastructure in the Country. This will definitely help in reducing post harvest losses of perishable farm produce and ensuring their steady availability thereby, securing remunerative price of farm produce to producer-farmers and availability of fresh fruits & vegetables to consumers at affordable prices.

About the Training Program

The National Centre for Cold Chain development (NCCD) has introduced a one day online training program on "**Entrepreneurial Development and Skill Training for Ripening Chamber.**

Through this training project NCCD aims to fulfill the following objectives:

- Educate the potential entrepreneurs about
  - The financial viability of setting up a Fruit ripening chamber.
  - The entrepreneurial opportunities available in fruit Ripening Sector
  - The Technical standards on Fruit Ripening established by Ministry of Agriculture.
  - New MIDH guidelines and financial assistance available
  - Financial assistance available from Indian Banks
  - Educate the trainees about the harmful effects of Carbide ripened fruits
  - Promotion of standards, scientific procedures and best practices in fruit ripening.
  - Awareness of FSSAI guidelines, International trade related norms and other compliance.

  - Assist in providing employment opportunities to the trained candidates through our existing network of promoters of fruit ripening chambers.

It's a known fact that India, today, is an emerging economy that is destined to achieve milestones, on various fronts, in the near future. However, for India, to acquire the status of a "developed" nation, it needs to create 100 million jobs, statistics point out!

Experts confirm, in an endeavor to achieve this mark, tapping the potential of the unemployed and exploring opportunities in the employment market, so that each and every person plays a crucial role in contributing towards the growth of the Indian economy is necessary. However, how can one create 100 million jobs? And the million-dollar question is which industry will absorb people and bridge the employment gap? India is one of the largest producer of banana in the world with a production figure of 26509 thousand metric ton. Having huge consumption in the domestic market and much greater scope in the International market it becomes vital to produce best quality bananas which comply with the food safety laws.

The government has banned calcium carbide as per the Prevention of Food Adulteration Act 1954 because of its harmful effects. The alternative is that ripening of fruits can be done in the fruit ripening chambers with the help of Ethylene gas, RH control, Air Circulation & Humidity Control. Ethylene gas has no side effects and the quantity used in the ripening process is a mere 0.04%. But the availability of ripening chambers is very less in our country.

Hence there lies a good opportunity for Ripening Chambers to flourish directly contributing to the growth of the economy.

1. Bananas Physiology and Diseases

Bananas are chilling-sensitive and very specialized methods of handling have been developed for this fruit to avoid exposure to temperatures below 56°F (13°C) even for a few hours.

Most bananas are now removed from the stem in the tropics and hands or clusters are shipped in corrugated boxes with perforated polyethylene liners. Boxing has eliminated many sources of handling damage previously encountered in shipping stems. Green bananas are shipped at a pulp temperature range of 56 to 58°F (13 to 14°C); temperatures below 56°F (13°C) may cause chilling injury within 2 to 24 hours, depending on the cultivar, maturity stage, and temperature (the lower the temperature, the faster chilling injury will occur). Under-skin tissue browning is an early symptom of chilling injury.

Thermal Properties

	English	**Metric**
Moisture, %	74.26	--
Protein, %	1.03	--
Fat, %	0.48	--
Carbohydrate, %	23.43	--
Fiber, %	2.40	--
Ash, %	0.80	--
Specific Heat Above Freezing	0.85 Btu/lb*°F	3.56 kJ/(kg*K)
Specific Heat Below Freezing	0.48 Btu/lb*°F	2.03 kJ/(kg*K)
Latent Heat of Fusion	107 Btu/lb	248 kJ/kg

Storage Conditions

Temperature	**Holding Room:**	56 to 58°F (13 to 14°C)
	Ripening Room:	58 to 68°F (14 to 20°C)
Relative Humidity	**Green or Turning Fruit:**	90-95%
	Ripe Fruit:	85-90%
Atmosphere	2-5% oxygen and 2-5% carbon dioxide can be used to supplement temperature and humidity management during transport and storage. Postharvest life of mature green bananas can be extended by maintaining ethylene concentration below 1 ppm using ethylene scrubbers.	
Storage Period	Mature-green bananas can be stored for up to 4 weeks in	

	ethylene-free air or up to 6 weeks in a controlled atmosphere at 58°F (14°C)
Highest Freezing Point	30.6°F (-0.5°C)

Ripening

Bananas are shipped from the tropics in the mature-green stage in specially designed refrigerated vessels or marine containers and upon arrival are usually ripened at temperatures between 58 and 65°F (14 to 18°C) with 90 to 95% relative humidity. Within certain limits, the period required for ripening green fruit can be extended or shortened to meet trade requirements by adjusting the temperature. Under average conditions, ripening may be in as short a time as 4 days with higher temperatures or may be extended to 8 to 10 days with lower temperatures. Ripening room temperatures for bananas are varied frequently as compared to other produce coolers. Automatic temperature controllers or programmers are used in most facilities.

It is recommended that air circulating fans be operated continuously when ripening boxed fruit. This is necessary to insure uniform pulp temperatures throughout the room. Forced-air ripening systems are strongly recommended for new facilities.

Stacking to allow adequate air circulation is essential for uniform ripening of boxed bananas. Ideally boxes should be stacked in rows leaving a 4-inch (100 mm) air channel between adjacent rows.

Many ripening rooms are now being modified to use forced-air ripening, commonly called a Pressurized Ripening System, which provides more uniform temperatures and ethylene concentration throughout the room. In this system, the boxes are palletized in the tropics and are left on the pallets throughout distribution. No hand stacking in ripening rooms to improve circulation is needed. However, the boxes have additional holes to improve circulation of air and ethylene. In the room, pallets are often stacked 2 or 3 tiers high and the top and outside ends of the pallet rows are covered by tarps. The tarps restrict air movement in the room so that it is forced through the banana boxes. The pressurized ripening system uses fans mounted high on the back wall with intakes below that pull air from the room.

The addition of ethylene gas to ripening rooms for 24-48 hours is recommended to stimulate uniform ripening of mature-green bananas, regardless of ripening schedule. A concentration of only 100 ppm (0.01 per cent) ethylene is needed, which is 0.1 cu. ft. of ethylene per 1,000 cu. ft.

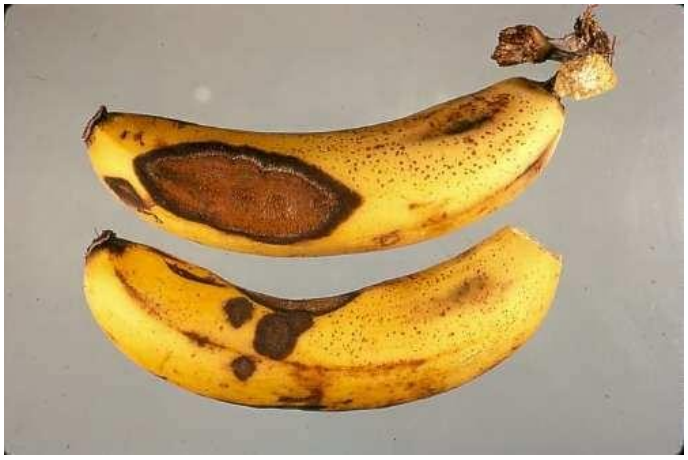
of room volume. The recommended pulp temperature for gassing boxed bananas is 58-65°F (14-18°C), depending on desired ripening time. Ethylene is explosive in air at a concentration between 2.8 and 28.6%. Carbon dioxide concentration should be kept below 1% to minimize its antagonistic effects on ethylene in inducing banana ripening.

The average highest freezing point of the banana fruit is 30.2°F (-1°C) for mature-green and 26.0°F (- 3°C) for ripening fruit. The highest freezing point of the peel is 30.6°F (-0.5°C).

An ammonia concentration of 0.8% causes rather severe injury to bananas. Ammonia fumes are best removed from storage rooms by aeration and washing the contaminated atmosphere with water if this is possible.

Controlled atmosphere transport and/or storage in 2-5% O2 with 2-5% CO2 at 58°F (14°C) is also feasible for up to 6 weeks. Bananas stored in controlled atmosphere should be ventilated with fresh air when ripening is desired. Maintaining high humidity (90-95%) during storage is recommended to avoid water loss which leads to brown discoloration of mechanically-damaged areas on the bananas.
As with all produce warehouses, banana ripening rooms should be maintained under a well planned, regularly executed sanitation program.

Diseases and Injuries



Anthracnose

Shallow brown or black spots on stems and skin as fruit ripens, possibly with whitish-hoary appearance and pink spore masses. Eventually, the flesh also decays. Anthracnose differs from simple bruising in that it has pink spores, whitish surface mold and the decay extends into the edible part of the fruit.

Control: Handle fruit carefully and keep ripening rooms clean, treating walls and floors with disinfectant. Postharvest hot water treatment can be effective.

Black Rot
The pathogen (Thielaviopsis) is transmitted by the fibrovascular system of the plant from wounds to the fruit and then into the crowns and stem ends of fingers. Produces brownish-black areas in peel at fruit ends. As fruit ripens, skin becomes grayish-black and water soaked. Pulp rarely affected.

Control: Paint freshly cut butts of fruit stalks with fungicide or dip in 100 ppm chlorinated water in the tropics.

Chilling Injury

Both green and ripe bananas are susceptible to chilling injury, but green fruit is more susceptible. Chilling is mainly a peel injury in which certain cells are killed. The dead cells darken and give the peel a characteristic smoky or dull-yellow appearance after ripening rather than a bright-yellow color. Ripe fruit, if chilled, develops a dull-brown color when later exposed to higher temperatures and is very susceptible to handling marks. The lowest temperature at which green bananas can safely be held to delay ripening is about 56°F (13°C) pulp temperature. The minimum temperatures causing chilling are not sharply defined and vary with the condition of the fruit, the cultivar, and duration of exposure. A few hours at 50°F (10°C) may cause slight peel dulling, and 12 hours at 45°F (7°C) generally causes enough chilling injury to affect salability of the fruit.

Control: Avoid temperatures below 56°F (13°C).

Fruit Spot
Circular, reddish-brown or black spots with a green halo, also has very small rust-colored specks or irregular brown pits, showing up after fruit turns yellow. Seasonal in nature, apparently physiological in character.

Control: Cull out medium or heavily spotted fruit. Not due to storage conditions.

Rhizopus Rot
Extensive soft rot of split and broken fruits with rapid development of course mold bearing white and black spore cases. Commonly observed in ripening rooms.

Control: Handle carefully to avoid skin breaks and bruising.

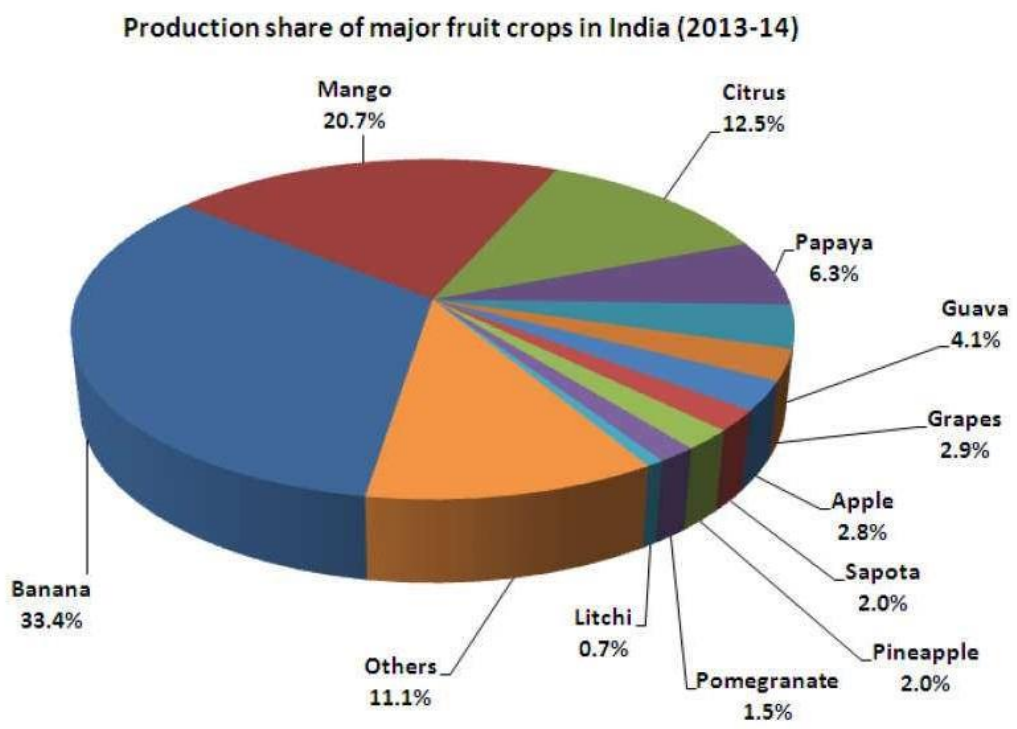
WFLO is indebted to Dr. Adel Kader, Department of Plant Sciences, University of California at Davis, for the review and revision of this topic.

2. Relevance of Banana in India with supporting facts

India is the largest banana producing country in the world. Bananas grow year-round in India and the citizens consume most of the country's whopping 30 tons produced annually. Additionally, banana is the nation's 7th largest crop. The only foods surpassing banana's yield are essentials such as rice, buffalo milk, wheat, and—perhaps surprisingly—sugar cane and mangos. 26 out of 29 Indian states grow bananas. Tamil Nadu grows 23 percent of India's supply, with Maharashtra and Gujarat growing the second and third largest volume, respectively. Other major banana growing states include Andhra Pradesh, Karnataka, Bihar, Madhya Pradesh, Uttar Pradesh, West Bengal and Assam.

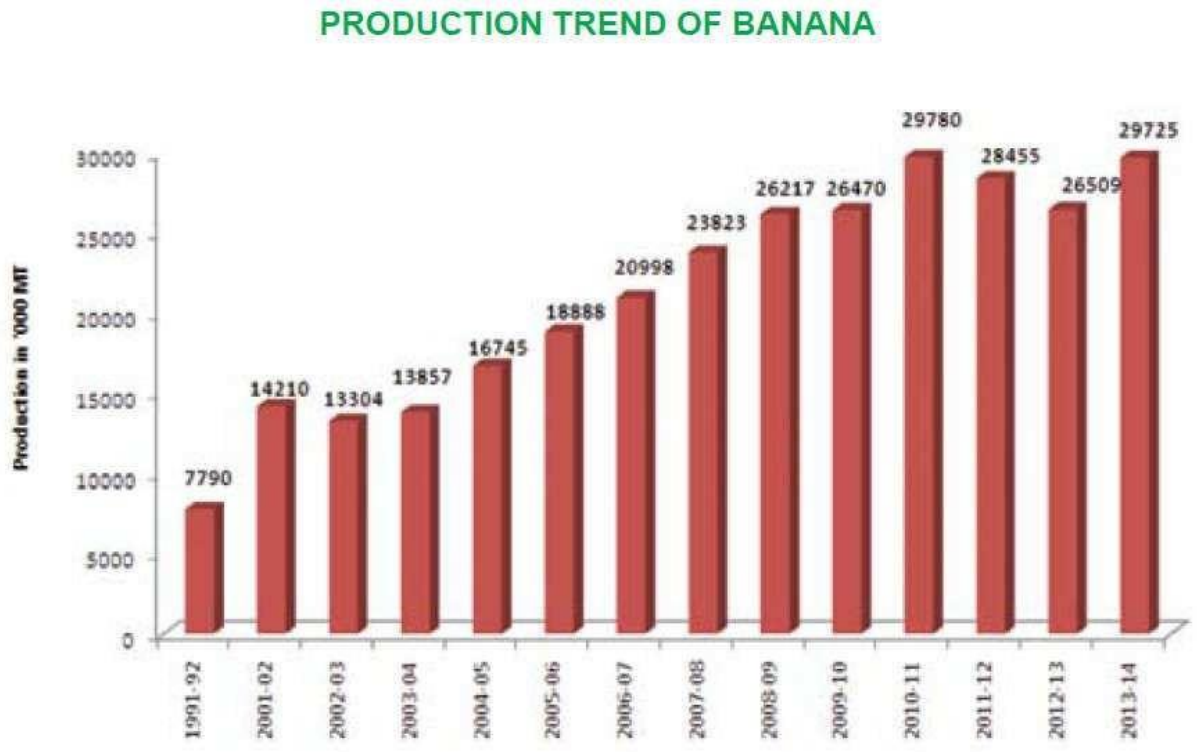
It is available throughout the year, across the country and is consumed by all strata of people in the society. Banana is a very popular fruit due to its low price and high nutritive value. It is consumed in fresh or cooked form both as ripe and raw fruit. The phenomenal increase in production recorded in India has been due to adoption of high density planting, use of tissue-cultured seedlings and drip irrigation which significantly improved productivity.

Production Share of Major Fruit Crops in India (2013-14)

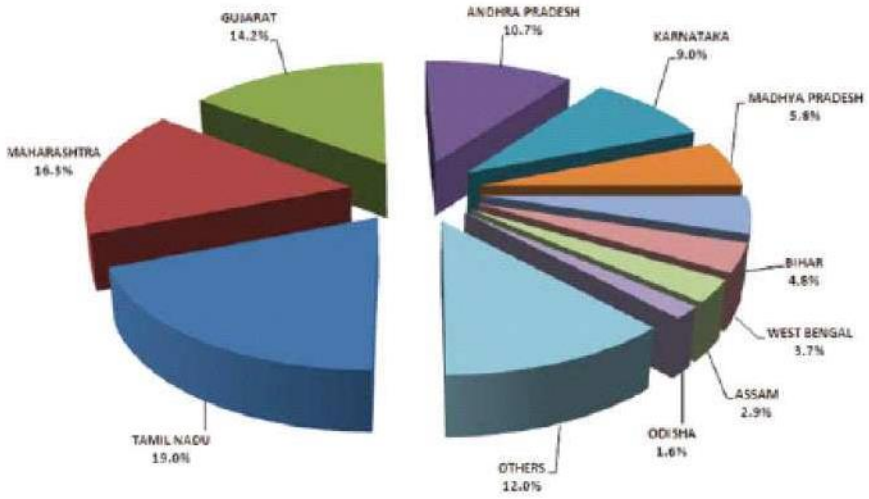


The production and productivity of Banana in last three years

	Area in '000 HA	Production in '000 mT	Productivity = mT/HA
2010-11	830	29780	35.9
2011-12	797	28455	35.7
2012-13	776	26509	34.2



LEADING BANANA PRODUCING STATES (2013-2014)



Major Banana Producing Belts in India

Andaman & nicobar island	:	South Andaman, North & Middle Andaman, Nicobar
Andhra Pradesh	:	West Godavari, Guntur, Kadapa, Anantapur, Kurnool, Medak, Nizamabad, Khammam
Arunachal Pradesh	:	Lower Subansiri, Pasighat, Papum Pare
Assam	:	Sonitpur, Lakhimpur, Golaghat, Nagaon, Morigaon, Kamrup, Cachar, Goalpara
Bihar	:	Vaishali, Bhagalpur, Khagaria, Katihar, Purnia, Samastipur
Chhattisgarh	:	Raipur, Gariaband, Baloda Bazar, Mahasamund, Dhamtari, Durg, Rajnandgaon, Balod, Bemetara, Kabirdham (Kawardha), Mungeli, Bilaspur, Janjgir- Champa, Raigarh, Surguja, Korba, Balrampur, Surajpur, Koriya, Jashpur, Bastar (Jagdalpur), Kondagaon, Narayanpur, Dantewada, Sukma, Bijapur, Kanker
Goa	:	Pernem (North Goa), Quepem (South Goa)
Gujarat	:	Anand (Borsad, Ankalav), Vadodara (Sankheda, Chani), Bharuch (Zagadia), Narmada (Rajpipla), Surat (Kamrej)
Himachal Pradesh	:	Sirmour (Nahan)
Jharkhand	:	Sahibganj
Kerala	:	Thiruvanantapuram (Pallichal, Kottukal, Nedumangad, Kattakada, Chenkal), Kollam (Punalur, Anchal, Sasthamkotta), Kottayam (Kanjirapally, Iratupeta), Thrissur (Ollukkara, Kodakara, Irinjalakuda), Palakkad (Mannarcaud, Pattambi, Agali, Sreekrishnapuram), Malappuram (Kondotty, Vazhayur, Vazhakkad), Kozhikode (Kunnummel, Thodannur, Mukkam), Wayanad (Mananthavadi, Sulthanbathery), Kannur (Thaliparamba, Irikkur, Peravoor), Kasargod (Kanhangad)

Karnataka	:	Hassan, Shimoga, Bengaluru, Chickmagalore, Dakshina Kannada, Tumkur
Madhya Pradesh	:	Balaghat, Kukshi, Dhar
Maharashtra	:	Jalgaon, Nanded , Parbhani. Throughout Maharashtra (Grand naine)
Manipur	:	Thoubal, Ukhrul, Tamenglong, Chandal, Churachandpur, Imphal East, Imphal West, Bishnupur
Meghalaya	:	Garo Hills, West Khasi Hills, Ri-bhoi, East Khasi Hill, Jaintia Hills
Mizoram	:	North and West Part of Mizoram, Chhimheipui, Serchip
Nagaland	:	Mokokchung, Wokha, Kohima, Zunheboto, Dimapur, Mon, Tuensang, Phek, Kiphire, Longleng, Peren
Odisha	:	Puri, Cuttack, Balasore, Bhadrak, Angul, Dhenkanal, Bolangir, Kalahabdi, Koraput, Rayagada, All Districts (Grand naine)
Punjab	:	Ludhiana, Patiala, Sangrur, Fatehgarh Sahib
Sikkim	:	North Sikkim (Phidang Samdon), East Sikkim (Khamdong, Pandam, Kamaray, L-Syari, Sirwani, Marchack, Nazitam, Amba Biring, Reshi Mulukay), South Sikkim (Samatar, Kamrang, Wok Pakzor, Mellidaa, Lingmo), West Sikkim (L/Rangit, Omchung, Kengsa, Chingthang, Barfok, Daramdin, Tharpu)
Tripura	:	South Tripura (Karbook, Bagafa, Satchand), West Tripura (Bishalgarh, Knowai, Sonamura, Hezamara), North Tripura (Panisagar, Dasda, Pecharthal), Dhalai (Manu, Ambassa)
Tamil Nadu	:	Coimbatore, Erode, Kanyakumari, Thoothukudi, Tiruchirapalli, Tirunelveli, Vellore, Karur, Krishnagiri, Salem, Nilgiris, Tiruvannamalai, Madurai
Uttar Pradesh	:	Bahraich, Shravasti, Gonda, Balrampur, Basti, Sidharthnagar, Gorakhpur, Maharajganj, Kushinagar, Deoria, Faizabad, Barabanki, Allahabad, Kaushambi, Pilibhit, Lakhimpur Kheri, Sitapur
Uttarakhand	:	Haridwar, Kotdwar
West Bengal	:	Jalpaiguri, Cooch Behar, Nadia, 24 Parganas (North & South), Hooghly, Bardhaman, Midnapore (West & East), Murshidabad, Uttar Dinajpore, Dakshin Dinajpore, Malda, Birbhum, Bankura

Shorter Shelf Life

Like any other agricultural produce, the banana too is highly perishable. In the raw state and at a low temperature the shelf life is long. However, with high temperatures, the natural process of ripening begins with the shelf life of ripe banana of just a day or two.

Prevalent unacceptable practices of ripening

Popularly known as "***masala",*** calcium carbide is used extensively to ripen bananas. The chemical, calcium carbide, is banned under Section 44 A of the Prevention of Food Adulteration Act, but is put to rampant use in godowns across the country. Unscrupulous traders use the chemical to cash in on the soaring demand, even if it means putting unsuspecting consumers at risk.

Industrial-grade calcium carbide may contain traces of arsenic and phosphorous, which are harmful. Experts say carbide can damage kidney, heart and liver and can also cause ulcer and gastric problems. Calcium carbide may have a harmful effect on brain, lungs and other vital organs. Toxic and carcinogenic - it is especially harmful for children. Dissolved in water, calcium carbide produces acetylene that acts as an artificial ripening agent. Acetylene is believed to affect the nervous system by reducing oxygen supply to the brain.

Calcium carbide is cheap. One kg of this chemical costs Rs.25-30, which can ripen 10 tonnes of fruit. Using calcium carbide is also a less cumbersome procedure. All that a trader has to do is wrap a small quantity of calcium carbide in a paper packet and keep it near bananas. This box is kept in a closed space for one or two days. Due to the moisture content in the fruit, heat and acetylene gas are produced and that hastens the ripening process. Ripening starts within 24 to 48 hours.

International scenario and Economic Importance

Bananas are the fifth largest agricultural commodity in world trade after cereals, sugar, coffee and cocoa. India, Ecuador, Brazil and China alone produce half of total bananas of the world. The advantage of this fruit is its availability round the year. However, the country's export contribution is minimal mainly due to huge domestic consumption and large chunk of the produce going waste. An ambitious plan was drawn up by the Confederation of Indian Industries (CII) to export Indian-grown bananas globally to China, East Asia, the Middle East and Europe. It was estimated that the annual trade could be worth $1.2bn (£750m).

For this we require the bananas to be excess then the demand and should be of a quality aligned to International standards. Banana ripening chambers and latest technologies can assist us to reach this goal sooner. For accomplishing this we need more banana ripening chambers to be set in the country and more workforce trained in the field.

3. Introduction to Ripening and hazards of Carbide Ripened fruits

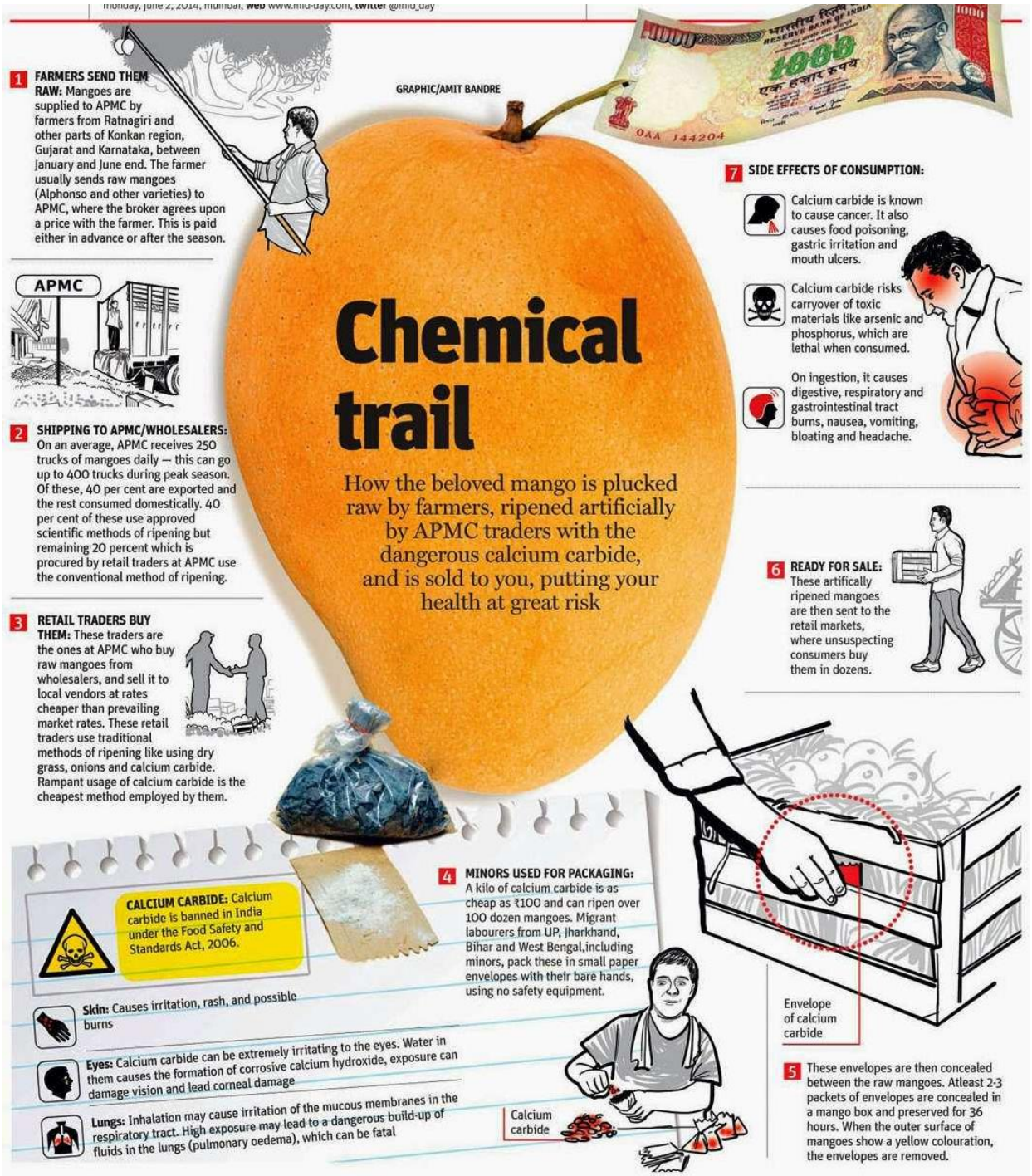
Presently, the whole world is emphasizing on malnutrition, food safety and health security. Several programmes have also been launched in this regard. The year 2008–09 was declared as the 'Food Safety and Quality Year' by the Government of India. With modern transport and cold chain management system, it is possible to have fresh fruits practically all the year round, where it is produced and also in areas where it is not possible to grow fruits. As a consequence, consumption of fruits has increased considerably in our country. Fruits are the best natural food for all. Nowadays fruits are deliberately being contaminated by chemicals causing serious health hazards. Toxic chemicals are indiscriminately used to grow, ripen and make fruits appear fresher or even last longer, particularly during early and offseason. Among the pretreatments, which are mostly followed for fruits intended for better consumer acceptance and facilitating better marketing, is artificial fruit ripening.

What is ripening?

Controlled ripening is done to achieve a uniform marketable fruit. Ripening, in general, is a physiological process which makes the fruit edible, palatable and nutritious. In nature fruits ripen after attainment of proper maturity by a sequence of physical and biochemical events and the process is irreversible, ultimately leading to senescence. Whether fruits ripen on the plant or after harvest, the general ripening changes associated with the ripening process are easily recognizable. During ripening fruits soften, change colour and develop characteristic aroma and flavour. There is also a reduction in sourness (acids) and increase in the sweetness, etc.6. Underlying these changes, there may be changes in hormone levels, respiration and cellular organization. Factors influencing the process of ripening include stage of fruit maturity and the environment where it has to be allowed to ripen, including temperature and relative humidity.

Controlled ripening

Unsaturated hydrocarbons, particularly acetylene, ethylene, etc. can promote ripening and induce colour changes effectively. Although the cosmetic quality of such artificially ripened fruit was found to improve. The most commonly used ripening agent is Calcium Carbide. When hydrolysed, it produces Acetylene used in fruit ripening. On the contrary, use of acetylene gas generated from CaC2 induces ripening of fruits similar to ethylene. This method is being used in most of the climacteric fruits (fruits which are picked when mature, and ripened off the tree, i.e. only after harvesting) like mango and banana and in non climacteric fruits like citrus for degreening. Although fruits developed good peel colour with CaC2, the intensity of colour developed commensurates with increase in the concentration of CaC2 used; but fruits were less in flavour volatiles and had shorter shelf-life14. Actually CaC2 only changes the skin colour, whereas the fruit remains raw inside. More raw/immature the fruit, higher CaC2 is required to ripen it. This makes the fruit tasteless, unhealthy and toxic. It also breaks down the organic composition of vitamins and other micronutrients. Chemicals have the potential to damage the vital organs of the body. CaC2 is used for ripening mango and banana and Papaya in India.



What is CaC2?

Calcium carbide is popularly known as ‘masala’, and is used as a ripening agent. It is colourless when pure, but black to greyish-white in colour otherwise, with slight garlic-like odour. When it reacts with water, CaC2 produces acetylene gas which is an analogue of ethylene and quickens the ripening process. It also contains traces of arsenic and phosphorus hydride. Acetylene prepared from CaC2 also contains phosphine and some arsine up to 95 and 3 ppm respectively. A strong reactive chemical, CaC2 has carcinogenic properties and is used in gas welding3. Acetylene gas is flammable and explosive even in a low concentration compared to ethylene.

Besides, indiscriminate use of pesticides on different types of fruits can lead to poisonous effects. Due to lack of awareness and education people consume chemically ripened fruits. Being cheap (1 kg of this chemical costs Rs 25–30, and can ripen 200 kg of mangoes),

Effects of CaC2 on fruit quality

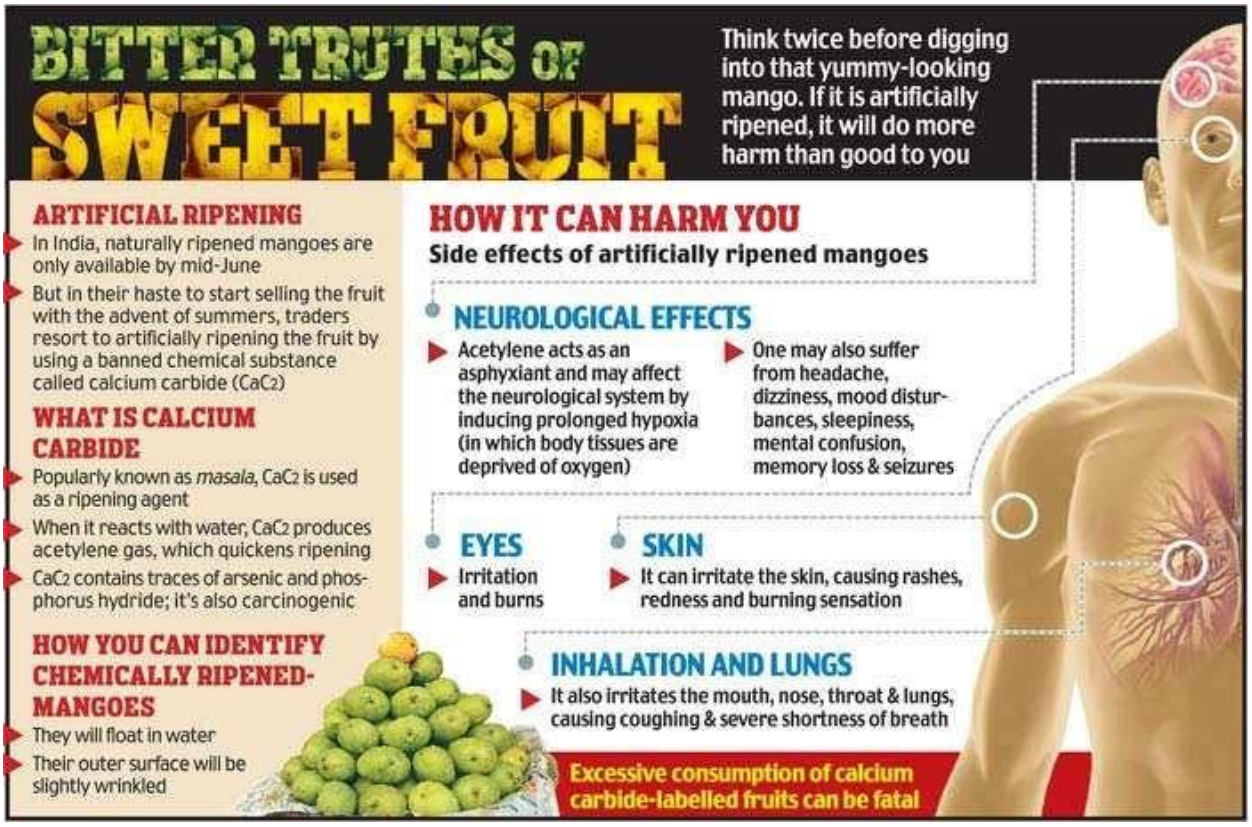
As the fruits are sent to different places, requiring several days in ordinary or refrigerated transportation, only firm but mature fruits are least damaged during marketing. They are ripened at the destination markets before retailing. Using CaC2 is also a less cumbersome procedure. All that a trader has to do is to wrap a small quantity of CaC2 in a paper packet, and keep this packet near a pile or box of fruits. As chemical reaction takes place, because of moisture content in the fruit, heat and acetylene gas are produced, which hastens the ripening process. In the case of banana, ripening starts within 24–48 h, depending on the ambient temperature. When the fruits yield to slight finger pressure, they are kept under ice slabs for lowering the temperature and colour develops. Apparently, green bananas can transform into yellow appetizers. However, fruits ripened with CaC2 are overly soft and less tasty. They also have a shorter shelf-life. An artificially ripened fruit would present a yellow outer skin, but the tissue inside would not be ripe or itself remains green and raw Though mangoes ripen quickly (two days), they cannot be stored for more than two days. When CaC2 is used on raw fruit, the amount of the chemical needed to ripen the fruit has to be increased. This results in the fruit becoming even more tasteless and possibly toxic.

Ban on using CaC2

Considering the possibilities of its hazardous effects, CaC2 is banned in many countries, but it is widely used in India, Pakistan, Bangladesh, Nepal and other countries for ripening fruits. In spite of the high consumption of fruits, and the obvious shift to horticulture as part of the crop-diversification plan, the concerned authorities have failed to devise any effective action plan to check malpractices in ripening.

In India, artificial ripening is banned under the Prevention of Food Adulteration (PFA) Act, 1954, and the Prevention of Food Adulteration Rules, 1955. According to rules 44AA of the PFA Rules 1955, no fruit can be ripened with the aid of CaC2. Those convicted under this Act could face imprisonment for three years and a fine of Rs 1000. But there are hardly any cases where the traders or retailers have been booked for accelerating ripening by the use of harmful chemicals. Several news reports have highlighted the open use of CaC2 in different parts of the country. Recently, the Union Health Ministry has sent a circular to all state food authorities with the Food Safety and Standards Authority of India, stressing the need to take legal action against those found guilty of violation of the PFA rules.

Health hazards



As discussed earlier, CaC2 contains traces of arsenic and phosphorus hydride. It causes several acute and chronic health effects. In humans, acetylene is not acutely toxic below its lower explosive limit of 2.5% and inhalation of 10% acetylene for 1 h does not cause acute toxicity, whereas inhalation of 33% or 35% can cause unconsciousness within 7 and 5 min respectively. The early symptoms of arsenic or phosphorus poisoning include vomiting, diarrhoea with or without blood, burning sensation of the chest and abdomen, thirst, weakness, difficulty in swallowing, irritation or burning in the eyes and skin, permanent eye damage, ulcers on the skin, irritation in the mouth, nose and throat. Throat sores, cough, and wheezing and shortness of breath may also occur soon after exposure to the chemical. Higher exposure may cause a build-up of fluids in the lungs. Eating artificially ripened mangoes causes stomach upset because the alkaline substance is an irritant that erodes the mucosal tissue in the stomach and disrupts intestinal function. Chronic exposure to the chemical could lead to peptic ulcer. As CaC2 imitates acetylene gas, it may affect the neurological system by inducing prolonged hypoxia.

Recent findings related to carbide poisoning have reported headache, dizziness, mood disturbances, sleepiness, mental confusion, memory loss, cerebral oedema and seizure. Though eating the fruit will not bring about such an allergic reaction, the method of ripening it could cause such problems. Studies conducted by Erciyes University (Turkey) during 2005 revealed that CaC2 is hazardous as it contains traces of arsenic and phosphorus. It has also been observed that humans exposed to 35% acetylene were unconscious after 5 min and commencing intoxication was observed after 25 sec, marked intoxication after 1 min. Other effects include

numbness in the legs and hands, general weakness, cold and damp skin and low blood pressure. Although most cases of arsenic and phosphorus poisoning are detected before they become fatal, pregnant women are particularly vulnerable. The chemical residue in the fruit could lead to miscarriage. But, the literature on CaC2/acetylene toxicity does not describe cardiovascular or electrocardiographic abnormalities.

Identification of CaC2-ripened fruits

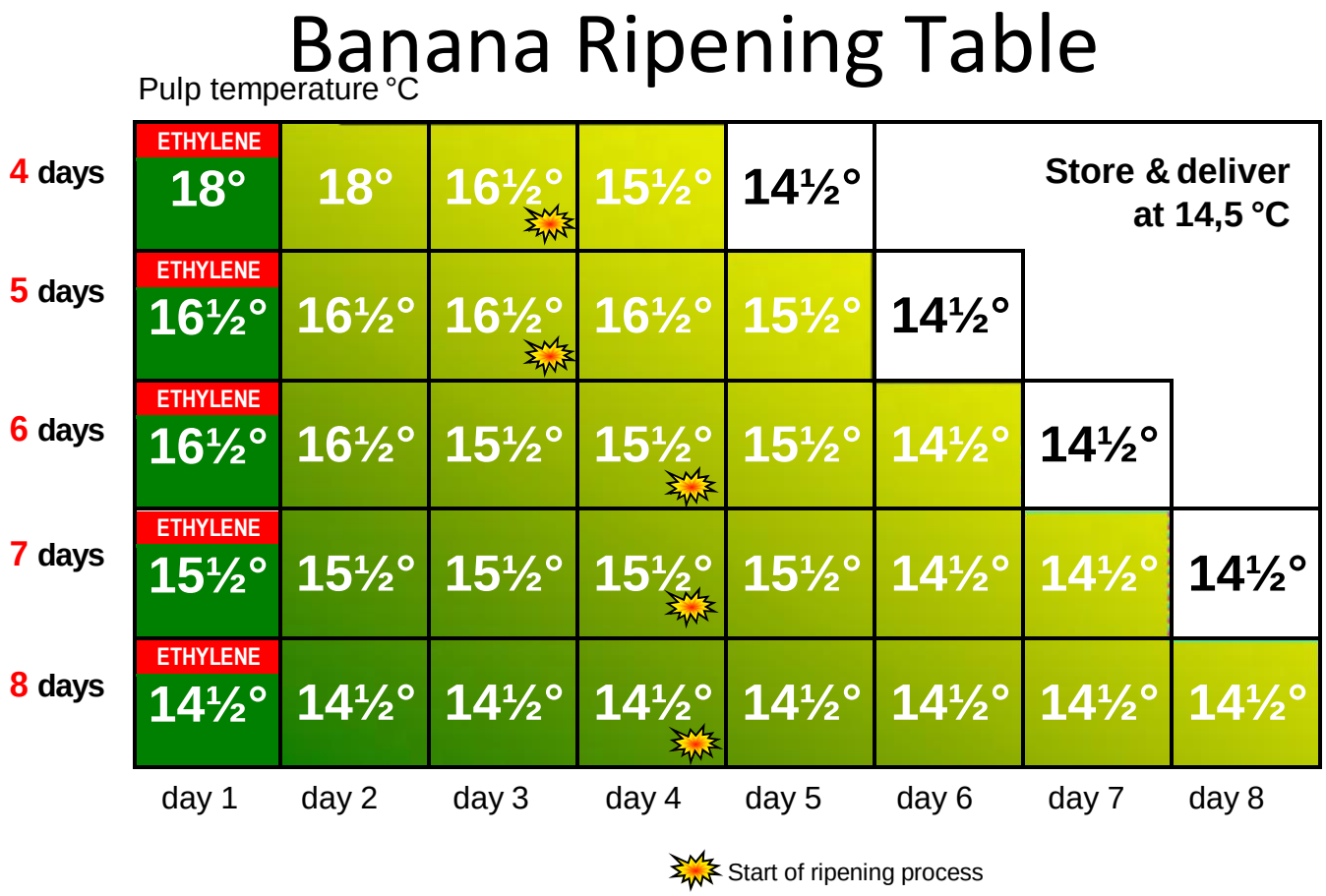
Fruits that look attractive outside may not be good for health. Fruits that have a uniform colour, for example, a bunch of bananas having a uniform colour, are more likely to have been artificially ripened.

Artificial ripening of fruits is done for commercial purposes with chemicals. The naturally ripened fruits are not uniformly yellow; rather, they are of green and yellow. When tomatoes are uniformly red, or mango and papaya are uniformly orange/yellow, then CaC2 may have been used; bananas can also be identified if the stem is dark green whereas the fruits are all yellow. While purchasing fruits and vegetables, one should not select those that are homogenously ripened and with eye-catching bright colours. Washing and peeling procedures before eating the fruit could help in minimizing the risks associated with the use of CaC2. Washing the fruits under running water for a few minutes may help minimize the chemical contents, if any, adhering to the fruits. While eating mangoes and apples, it is better to cut the fruit into pieces, rather than consuming them directly.

It is not advisable to buy fruits when they arrive in the market before the due period. One can be almost sure that they have been artificially ripened. June and July, which marks the end of the mango season, would be the best time to taste the fruit as the market would be flooded with naturally ripe mangoes. Suspected samples may be tested in the laboratory for phosphorus and arsenic residues on the surface of the fruits.

4. Banana Ripening Process

Climacteric fruits like mango, banana, papaya, sapota and custard apple are often harvested in a mature but unripe condition and then subsequently allowed to ripen by natural release of ripening hormone (ethylene) from the fruit. However, natural ripening in some fruits is a slow process, which leads to high weight loss, desiccation of fruits and uneven ripening. With the rapid development of fruit trade, artificial ripening has become essential and the methods practiced earlier by small traders are smoking and calcium carbide treatment.



Ethylene Gas

- Naturally occurring plant hormone
- Produced in all plant tissues
- Governs many physiological functions, including senescence and ripening
- Produced in greater amounts as plant organs (fruits) mature.
- Also ethylene is produced in response to plant stress
- Colorless gas, slightly sweet odor, soluble in water.
- Normally produced during banana fruit ripening
- If applied to bananas, it initiates ripening and assures even ripening
- Only 1 ppm is required to initiate ripening, but up to 1000 ppm are frequently used.
- Banana fruits are exposed to the gas for about 24 hours.

Note: a concentration of ethylene gas higher than 2.7% (27,000 ppm) can be explosive

Banana Ripening Rooms

Banana ripening rooms are very important for proper and efficient banana ripening; not just any room will suffice. A commercial ripening room must have the following:

1. The room must be as air tight as possible to prevent ethylene loss. This also prevents ethylene from entering unwanted areas (like other banana rooms or cold storage rooms holding ethylene-sensitive items).
2. The room must be properly insulated to be able to control the temperature within a degree or so.
3. The room must have adequate refrigeration capacity to accurately control pulp temperature.
4. The room may need heating equipment in order to maintain proper room temperature in cold weather.
5. The room must have adequate air circulation. Because uniform pulp temperatures throughout the load are essential for even ripening, the refrigerated air in the room must circulate at all times and uniformly throughout the load. For pressurized, forced air ripening rooms, this is typically inherent in the design. However, for non-pressurized rooms, the boxes of bananas should be "air stacked". That is, the boxes should be offset to allow the air to circulate among all the boxes since a non-pressurized room design will not pass air through boxes but around them.

Monitor pulp temperatures closely:

- Avoid "chilling" or "cooking" the fruit. Bananas are very sensitive to temperatures. Chilling will occur if the fruit is subject to temperatures below 56°F (13°C) for several hours. It causes the peel to have a smoky, dull gray appearance. This may not show up for 18 to 24 hours after chilling occurs.
- Cooked bananas result from excessively high temperatures; avoid temperatures above 65°F (18°C). The peel will have a brown to orange appearance. The fruit may be soft and have a short shelf life.

Maintain proper humidity levels:

For best ripening results, humidity should be 85 to 95%. If the humidity is too low, install a humidifier; wetting the floor of the room with water may increase the humidity but may cause sanitation issues.

When ready to ripen:

- Determine how in how many days the room of bananas will be needed; raise pulp temperatures to at least 58°F (14°C).

- Follow proven ripening schedules to adjust daily pulp temperatures. No chart however can account for the unique differences in every load of bananas that will be ripened. Frequent inspection of pulp softening and color change followed by temperature adjustments are vital to proper color achievement.

- Apply 100 - 150 ppm ethylene for a minimum of 24 hours during the initial phase of the ripening cycle. Fruit that is less mature may take an additional 24 hours of ethylene application.

Please note that there are reports of bananas responding better to higher ethylene levels. While 100 ppm is the accepted standard to initiate ripening and ethylene production in bananas, there are some companies that require their ripening personnel to use 300+ ppm, saying that today's banana ripens quicker and more uniformly with this higher level. If you are having difficulty with bananas ripening properly, verifying current ethylene levels and then perhaps increasing them may resolve ripening issues. There are other factors that cause poor ripening, like inadequate humidity and immature fruit; ethylene is not always the culprit.

When bananas are ripening, they release carbon dioxide which will build up in a ripening room. The production begins as the fruit ripens enters the “climacteric” phase, or the period when bananas release ethylene and and have an elevated rate of respiration (along with a great deal of other physiological changes). Respiration involves the uptake of oxygen, the release of carbon dioxide, and the breakdown of starches. Carbon dioxide concentrations above 1% (10,000 ppm) will retard ripening, delay the effects of ethylene and cause quality problems. Therefore, it is recommended to vent rooms by opening the doors for 20 minutes every 12 hours, after the first

24 hours of ripening. Other venting methods are by automatic fan (either timed or sensor-based) or "flow-though" (constant) ventilation.

Methods of Introducing Ethylene Gas

- **Catalytic Generators(e.g., '('Ethy--Gen‘‘):** A method by which a liquid concentrate 'Ethy-Gen' is decomposed in an electrically powered catalytic generator, to produce ethylene gas. The 'Ethy-Gen' concentrate is supplied in containers which produce about 12 ft3 (0.33 m3) of ethylene gas. The amount of liquid put in the generator depends on size of ripening room

- **Ethylene Cartridges:** Each ethylene cartridge contains approximately 51g of pure ethylene and the ethylene concentration in the room may be controlled simply and accurately by using the appropriate number of cartridges. Ethylene released by piercing cartridge with a tool which is supplied.

- **Ethylene and Ethylene/Nitrogen Cylinders:** The explosion risk from ethylene can be eliminated by the use of a mixture of gas a consisting of 5% ethylene in nitrogen.

- **Pure Ethylene Cylinders:** Pure ethylene can be obtained in cylinders.

Shipping suggestions

- Bananas bruise easily, green or ripe. Careful handling at all stages will reduce bruising and enable you to sell the bananas for more money.
- Bananas also chill easily, as described above. If shipping on a mixed load at temperatures lower than 55°F (12.8°C), the it is highly suggested to use Pallet Covers to protect the fruit by holding pulp temperatures above 56°F (13°C

Ingredients for Proper Ripening

Setting up the correct parameters to ripen any fruit is critical. Also key is to have management instituted so that constant monitoring of the ripening process occurs.

Here are elements that are vital to any ripening program:

- **Mature fruit.** Immature fruit may ripen, but typically will not have full flavor development and may not have full cosmetic appeal. Ripening such fruit will require extended ethylene application and a longer ripening cycle. For proper results, ripen only mature fruit!

- **Age of fruit. It** is good to know the quality of the fruit to be ripened. Age and history of conditions that the fruit has been exposed to will help in determining the proper ripening cycle.

- **Proper temperature.** Key to the ripening process is pulp, or core, temperature of fruit. Keeping a close eye on this temperature of fruit while ripening helps to control the process and dictate the speed that the fruit ripens. The ability to control the pulp temperature is determined by ripening room design. The room must be able to remove heat generated by the the fruit as it ripens; fruits vary in the amount of respiration, but the highest are avocados and bananas.

- **Time.** It is imperative not to rush the ripening process! Increasing temperature beyond proven upper limits for a particular fruit in order to speed up ripening typically causes much more harm than benefit..."cooked" fruit, shortened shelf life, dissatisfied customers, etc.

- **Airflow.** The room must have properly sized fans to facilitate air flow; if the design is forced air / pressurized, then the room system should be able to maintain the pulp temperature of interior boxes of a pallet to within a degree. If not pressurized ("conventional" rooms), then each box should be positioned on the pallet in a "cross-stack" pattern to facilitate airflow.

- **Humidity.** The relative humidity (RH%) for most fruits should be maintained at 90-95%. Improper levels will result in weight loss and cosmetic damage.

- **Ethylene.** To trigger the fruit within a ripening room to ripen uniformly and predictably, an external source of ethylene is required for most fruits. Ethylene is a natural plant hormone that affects the growth, development, ripening, and senescence (aging) of all plants. Ethylene has been found not harmful or toxic to humans in the concentrations found in ripening rooms (typically less than 250 ppm). In fact, ethylene was used medically as a anesthetic in concentrations significantly greater than that found in a ripening room. For more information on ethylene, please see our Resources page.

- **Ethylene** is explosive at 27,000 ppm; however, all that is required to ripen fruit is 100 - 150 ppm. There are several sources of ethylene application systems available; the safest form is ethylene generators and concentrate. In fact, the United Kingdom's HSE has stated in a document that "the use of cylinders of pure ethylene should be vigorously discouraged."

- **Ripening rooms** should have a smoke test performed to check for air leaks at least once per year. This will help show where ethylene will escape and cause premature ripening in other rooms or damage to other types of fruit.

- **Carbon Dioxide / Oxygen**. As fruit ripens, it's respiration decreases the oxygen in a ripening room and emits carbon dioxide. Concentrations above 1% (10,000 ppm) will retard ripening, delay the effects of ethylene and cause quality problems. Therefore regular ventilation is required to keep carbon dioxide levels below 1%.

5.
Ripening room and stacking practices

Ripening Room Dimensions

- **Standard Ripening Rooms**

  Standard room dimension: 24 pallets with 48 boxes of 18 kg bananas each (24 pallets = 1 full truck load). Also rooms for 0.5, 1, 1.5 or 2 truck loads (12, 24, 36 or 48 pallets).

- **Standard Ranges Ripening Coolers**

  - *Air cooler ranges optimised for all ripening room dimension.*

Banana Ripening Systems

- **Block Stack**
- **Tight Stack**
  - *Tarp System*
  - *Airbag / Side Curtain System*
  - *(Chiquita 2000 System)*

Block Stack vs Tight Stack

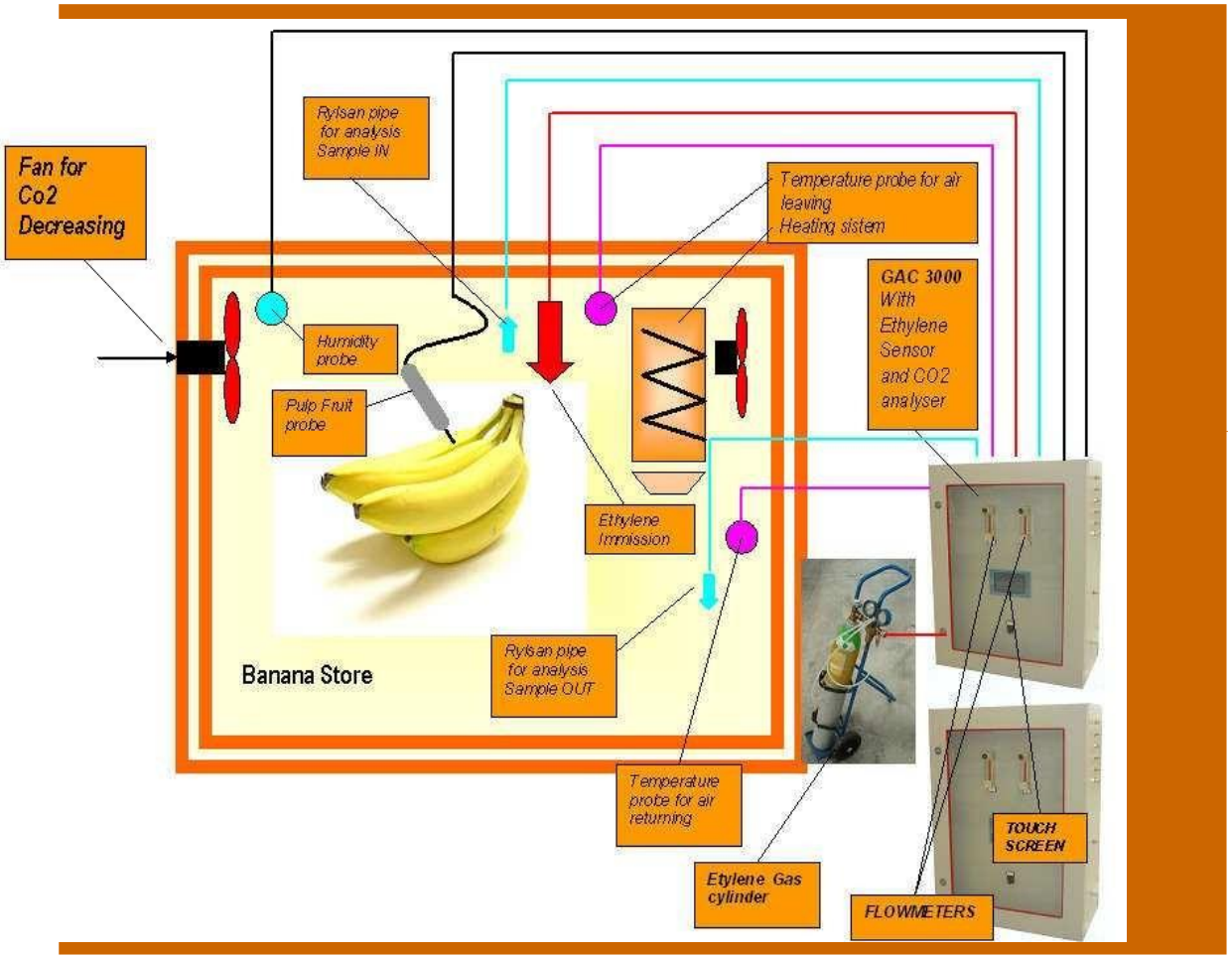
Block Stack

- *5 boxes per layer, interspace*
- *Interspace between pallets*
- *“Flow-around“ air circulation*
- *Ripening process hard to control*
- *Long ripening period (min. 6 days)*
- *Poor end quality (uneven ripening)*
- *Out of date system*

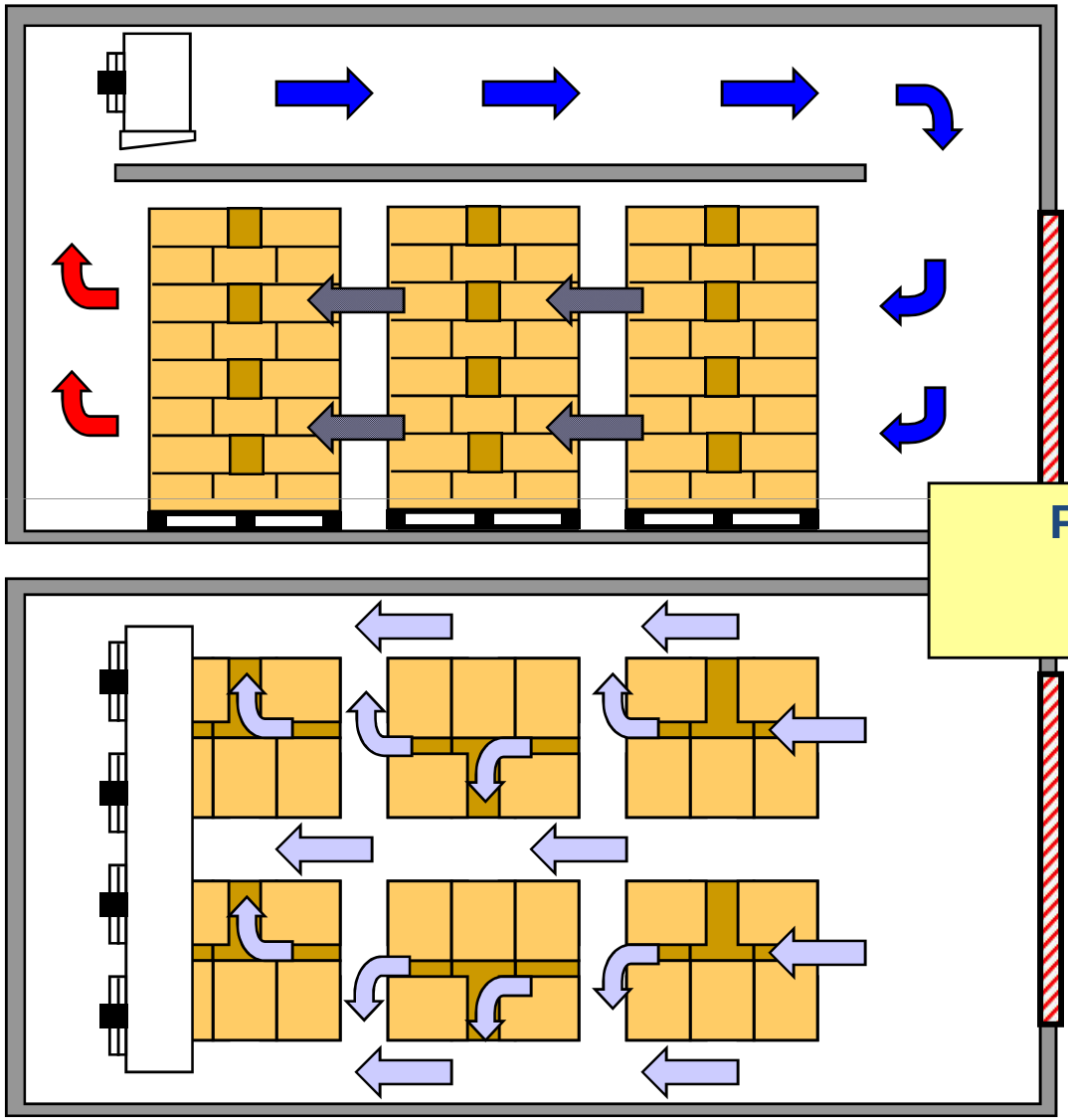
Tight Stack

- *6 boxes per layer, no interspace*
- *No interspace between pallets*
- *“Flow-through“ air circulation*
- *Controlable ripening process*
- *Shorter ripening period (min. 4 days)*
- *High end quality (very evenly ripened bananas)*
- *More pallets per ripening room*

Equipment layout of Ripening Room

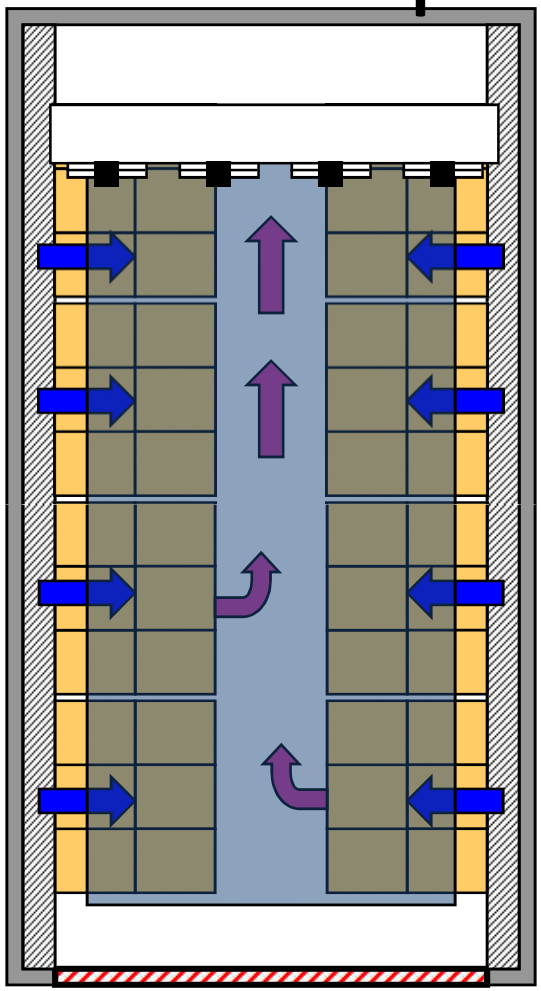


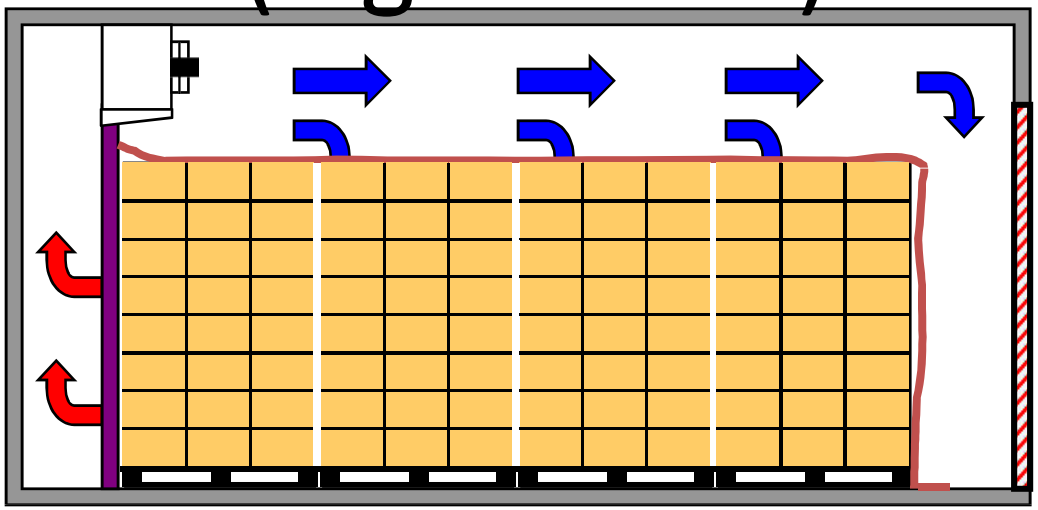
Block Stack

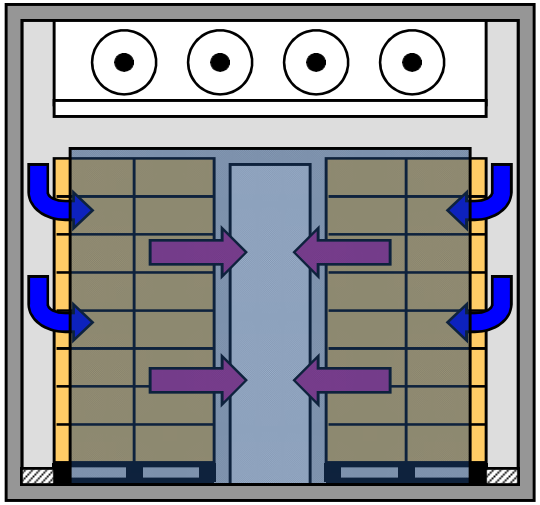


Flow around circulation

Tarp System (Tight Stack)



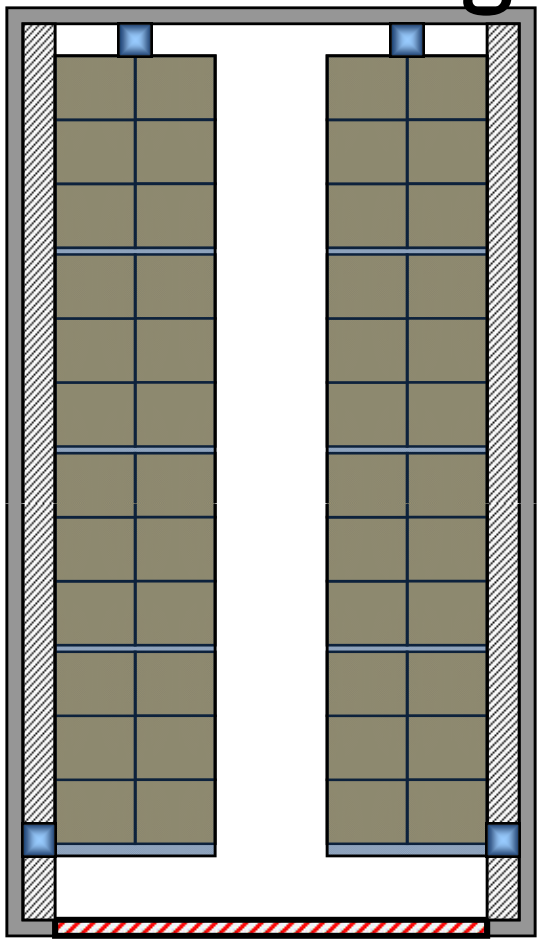


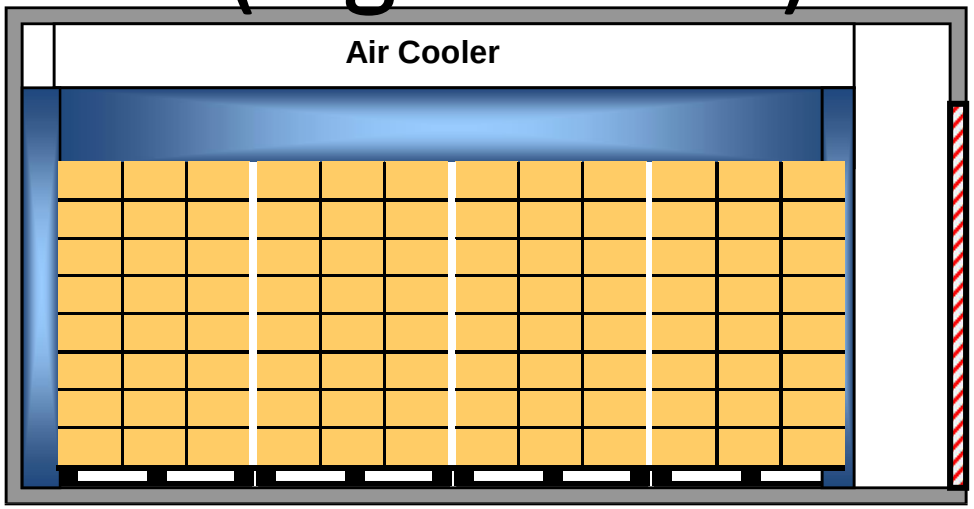


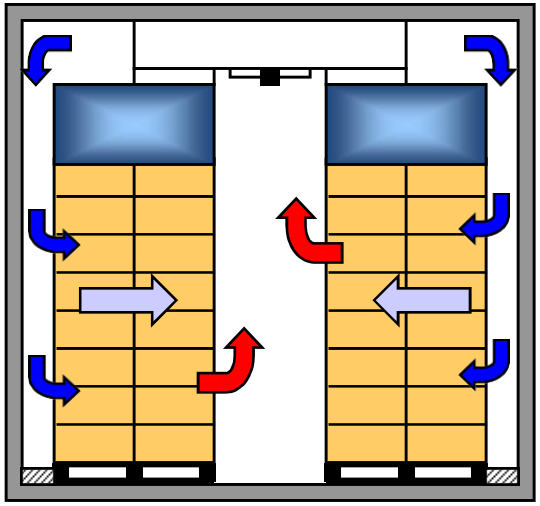
Flow through circulation

Tarp System (2 tier)

Airbag System (Tight Stack)







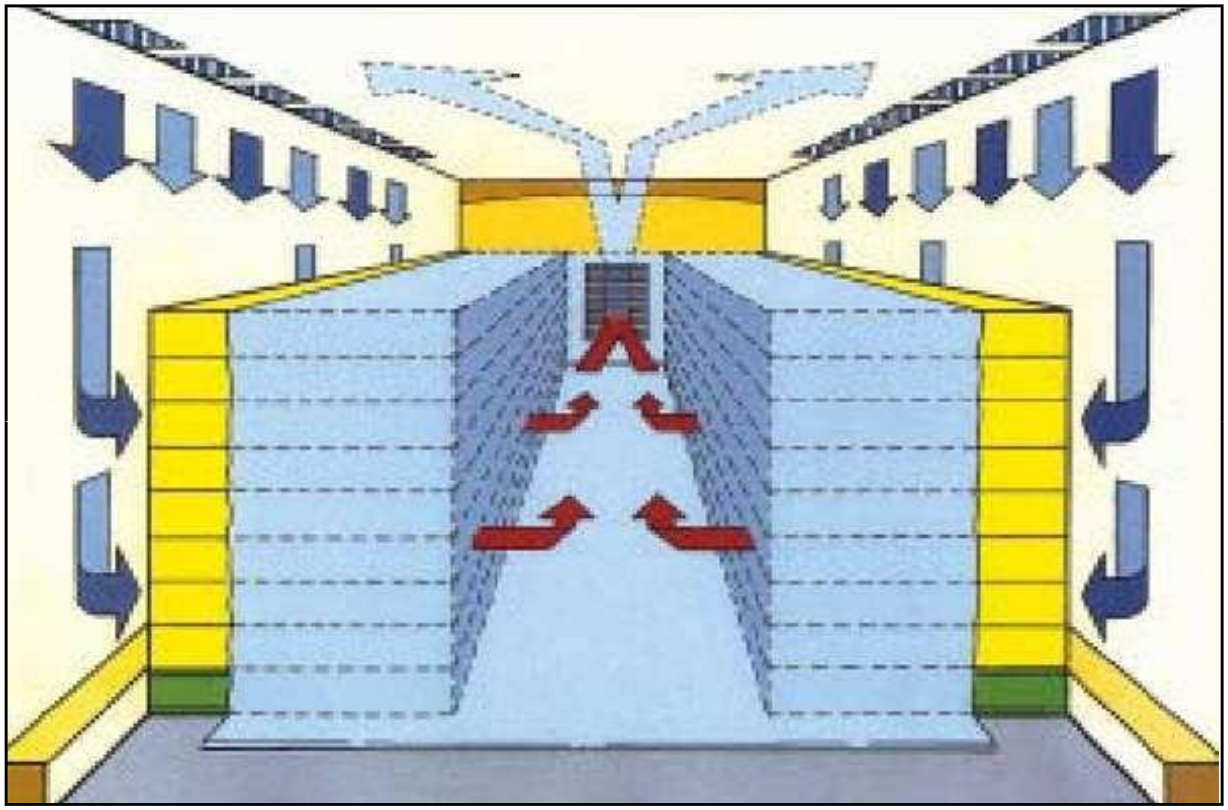
Flow through circulation

Airbag System

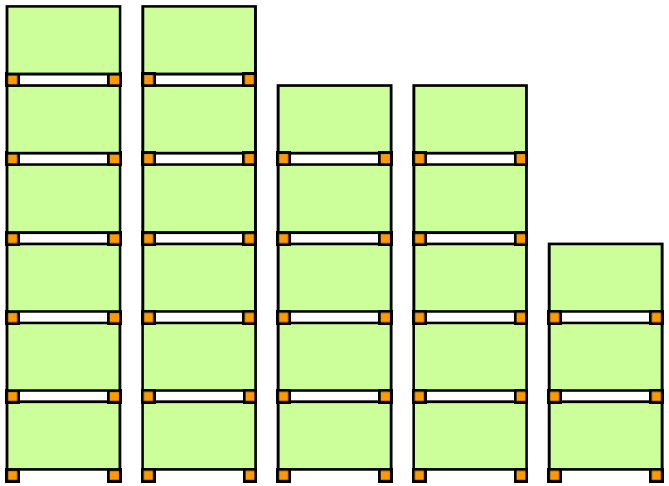
Side Curtain System

Airbag / Side Curtain Cooler

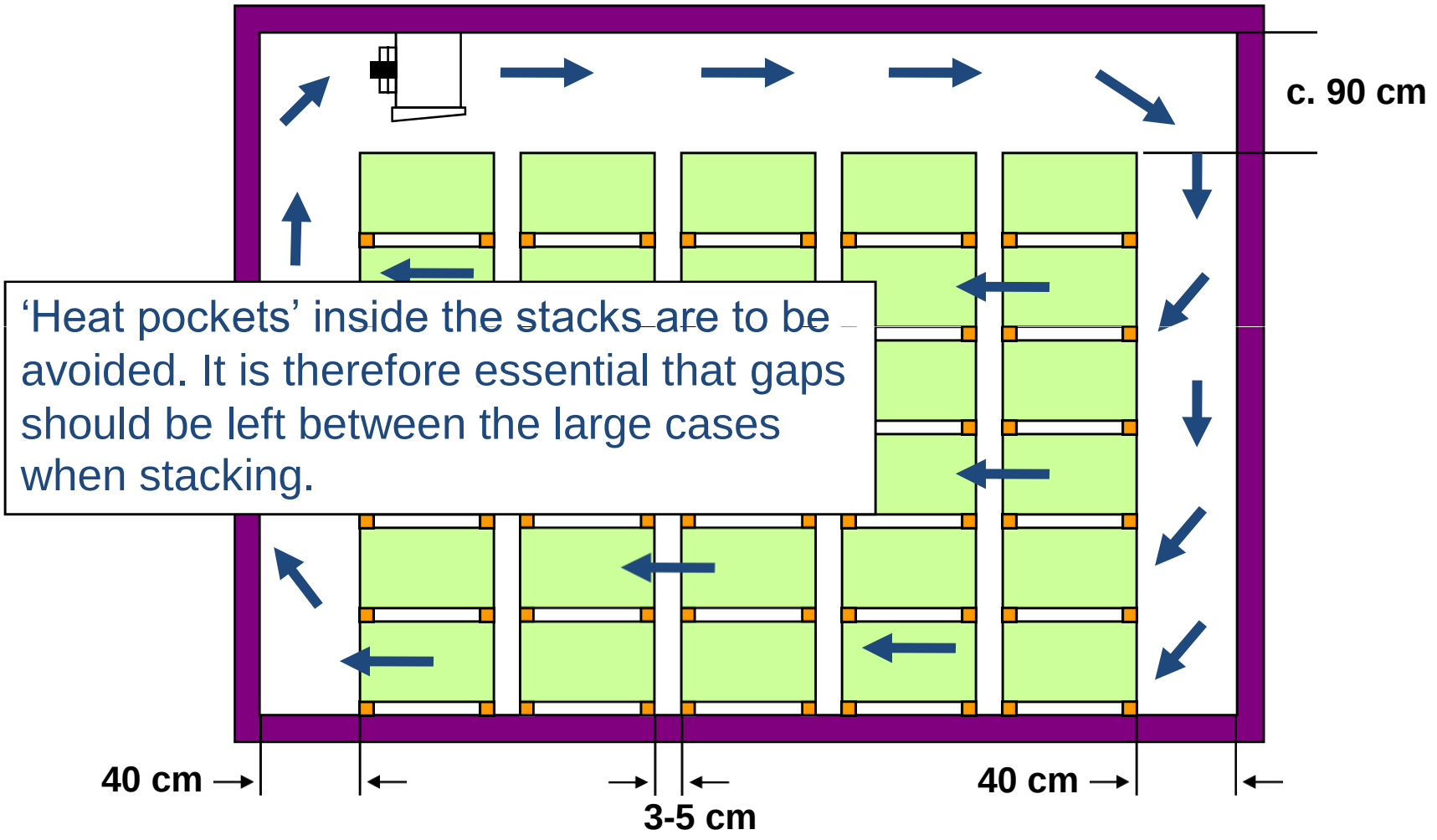
Chiquita 2000 System



Proper stacking

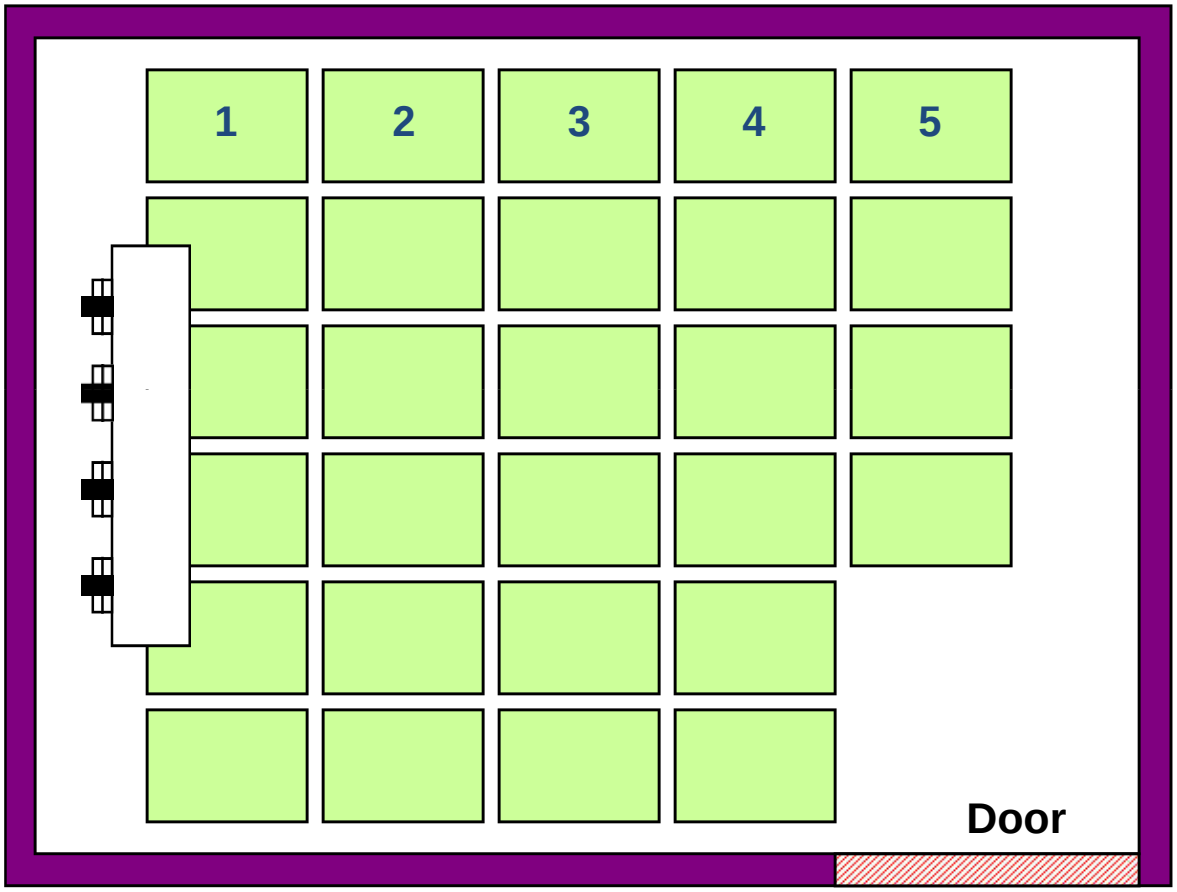


Air circulation in the chillroom

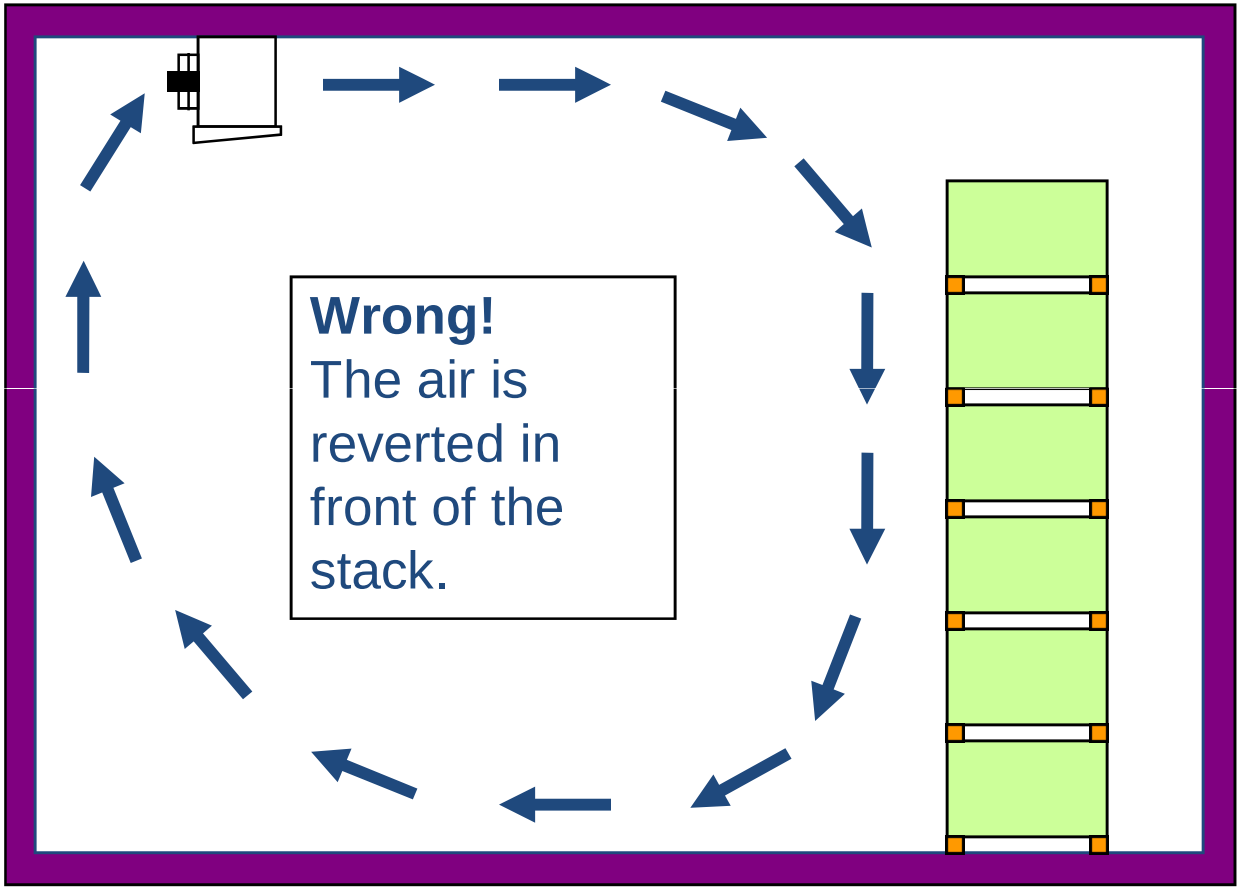


‘Heat pockets’ inside the stacks are to be avoided. It is therefore essential that gaps should be left between the large cases when stacking.

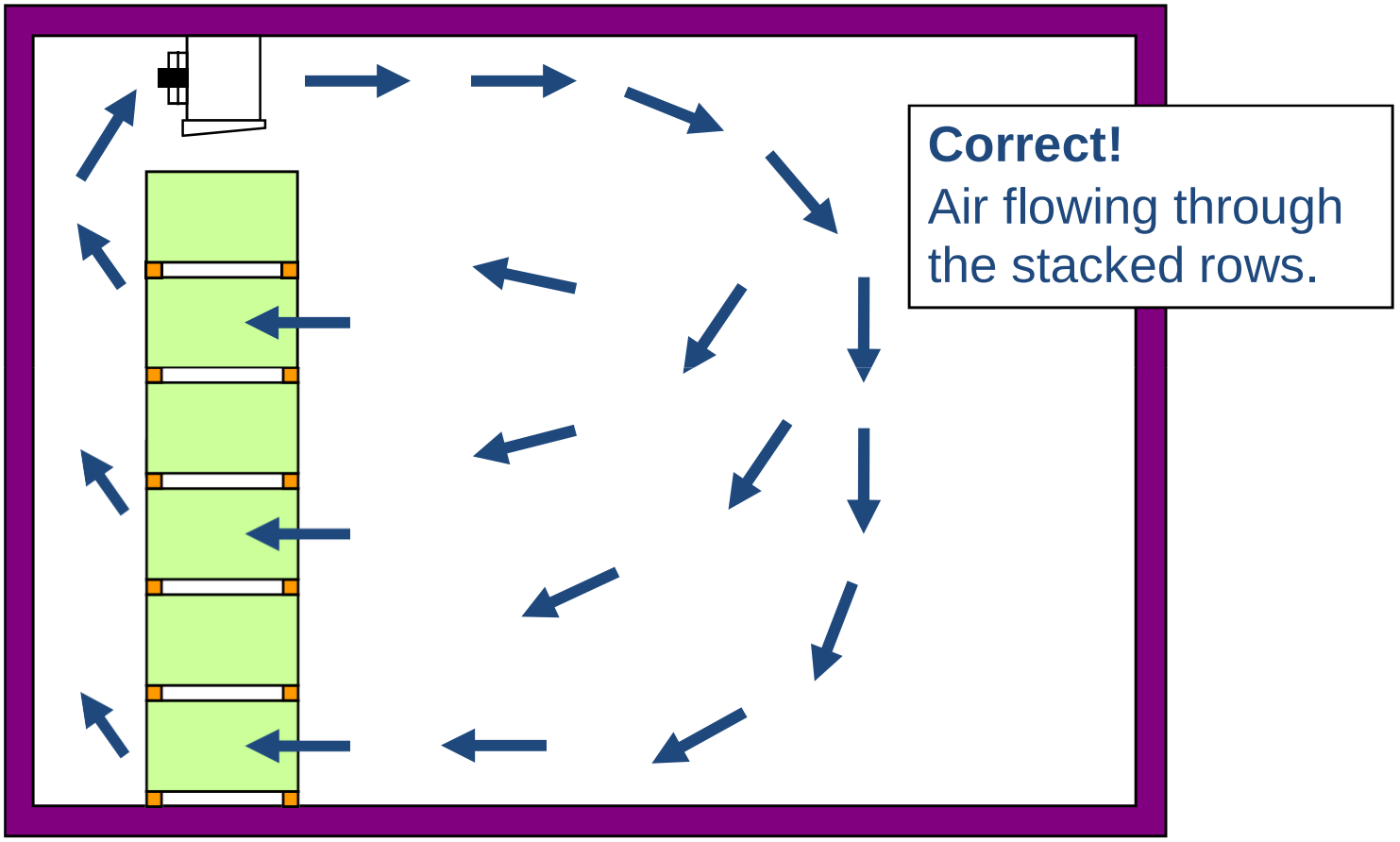
Stacking sequence during storage



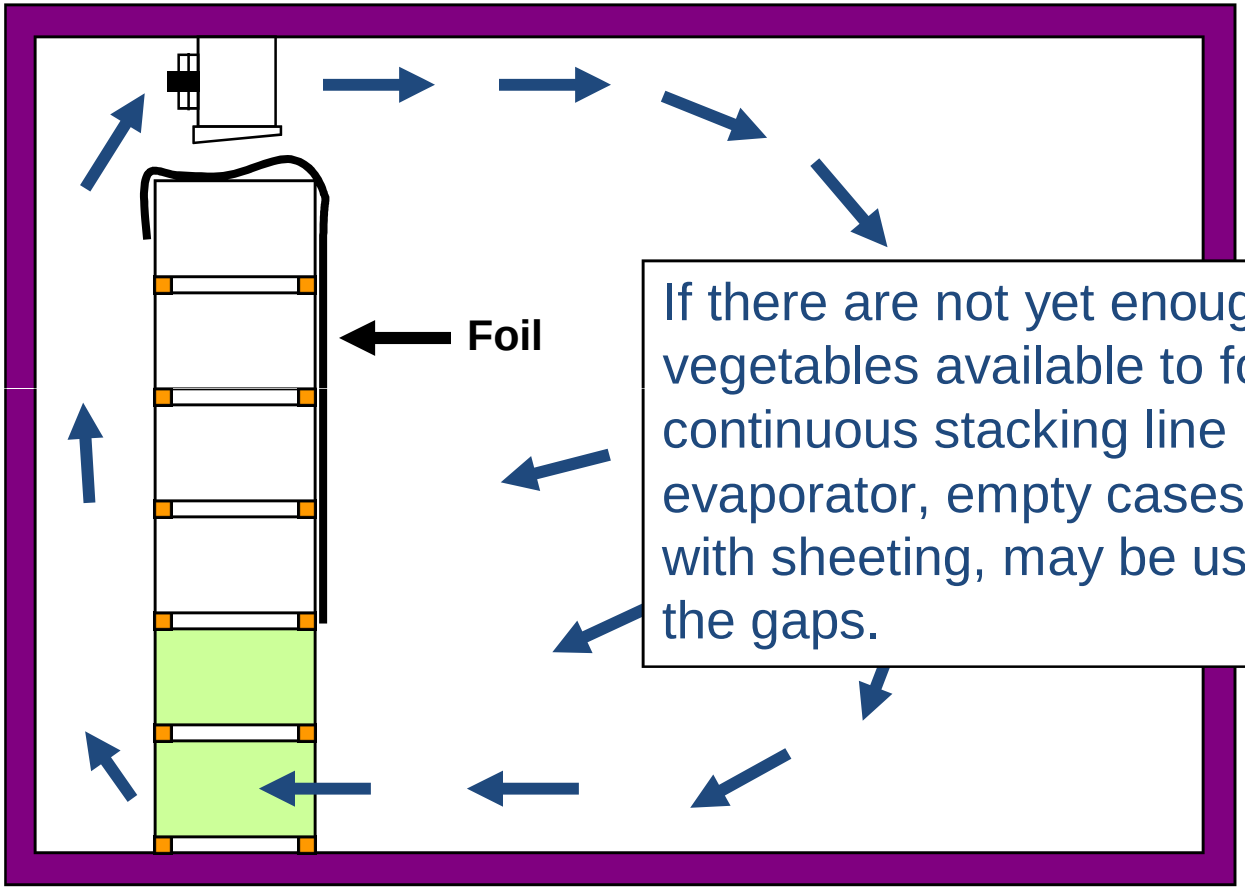
Stacking sequence during storage



Stacking sequence during storage



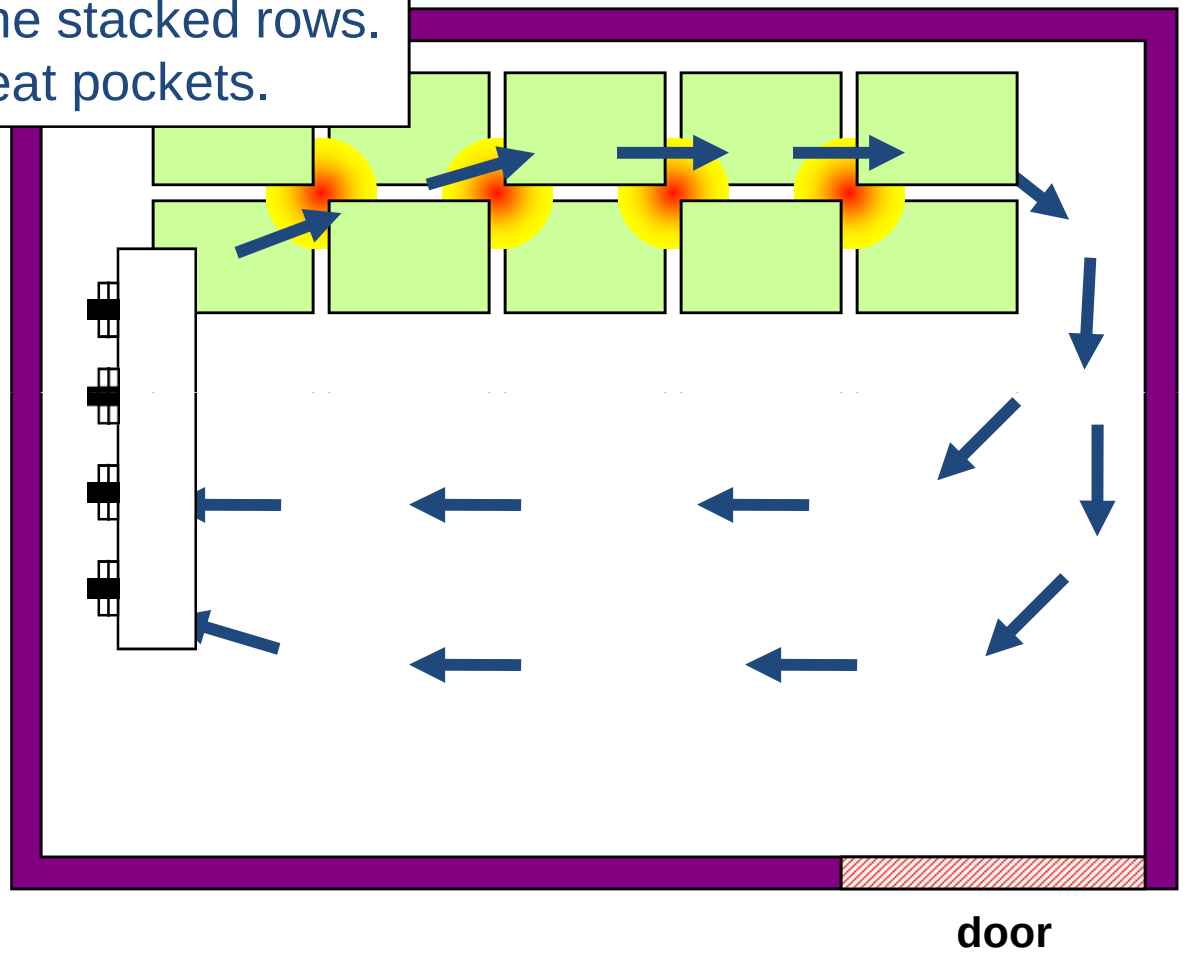
Proper stacking during loading



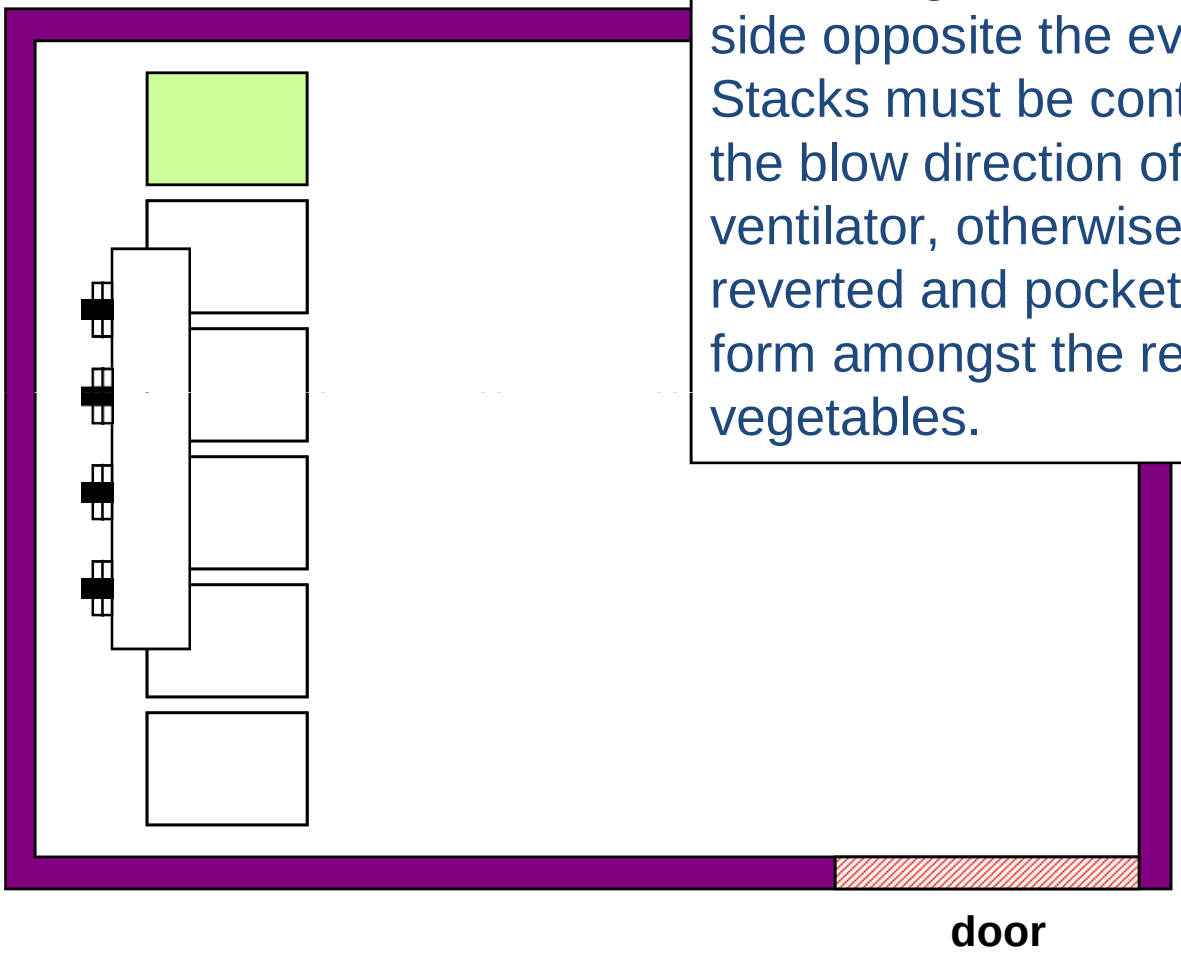
If there are not yet enough vegetables available to form a continuous stacking line under the evaporator, empty cases, covered with sheeting, may be used to fill the gaps.

Incorrect unloading

There is no airflow through the stacked rows. Result: heat pockets.



Correct unloading



Unloading should start on the side opposite the evaporator. Stacks must be continuous in the blow direction of the ventilator, otherwise the air is reverted and pockets of heat form amongst the remaining vegetables.

6. Technical Standards for Ripening Chambers/ Units

Background Facts

It is noticed that ripening chambers which are being set up under various schemes of horticulture development, do not adhere to appropriate technical standards. Main shortcomings noticed are as follows:

- Inadequate building design;
- Use of inadequate / unreliable insulation material
- Use of energy inefficient refrigeration units
- Lack of uniform air flow circulation system
- Lack of controlled conditions and technology for ethylene, temperature and relative humidity
- Lack of proper ventilation systems and exhaust fans for Co 2 emission
- Lack of monitoring and control system and display devices;
- Use of unsafe electrical devices

Technical Param eters for Pressurized Ripening Chamber

- All the applicable latest codes and standards published by the Bureau of Indian Standards and all other standards, shall govern in all respects of design, workmanship, quality, properties of materials, method of testing and method of measurements.
- Generally relevant 'IS specification' and 'Code of Practices' shall be used for all electrical, mechanical and civil works / installation, however, wherever IS code is not available, relevant standard codes of ASME / ASHRAE / IIAR or other International Codes are to be followed.
- Even for Ripening of Fruits and Vegetables' the process as recommended by IS Standards (e.g. IS 11977 of 1987 for ripening of green banana) or as per International Standards should be followed.

Civil Structure – building design

- Structural Safety – Structural design as per BIS Code
- Adherence to local Building Regulations
- Concrete floor with sufficient load bearing capacity
- Chamber size is not smaller than 50 Cu M for preventing building up of high concentration of ethylene.

Ripening Room Dimensions

- Ripening Room dimensions will depend on number of tiers and number of pallets to be stored.
- Number of chambers may vary from four to eight depending on ripening cycle in terms of number of days.
- Chambers will be generally identical in dimension. In low cost solution, one ethylene exposure chamber may be accompanied by single storage hall of, say, four times the size of the former.
- Further Increase in number of chambers in multiple of ripening cycle may be undertaken but situation in which mechanised handling is possible, multi tier ripening chamber is an alternative option available. Number of tiers may go up to three.

Ripening Room Construction

Construction Features

- Ripening Room Chambers should be designed and constructed to hermetically seal with appropriate closures / doors.
- The key feature of ripening rooms is that conditioned air is forced through the product rather than the product just being stored in a temperature controlled room.
- The system passes air though each pallet or series of pallets before returning to the evaporator.
- It is recommended for ripening of fruits in crates and are mandatory for fruits in CFB boxes and single or multi-tier stacking system.
- The airflow within the ripening rooms is to be designed to penetrate all boxes of fruit with an even airflow throughout the room resulting in all fruit being ripened uniformly.
- Recommend air flow is 0.3 cfm per pound of bananas or 2000 m3/ per hour / per metric ton of product.

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- Ripening rooms may be constructed of PUF panels or by application of suitable thermal insulation with vapour barrier and cladding on walls, floor and ceiling of civil structure. In any case, inner chamber surface should be of food grade cladding.

- The insulation envelope shall be designed to ensure that air pressure created by fans does not affect the integrity of the cold store structure or the panel joints.

- The height of wall panels is often such that care must be taken to ensure that adequate stability of the wall panels is maintained. If ceiling support are provided, the Ceiling support system shall be connected to the main structure in a manner which takes into account:

a. The method of supporting the insulating ceiling panels
b. The position of the supports to avoid local over stress within the supports, the suspended ceiling or the main structure
c. The expansion and contraction of the main structure.

Ripening Room Doors

- Ripening doors should be designed for minimal gas leakage. In general.
- For single tier loading, hinged doors, and in some cases, sliding doors are used. The doors should be designed for rugged operation and easy access for incoming and outgoing fruits on pallets.
- When stacking is multi-tier and handling of pallets is mechanised, wider openings of doors are required.
- Care should be taken when positioning doors adjacent to fans to avoid ingress or egress of air as significant changes in store pressure can occur when such doors are opened.
- Where possible the door should be located on the external (warm side) of the cold store insulation.
- Large doors shall be supported by a sub-frame independent of the insulating panels.
- Automatic doors shall open and close promptly and shall incorporate a safety device to avoid injury to personnel or damage to

….continue

- All doors required for means of escape purposes shall be easily and immediately operable from the inside at all times. Doors, which open automatically, are not acceptable for means of escape unless they have a manual override and can be opened manually in the event of a power failure.

- In case of multi tier stacking, doors are rolling up type and therefore, following desirable safety features for doors should be ensured:

a. Internal Door Release
b. Bottom Edge Pressure Operated Safety Stop
c. Cable Break Electrical Safety Stop
d. Spring Break Mechanical Safety Stop
e. Vision Panel with emergency Knock out panel
f. Vertical "D" section flexible seal for effective sealing in condition of reverse airflow for uniform ripening.
g. Door protection by Goal Post Protection which protect door perimeters or Single Fixed Bollards doors suitable for ripening chamber.

Insulation material

- Some manufacturers recommend Rockwool or Polyisocyanurate (PIR) core composite panels for fire proofing. However, Polyurethane (PUR) Foam / EPS / Extruded polystyrene are also used.
- *PUF panels are advisable for ripening chambers*. Minimum 60 mm thick up to 120mm thick (PUF) insulated sandwiched panel (minimum density of 40 Kg / M 3) depending on the design requirements; or any other insulation material having minimum R value of 2.6 M 2 .K / W.
- Floor shall have PUF slab 60 mm (minimum density of 40 Kg / M 3) or any other equivalent insulating material is recommended.
- Covering floor insulation with 100mm concrete is recommended. Floor finish should be smooth with polymer coating so has to be kept clean.

Facing Materials

One of the following coverings may be used; the first three are used more frequently than the others and a minimum total coated thickness of 0,5 mm is recommended.

A vapour seal shall be used on the outer facing of materials, which are permeable, such as brick masonry:

- Galvanized steel sheeting
- Suitable plastic coated galvanized steel sheeting
- Polyester coated galvanized steel sheeting
- Stainless steel sheeting
- Aluminium sheeting
- Aluminium/ zinc protected steel sheeting
- Glass reinforced plastics

Adhesives

- Certain adhesives have a combustible solvent base which can be absorbed by and remain in the panel insulation. These solvents should, therefore, be avoided.

- Certain adhesives should be stored under controlled conditions and the manufacturer's requirements should be strictly observed; many adhesives have a maximum shelflife.

- Adhesives should not have a lingering taint

Temperature & Humidity levels

- Ripening is preferred at a lower temperature but above level of chilling injury. System has to be designed to achieve prescribed ripening conditions in terms of temperature and relative humidity for target fruits. Generally, RH level of 90- 95% is recommended to prevent moisture loss.

Heat Load Calculation and Refrigerant

- Cooling and heating system needs to be designed based on heat load calculation. As per Kyoto Protocol standards, any ecofriendly refrigerant should be used including ammonia, R-134a and R 404a.

Cooling / heating coils and plenum chamber

- Cooling coils are manufactured from Copper or Stainless Steel Tubes and Aluminium Fins. The coils must provide exceptionally large surface area to ensure high natural humidity levels within ripening rooms.
- In case of ammonia as refrigerant, copper tube shall not be used.
- In case of a plenum chamber; cooling coils and fans must be easily accessible via single access hatch located above or at the end of the plenum chamber at roof level.
- Electric heating elements should be used for heating ripening room during lower temperature season as per design requirement and be placed in easily accessible locations.
- Open flame type chamber heating should never be used due to explosive nature of ethylene.
- Fixing of the cooler shall be arranged to avoid disturbance of the ceiling panel support system.

Material to be used for ripening

- Ethylene gas with suitable detection and dosing equipment to maintain ethylene concentration within required levels depending on product (Range 10 to 200 ppm).

Ethylene Generator and Dosing device

- Ethylene may be introduced in ripening chambers in one of the three ways- by using independent ethylene generator with regulator; ethylene cartridges and ethylene-nitrogen mixture (5% ethylene + 95% nitrogen) cylinder.
- Centralized Ethylene supply with Automation for multiple chambers for controlled and safe dosing of ethylene may be preferred for larger units.
- If a generator containing ethanol based solution requires to be moved, it should be switched off, the mains cord removed from the socket outlet, and the manufacturer's instructions closely followed.
- It may be borne in mind that ethylene in concentration above 27000 ppm may explode.

Specification for Air circulation system

- Minimum air flow should be 2000 M 3 per hour, per MT of product ripened at 95%.
- In Ripening Units type-1, air circulation is modified for uniform ripening by introduction of system of Tarp, Tarp/ Lock Sock System / Air Bag for Vertical Air Circulation or Horizontal Air Flow.
- In case of Ripening Units type -2, air circulation fans should have adequate static pressure for uniform air/ ethylene flow through the ventilation holes provided in the CFB boxes/ Plastic Crates / Plastic Bags containing fruits. For this, large diameter, reversible axial flow fans should be installed in the false ceiling accessible via a single access hatch for *air supply under pressure*.

Sensor and Control Devices

- Suitable sensors and controlled devices should be used for maintaining following parameters. For this, temperature & humidity loggers and Ripening Chamber Air Analysis Kit (for Ethylene and CO2 levels) may be used.

a. Temperature
b. Relative humidity
c. Ethylene concentration
d. CO2 Concentration

- PLC device also known as Ripening Room Management System –" RMS" is must in Ripening Unit Type-2. The controller provides total control of the ripening system allowing operators secure and password protected access to following functions

a. Clear real time temperature display and control
b. Fan speed and energy usage
c. Ventilation intervals
d. Relative humidity indicator and control
e. Ethylene level monitoring and regulation
f. Door & Lighting control
g. Pallet loading and isolation

Electrical plug point

- For operating Portable Ethylene Generator, an Electrical Plug point is required inside the room. Metal Clad Plug point in the Metal Socket housing with the independent circuit breaker system, in order to isolate the system independent with the rest of the System, is recommended.

- For centralized gas emission, no electrical connections are required inside the room.

Pallet Racking and Material Handling

- Ripening unit with single tier stacking should have a manually operated pallet lifting and carrying device.
- For multi-tier stacking motorised forklift should be provided. In such cases, in order to assist loading at upper levels, fork lift guides are to be installed to form a centre aisle which are strengthened by back filling with concrete.
- To facilitate loading and centralizing the fork lift truck in the drive in racking, the middle and upper tiers of racking are offset from the lower tier.
- An access ladder is also provided to the rear wall for access to an optional grated walkway at middle and upper pallet levels.

Some Useful Appliances and Instruments

Weighing Scales and Fruit Inspection Instruments such as follow:

a. Weighing Scale
b. Firmness Tester
c. Refractometer
d. Sizers and Callipers
e. Produce Knife

Safety Certification

- Various fire detection and prevention systems and devices are commercially available and use of these is good practice.
- They include detectors for heat and smoke; fixed water-sprinkling system, inert gas snuffing systems, smoke release valves, flameproof barriers, fire breaks formed by the separation of chambers, etc.
- All devices used shall have been tested at low temperatures and shown to be satisfactory.
- Certification for safe storage of ethylene and for system for prevention of ignition and explosion from competent authority, as per statutory requirement, if any, must be taken.
- Similarly, safety for workers against suffocation must be ensured.
- Certification from following Certification Authority is necessary

a. Factory Inspector
b. Fire Fighting Inspector
c. Electrical Safety Inspector

Variation / amendment Clause

- The standards prescribed above are not intended to prevent or discourage variations arising out of new concepts, innovations and R & D in building design & construction, thermal insulation and cooling & refrigeration technology etc.
- However, any variations or deviations from the above prescribed standards must be supported by scientific/ technical details for prior approval of the competent authority, on the basis of merit who may decide the proposal in view of relevant technical details including critical storage requirements, energy efficiency (coefficient of performance), availability of Standards, environmental concerns, safety etc.
- Similarly, periodic amendment of standards for general application may also be undertaken by the National Horticulture Board; in consultation with a committee of subject matter experts duly constituted for this purpose.

बागवानी मिशन
Horticulture Mission

Information Bulletin

(Ministry of Agriculture and Farmers Welfare)

"Centrally Sponsored Scheme for Cold-chain Projects"

सत्यमेव जयते
Ministry of Agriculture and Farmers Welfare

Cold-chain logistics is a thrust area for development, and considered as part of the second green revolution. Cold-chain is an end-to-end logistics bridge and provides for uninterrupted custody of the value harvested at farm-gate, up to end-consumers. The Government of India supports the development of cold-chain through the Mission on Integrated Development of Horticulture (MIDH) of the Ministry of Agriculture and Farmers Welfare. MIDH provides several incentives to interested stakeholders and promoters. Financial assistance of 35% to 50% of admissible cost of projects is granted.

Who can apply: **Private Industry, Entrepreneurs, Cooperatives, Farmer groups, PSUs.**

When to apply: **Scheme is demand driven and can be availed all through the year.**

Where to apply: **Office of local Horticulture Mission or National Horticulture Board.**

Components: **Modern Pack-houses with Pre-coolers, Cold Rooms, Cold Stores, Reefer Vehicles, Reefer Containers, Ripening Units, Alternate Energy, Retail shelves, Vending carts.**

Requirements: Fully funded project with loan sanctioned from a nationalised Bank. Subsidy is directly linked to credit availed to incentivise owners by reducing their credit burden. The supported components are explained in the scheme Guidelines, and should abide minimum System Standards.

Guidelines & System Standards: See www.MIDH.gov.in *or* www.NCCD.gov.in

For more information: Contact the closest State Horticulture Department or your State's Nodal Officer for Cold-chain Development (NOCD).

Benefits of investing in Cold-chain

- Low interest loan from Warehousing Infrastructure Fund (NABARD) -
- 100% FDI through the automatic approval route, and ECB route open -
- Credit linked Subsidy to projects @ 35% to 50% of admissible costs (MIDH) -
- GST exemption for preconditioning, storing, transporting agricultural produce -
- Rewards of endless Demand, Smart-Bridge between rural & urban, reduce Food loss -
- Growing market for Fresh Fruits and Vegetables, domestic and international -
- Option to avail of Negotiable Warehousing Receipts as per WDRA norms -
- Investment Linked 100% Tax Deduction (Section 35-AD of IT Act) -

Issued on Public Interest by the National Centre for Cold-chain Development
www.nccd.gov.in | www.midh.gov.in