THE HORTICULTURE INDUSTRY IN TANZANIA

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SUMMARY AND RECOMMENDATIONS

Fruit and vegetable production and export are becoming increasingly important in the Tanzanian economy. Area under cultivation has increased from 271,000 hectares in 1986 to 354,000 hectares in 1992, equivalent to 5.1% annual rate of growth. Correspondingly, production increased from 4.8 million tons to 7.2 million tons. Export performance was equally impressive. Recorded official export earnings tripled from US$ 680,000 in 1986 to US$ 1.7 million in 1992. Actual export earnings appear to be many times higher because of unquantified under-invoicing and outward smuggling activities. Rough estimates come up with figures as high as US$ 22.3 million for 1992. Tanzania stands to gain by undertaking further liberalization of the trade and exchange control regime to lure unofficial exports to the official system.

The production of horticulture crops is detailed in section II. The country is endowed with good soils and rainfall suitable for the production of various horticulture crops. While production of fruits and vegetables is undertaken in all the 22 regions in the country, areas with highest potential are: Tanga in the Usambara highlands, Kilimanjaro - Arusha in the North-eastern highlands, and Morogoro in the Uluguru mountains. Dodoma region has potential for the growth of grapes and water melon. Total production of fruits and vegetables in 1991/92 was 7.2 million tons grown on 354,000 hectares (Table 1). Estimates for 1993-95 are between 9.5 and 10.3 million tons by year 2000. To realize projected production potential, improvements are needed in horticulture production technology (particularly better seeds), improved rural-urban feeder road network and the growth of privately owned processing plants and storage facilities. *Except for feeder road improvement which will require government mobilization of village communities to inculcate a sustainable road maintenance culture, we expect private agents working with*

farmers to provide the engine of growth in this sector within a framework of an ever improved policy environment.

Domestic marketing of horticulture produce is detailed in Section III. Domestic urban demand for vegetables is currently 153,000 tons per year which gives consumption levels of 30.6 kilograms per capita per year. The demand for vegetables in rural areas is 552,000 tons or 27.6 kilograms per capita per year. These consumption levels are about half the required minimum international nutritional standards. The demand for fruits in urban centers is 107,000 tons per annum equivalent to 21.4 kilograms per capita. The demand for fruits in rural areas is 214,000 tons or 10.7 kilograms per capita per year. With minimum nutritional requirements estimated at 18.7 kilograms per capita per year, rural population in Tanzania does not meet their minimum fruit consumption needs. *A nation-wide educational and promotional campaign is needed to provide awareness of the importance of fruits and vegetables in improving the nutritional quality of food in the country.* The entire national agricultural extension service staff and social welfare workers have to be mobilized to carry out this campaign task on a regular basis. Additionally, a subject on basic nutrition should be introduced in class six and seven to ensure that future Tanzanian citizens are aware of the importance of fruits and vegetables in their regular diet.

Domestic marketing of fruits and vegetables is completely decontrolled. Prices are determined by supply and demand, being lowest during the off-season period. The main problem facing domestic marketing is high crop wastage, often exceeding 20% of the marketable produce and deterioration of produce quality. Improved road transportation network, particularly rural feeder roads, storage facilities, more secure packing materials and a larger number of privately owned processing plants located on

major supply areas are key to improved domestic marketing.

Section IV provides an analysis of the export market. Tanzania has a large untapped potential in the horticulture export market. Over 23 countries import fruits and vegetables from Tanzania (Table 2) from about 30 exporters (Annex 3). But official figures shows an annual average of only US$1.1 million export earnings over the past six years. Given the large number of importing countries and Tanzanian exporters, we are led to believe that actual export earnings are many times larger. *Further decontrol of the import and export trade regime coupled with greater relaxation of foreign exchange controls are necessary. In addition a review of the retention scheme to provide greater and more flexible usage of retention proceeds is urgently needed to provide incentives that would lead to a reduction in under-invoicing and outward smuggling activities.*

The main problem facing horticultural exporters relate to export procedures/regulations which are cumbersome and often frustrate potential investors. Specific recommendations to deal with this and other market problems are discussed in the text. *The government should designate one export support institution, such as the Board of External Trade (BET) to become the nation's one-stop-center for exporter information, registration, licensing and certification of compliance with exchange control regulations.* This procedure should save valuable exporter time and cut red tape.

Equally important if Tanzania is to win a spot in the export market are major drives to improve produce quality, better packaging and labelling as well as high performance in terms of consistency and reliability of supply. Support institutions such as BET, Tanzania horticulture exporters association (TANHOPE) and the chambers of commerce have a vital role to play in terms of supplying market information and assisting exporters to meet the highly competitive export standards.

Annexes 1 - 8 provides some information that should prove

useful to producers and exporters of horticultural produce. Producers with problems in the cultivation of some crops should refer to Annex 1: Horticulture Research Institutes. Traders and exporters interested in the seasonality of supply should refer to Annex 2. Annex 3 lists the horticulture main exporters. Annex 4 provides list of horticulture processing companies. Some promotional institutions which may be of assistance to exporters are given in Annex 5. A list of major importers is given in Annex 6. Annex 7 shows the temperature recommended during transport and storage of horticulture produce. Annex 8 provides useful international standards for maintaining horticulture produce quality.

GENERAL RECOMMENDATIONS FOR HORTICULTURE INTERVENTIONS

1. **The government should designate one export support institution, such as the Board of External Trade (BET) or TANHOPE to become the nation's one-stop-center for horticulture exporter information, registration, licensing and certification of compliance with exchange control regulations.**

2. **The government should review the current export retention scheme to allow 100% retention as well as provide greater flexibility in the usage of retention proceeds so as to provide incentives to increase exports, reduce under-invoicing and curb outward smuggling activities.**

3. **An improved rural-urban feeder road network is a prerequisite for further improvement in horticulture production and marketing. The government should mobilize the resources of the private sector and involve village communities in constructing and maintaining rural roads.**

4. **A nation-wide educational and promotional campaign is needed to provide awareness of the importance of fruits and**

vegetables in improving the nutritional quality of food in the country. This may entail using the entire national agricultural extension service staff and social welfare workers to conduct this educational drive on a regular basis. The success of this campaign may require recruiting and promoting more women to higher positions in the national agricultural extension services.

SPECIFIC HORTICULTURE IMPROVEMENT INTERVENTIONS

5. Increased horticulture production is likely to come from improved husbandry practices and intensification of production to attain higher yields. Consolidation of the fragmented land holdings and speeding up private land title ownership are essential if farmers are to continuously improve farming systems and yields.

6. Lack of adequate processing capacity for horticulture crops is a major problem facing producers. The government should encourage private firms to establish and operate processing plants in the major producing areas. Processing should provide greater incentives to increase production and should result in higher incomes due to sale of greater value-added fruits and vegetables.

7. Improvements in the Tanga port to handle more ships more frequently is essential for further improvement of the export potential from Tanga, Kilimanjaro and Arusha regions.

8. Improvements in the cold room facilities at the Kilimanjaro and Dar es Salaam International Airports and larger freight capacity are essential for improving the country's export potential of horticulture products.

9. An exporter should be issued with a blanket license for a period of one year rather than the current per consignment license. Such a license should specify the horticulture products to be exported. The CD3 form should then be completed at the point of export exit for each consignment.

10. The Ministry of Agriculture and Livestock Development should provide efficient and permanent phytosanitary inspection services at both Kilimanjaro and Dar es Salaam airports as well as at the port of shipment.

11. TANHOPE, the horticulture exporters association, should establish a horticulture information center, funded by contributions from exporting firms and a small fee from other users.

12. The Civil Aviation (DCA) in close cooperation with BET should discuss with the airlines some current disparities in operations and airfreight costs and seek agreement from the airlines that Tanzania's air freight requirements will be met at reasonable cost to the exporters.

13. Kibo Paper Industries should make every effort to improve quality and provide export packaging manufactured from raw paper pulp rather than the inferior recycled paper now in use. The export market is particularly sensitive to poor packaging and fruit damage.

14. For Tanzania horticulture exporters to secure a firm market, high performance is required in terms of quality, consistency and reliability. Exporters should benefit from adhering to the international standards included as annex to this report.

II. HORTICULTURE PRODUCTION

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There are no reliable and accurate overall statistics for horticultural production in Tanzania. Estimates show that a large quantity of what is produced is spoiled and some consumed at home. The residual which passes through the various regional, district and ward markets is known and may be used as an indicative criteria for environmental suitability for crops and existence of farming skills. As Table 1 shows, fruits were grown on about 354,000 hectares producing 7.2 million tons, equivalent to 20 tons per hectare. During the same year in 1991/92, about 192,000 hectares of vegetables were grown, producing 5.2 million tons, equivalent to 27 tons per hectare.

Tanzania is bestowed with good weather, particularly in the northern and southern highlands for the growth of temperate and subtropical fruits, vegetables and flowers. The coastal belt has high potential for production of most tropical fruits and vegetables. However, very little of this potential has been exploited. Major reasons appear to point to lack of market during the harvest period which tend to discourage further production. This in turn may be due to lack of processing plants which would exploit the large production and encourage further production. Other problems relate to poor transportation, particularly from the village to the towns and inadequate research which has resulted in unavailability of seeds and vegetative planting materials of improved varieties.

Given the specific nature of production, the following sections discuss regional production characteristics and assesses potential for further growth in these regions.

TANGA REGION

Six districts make up Tanga region: Korogwe, Pangani, Handeni, Tanga, Lushoto and Muheza. Mean annual rainfall ranges between 400 - 2200mm, with main rains between March and May. Short rains fall between November - December. Mean temperatures are relatively uniform throughout the year. The soils are suitable for various tropical and sub-tropical fruits and vegetables, particularly citrus and mangoes and tomatoes.

Land use and farming systems

Tanga region, like other parts of the country, most production emanates from small farmers who cultivate small plots of vegetables and have a number of citrus and mango trees. Fruit is generally treated as a low input/low labor cash crop, and much of it is sold on the tree.

During the survey, land shortage close to established villages was noticed. Some holdings are fragmented and farmers waste a lot of time travelling between fields. This fragmentation and land shortage has resulted in some reluctance to plant improved mango varieties because these take up a lot of room which cannot be made available on land close to the house. If planted on more distant land, farmers are afraid of risk involved, particularly theft of the fruit.

vegetable production and marketing scheme, based on groups of growers who produced or at least sold their vegetables communally to LIDEP which arranged for collection and marketing, mainly to Dar es Salaam.

Table 1: PRODUCTION FIGURES FOR FRUITS AND VEGETABLES 1991/92

	Area (ha) (000)	Prod. (tons) (000)	Average Yield (Tons/ha)
Vegetables			
Tomatoes	14	440	32
Amaranthus	26	940	36
Cabbages	16	800	50
Aubergines	6	160	27
Sweetpepper	6	154	26
Lettuce	2	7	4
Okra	14	450	32
Onions	49	1100	23
Garlic	7	20	3
Sweet Potatoes	24	1400	58
Irish Potatoes	23	200	9
Hot Pepper	3	6	2
Chinese Cabbage			
Green Beans	2	12	6
Asparagus			
Ginger			
TOTAL VEGETABLES	192	5239	27
Fruits			
Citrus (Oranges)	22	66	3
Pineapples	28	66	2
Mangoes	5	55	20
Avocadoes	2	8	4
Sour Sweet sop	1	7	8
Peaches and Apples	11	97	9
Jackfruit and Breadfruit	2	13	7
Pears	2	280	140
Plums	1	10	10
Hog Plum	1	7	7
Litch and Rambutan	1	1	1
Mangosteen and Durian	1	1	1
Banana	85	1300	15
Papaya	1	22	22
TOTAL FRUIT & VEGETABLES	354	7235	20

Source: RADOs/Ministry of Agriculture

Vegetable production is well developed in the Usambara mountains (Lushoto District). Production here benefitted from a large technical assistance project - the Lushoto Integrated Development Project (LIDEP) from 1970-78. LIDEP organized a

During the LIDEP era, farmers were keen to expand production and many mixed banana/coffee plots were converted into vegetables. Incomes from tea were competitive with vegetables, so tea survived. But despite much assistance to the farmers by LIDEP management, the quantities produced and delivered by each farmer was very small, less than 10 kg on average for each delivery day. This made collection, weighing and administration by LIDEP unprofitable as a commercial venture. The LIDEP scheme collapsed in 1978 largely because of rising overhead costs and loss of confidence of growers. But private traders took over and production of vegetables and fruits expanded. Today the Soni-Lushoto area is a major purchasing center for traders who buy produce for transport to Tanga and Dar es Salaam.

The LIDEP scheme was followed by an extension project which also failed because of lack of inputs and inability to get reliable transport for the extensionists. Currently, the Tanga Integrated Rural Development project (TIRDEP) is assisting fruit tree farmers. TIRDEP is mainly interested in producing and distributing improved budded seedlings.

Several sisal estates in Tanga have now diversified and established commercial citrus orchards, mainly oranges and a few are now in the process of establishing commercial pineapple production.

Present Horticulture Production

Table 2 summarizes production of horticultural crops in Tanga region in 1991/92.

Tanga region is a major supplier of citrus fruits to Dar es Salaam and the northern corridor. Production is most intensive in Muheza District while mango production is common to all districts except Lushoto.

Table 2 : Tanga Horticulture Production 1991/92

Crop	Tons
Oranges	11,000
Mango	6,500
Pineapple	850
Papaw	470
Banana	180,200
Total	199,020

Source: RADO, Tanga

Lushoto produces a wide range of vegetables including: cabbages, tomatoes. (November-March), cauliflowers, salads, chines cabbage, etc. But the survey showed that crops tend to be damaged by the heavy rains in April and the cool overcast weather in the following months lead to a scarcity of vegetables. This result in high prices from May to August.

Muheza district is the leading citrus producer in the region. Main fruits include: Oranges, mangoes and pineapples. Important vegetables include: tomatoes, cabbages, and onions. Tanga district produces oranges, bananas, papaw, pineapples and grapefruit. Vegetables include: spinach, tomatoes, okara, cabbage and eggplant. Korogwe district produces mangoes oranges, bananas and tangerines. Handeni district produces bananas, oranges, mangoes and pineapple. Lack of adequate rainfall hinders large scale horticulture production in the district. Pangani district is not well established for horticultural production because of poor soil conditions and generally poor transportation system. Vegetables are grown on small quantities and caters essentially for the local market for tomatoes, onions and cabbages.

Region peak production seasonal variations are shown in Annex 2.

An Assessment of Potential and Problems

Land: Availability of suitable land large enough to carry out commercial horticulture production is becoming increasingly difficult. *Increased production is likely to come from improved husbandry practices and intensification of production* to attain higher yields. Consolidation of the fragmented land holdings and speeding up private land title ownership are essential if farmers are to continuously improve farming systems and yields.

Transport Almost all main and feeder roads in Tanga region are in very bad condition. This has resulted in high costs of operating vehicles as well as high rate of spoilage which in turn has made payments to producers only 10-25 percent of the urban wholesale price. A prerequisite for further production and marketing is lies in improved road system to the village level.

Tanga has a local airstrip capable of handling propeller aircraft only. At present there are daily flights (except Saturdays) using F-27. The Twin Otters which used to fly through Tanga are on sale by Air Tanzania. Thus, Tanga does not have reliable airfreight capacity which constrains marketing, particularly for the export market.

With respect to sea, Tanga port handles both loose and container cargo. The port has no deep water berths and lighters are used with ships anchoring off. However, the turnaround times are reported to be much better than Dar es Salaam and in some cases as fast as 12 hours. Ships to Europe are fairly regular (average of one per week) with sailings to the middle East slightly less regular. *Improvements in the Tanga port to handle more ships more frequently is essential for further development of the export potential from Tanga region.*

Processing. Perhaps one of the main problems facing the horticultural industry in Tanga is lack of processing of crops produced. The parastatal National Milling Corporation (NMC) operates in canning plant at Korogwe equipped to process oranges, mangoes, pineapples and tomatoes. The plant has a capacity of 8 tones per eight-hour shift. However, the facility is operating at less than half its capacity because of shortages of fruit (NMC offers a lower price to producers than private traders) and cans. There are three other small plants owned by the District Development Corporations (also government owned) but none is functioning effectively. These plants operate at less than a third of their capacity due to outdated equipment, weak organization coupled with poor management, lack of packing materials and shortage of working capital. *Privatizing these public enterprise and encouraging private firms to establish and operate processing plants in Tanga region would result in greater production of horticultural crops and higher incomes resulting from the sale of greater value-added fruits and vegetables.*

MOROGORO REGION

Horticulture production in Morogoro region is carried out in four districts: Morogoro, Kilosa, Mahenge and Kilombero. Mean annual rainfall ranges between 200 - 1000mm. The rainy season extends from December to April with market hot and cool seasons and high sunshine totals. The Kilombero and Wami river valleys are covered with various alluvial or colluvial soils of considerable potential for horticulture production.

Land use and farming systems

Almost all horticulture production in Morogoro region is on small holdings. The only large commercial farm is at Magole, owned by a Dar es Salaam based exporter. Other smaller commercial farms are now being developed.

Mgeta situated on the Uluguru mountains is the major horticulture center. Vegetable growing in Mgeta is supported by small irrigated terraces high up on the slopes about 1,800m above sea level. The Mgeta area had a farmer's cooperative (Technzema) which has assisted in the marketing of their produce between 1952 and 1975 when the coop was liquidated because of high overhead costs and competition from private traders.

Morogoro accounts for about 2% of national production of horticulture, and largely from Morogoro district. Seasonality of production is shown in Annex 2.

An Assessment of Potential and Problems

Transport: Transportation is the major problem facing the horticulture industry in Morogoro. The main A7 road running through the region has been rehabilitated and is in reasonable

condition. Access to the Dar es Salaam market takes 3-4 hours but perishable produce suffer excessive bruising and damage. Transport charges are relatively high, particularly between the villages and the town center. *Improvement of the rural road network is prerequisite for further development of the horticulture production in the region.*

Present horticulture production

Table 3 summarizes the current production levels in Morogoro region.

Table 3: Morogoro Horticulture Production

Crop	Tones
Fruit	
Banana	47,200
Pineapple	11,450
Tangerine	7,600
Mango	6,200
Orange	3,150
Jackfruit	1,700
Lemon	1,450
Guava	227
Sub-total	78,977
Vegetables	
Onion	17,500
Cabbage	11,200
Beans (dry)	19,000
Egyplant	415
Mchicha (amaranthus)	230
Tomato	9,180
Okra	1,285
Peas	3,450
Carrot	250
Green Eggplant	37
Local vegetables	95
Sub-Total	62,642
Total	141,619

Source: RADO, Morogoro

The TAZARA railway passes through the south of region but to-date it appears very little use has been made of this transport system for carriage of perishables to Dar es Salaam or other horticultural produce. As with road transport costs, TAZARA's charges are considered excessive by most traders. The TRC central line passes through Morogoro town but at present trains are reported to be infrequent and extremely unreliable, in part due to frequent floods along the Kilosa route.

Marketing: Morogoro's proximity to Dar es salaam offers great potential for the development of the horticulture sector. In addition, the new capital, Dodoma is just within 3 hours drive from Morogoro town. Both urban centers offers considerable opportunity for the fresh market. To-date Morogoro does not have horticultural does not have horticultural processing facilities which result in large spoilage, particularly during the peak harvest period. The government would need to attract private firms to build and operate processing plants in this region to take advantage of the increasing large horticulture production.

IRINGA REGION

Horticulture production in Iringa region is carried out in the Southern highland zone: Kibau, Njombe and Tandala area. Rainfall is well distributed and averages 500 - 1400mm per year. The areas around Ruaha river are of various alluvial or colluvial soils which are of considerable potential for horticulture production.

Present Horticulture Production

The production of horticulture crops is carried out by small holders. Table 4 summarizes production of horticultural crops in Iringa region and the seasonality of production is shown in Annex 2.

Flowers Production: Two farms are currently growing flowers for sale in Iringa town and Dar es salaam. The main varieties grown include: rose, carnation, water lily, African lily, American lily, fresh flowers, statice, xeranthenum and aster.

Table 4: Iringa Horticulture Production, 1991/92

Crop	Tons
Fruit	
Bananas	12,000
Peaches	6,200
Papaw	7,000
Peas	17,600
Sub Total	42,800
Vegetables	
Cabbages	5,400
Cauliflower	11,000
Onions	8,700
Chinese Cabbage	540
Carrots	13,400
Irish & Sweet potatoes	5,800
Tomatoes	
Sub-total	44,840
Total	87,640

Source: RADO, Iringa

An Assessment of Potential and Problems

Transport: Like in other regions of the country, the feeder road

network is in poor condition. Transport to Dar es Salaam takes about 12 hours which is too long for perishable horticultural produce unless refrigerated or insulated transport is used. At present these facilities are not available. Transport costs are also more significant in this region because of the long distance to the main market - Dar es Salaam.

The TAZARA railway passes through the region but very little is made use of this mode to transport horticulture produce.

Air transport is not available at present and the Twin Otter which used have two weekly flights to Iringa is now on sale by Air Tanzania. But even then, the small aircraft had not freight capacity.

Improvement of the main highway to Dar es Salaam (A104) and the airstrip to allow for large planes would boost horticulture production in the region.

Processing: Iringa has one fruit and vegetable canning plant. A range of products are processed including tomato and fruit juices, canned vegetables, canned fruits, tomato puree, jams and vinegar. Production in this factory is mainly for the local market although surpluses have been exported. The capacity of the plant is 4-5 tones per day of raw materials and operates on average of 200 days per year. The main problem facing the processing plant is unavailability of quality tins cans, caps and closures for plastic bottles. The factor uses old equipment which requires rehabilitation or replacement.

Overall, Iringa region has considerable potential for the production of a wide range of temperate fruits and vegetables and out-of-season produce, especially onions and potatoes. The government would need to assist the region in infrastructure improvement, particularly feeder roads and encourage private

sector participation in large scale production, processing and marketing.

MBEYA REGION

There are four districts which produce horticulture crops in Mbeya region: Kyela, Rungwe, Mbozi and Mbeya. Rainfall pattern in Mbeya is fairly reliable and averages 600 - 1800mm. The rainy season starts in November and ends in April. Mbeya soils are of medium to high fertility which lend themselves to a wide range of horticulture production.

Present Horticulture Production

Production is done by small scale holders. A wide varieties of fruits and vegetables are grown but the quantities are small and hardly make their way out of the region except bananas. Rungwe district produces bananas, tangerines and peaches. Kyela produces mangoes, pineapples, oranges and bananas. Mbeya district produces peaches, cabbages, potatoes, onions and swiss chart. Mbozi produces pineapples, peas and tangerines. Aggregate production in 1991/92 is shown in Table 5.

Table 5: Mbeya Horticulture Production, 1991/92

	Area (ha)	Production (tons)
Fruit	13,600	178,000
Vegetable	7,510	89,250
Total	21,110	267,250

Source: **RADO, Mbeya**

An Assessment of Potential and Problems

Transport: Like in other regions of the country, the feeder road system is poor and needs improvement. The Mbeya - Dar es Salaam highway is in reasonable condition after major rehabilitation under the Integrated Road Project. Road transport to Zambia is fairly easy and some bananas and beans are known to be transported across the boarder to Zambia.

The TAZARA passes through Mbeya but little use is currently being made of this mode of transport.

Mbeya has a small airport but there are no flights to this town.

Processing: The Kyela District Development Corporation operates a small canning factory. At present only pineapples and citrus are processed. Mbeya has also a vegetable canning factory but its operation has been stopped pending repair of machinery.

Overall, Mbeya region has a very high potential for producing a variety of horticultural crops. Major outlets would include Zambia, Dodoma and Dar es Salaam for out-of-season produce. Already at full capacity, the processing plants in the region cannot be supplied adequately. The introduction of high-yielding varieties combined with modern intensive farming would improve production and meet regional demand while offering surplus produce for export. Supply to distant places like Dodoma and Dar es Salaam requires the development of commercial transport system and marketing channels that use cold stores and refrigerated vehicles to minimize loss and keep produce in top quality.

ARUSHA REGION

In Arusha, the highland areas around Oldeani, Babati, Hanang, and around Mount Meru (Arusha and Tengeru), have a high potential for horticulture production. Annual mean rainfall in these areas ranges between 800 - 2500mm. The rainy season occurs between March and May. The short rains fall between November and December. The soils around these areas are of volcanic origin which make them suitable for various types of fruit and vegetables. Much of the rest of Arusha region is occupied by weakly developed soils and low rainfall which does not allow continuous arable cultivation but more suitable for livestock farming.

Land use and the Farming System

Arusha has very fertile area where agricultural production is carried out on a continuous basis. Arumeru district, around Arusha town, and onwards on the Moshi road, there are large numbers of smallholders producing vegetables - cabbages, onions, tomatoes, which they supply to the local urban market. Around Mount Meru, bananas are interplanted with coffee on smallholdings. Bananas are the main staple food for the population living in this area. Large scale production is also carried out through estate farming largely coffee. Seed beans, flowerseeds and many beans are grown under contracts between small growers and various seed companies. At present one farm produces cut flowers and exports foliage to Holland.

A European Export Scheme was organized by NAFCO in the 1970s but performance up to now is unsatisfactory. At present one exporter is organizing small producers to produce green beans for exporting to the Belgium market.

Present Horticulture Production

Arusha is a major supplier of onions to Dar es Salaam, Mwanza, Shinyanga and Tabora urban markets during August and October. Rapid urbanization of Arusha has meant that a larger amount of fruits and vegetables grown is consumed within the region. Some farmers have found a ready market in the growing tourist industry, supplying hotels and ledges on contract.

The region produces tomatoes, onions, cabbages, carrots, sweet pepper and cauliflower. Lettuce , cucumber are grown to meet specific hotel requirements. The region is a net importer of fruit-citrus and pineapples from Coast, Morogoro and Tanga regions. The only fruit grown in small quantities are papaws and mangoes.

Table 6: Arusha Horticulture Production, 1991/92

	Area (ha)	Production (Tons)
Vegetables	2,700	38,340
Fruits	640	9,605
Total	3340	47,945

Source: RADO, Arusha

Flowers/Foliage

One company located in Nduruma in Arusha is producing and exporting cut foliage to Holland. The company is currently experimenting on the production of a wide range of species including: Euphorbia variegate, Ammi majur, Statice and Dill. The company plans to introduce the specie Alstroemesia which has great market potential but requires heavy initial investment.

This company has its own technical experts (one from Holland) and cold storage facilities. Irrigation using a nearby river is being practiced and specially designed packaging boxes are manufactured under contract with Kibo Paper Industries. The company exports twice weekly - through KLM Amsterdam and Sabena via Brussels. Exports are effected from Mid-September to the end of May. Airfreight space has so far been the main constraint for further exports from this company. Plans are underway to investigate the potential for using a chartered aircraft to achieve higher reliability of exports.

An Assessment of Potential and Problems

Arusha region has not yet realized its potential in the production of fruits and vegetables. Areas of great potential but which produces very low levels of production now include: Bashnet/Madunga area in Hanang district for temperate fruits; Kainam and Mummay areas in Mbulu district for temperate fruits; Mbuguni in Aru-Meru and Magugu/Babati in Hanang district and some parts of Kiteto district for citrus, pineapples and vegetables under irrigation; and Mto wa Mbu-in Masai district for bananas, vegetables citrus and pineapples.

Road communication in Arusha region, at least in those areas with horticulture potential, is better than in other regions. Air freight is done through Kilimanjaro International airport. At present airfreight capacity is only 11 tones per week to Europe but the situation is expected to improve as more aircrafts operate enroute KIA.

At present there are no processing plants for horticulture produce in Arusha Region but as production improves private firms may be interested in taking up that opportunity.

As the airfreight capacity at KIA improves, perhaps with

improved tourist industry bringing in a greater number of tourists, Arusha region has a great potential for exporting horticulture produce.

KILIMANJARO REGION

The area located on the slopes of Mount Kilimanjaro - the districts of Hai, Rombo and Moshi together with some as in Pare district have a high potential for the production of horticulture products. Rainfall ranges between 400mm in the lowland to 2200mm in the highlands. The soils are of volcanic origin, and fertile. With a large number of small rivers, irrigation can be practiced in some areas of this region.

Land use and farming systems

Bananas which are grown by small holder is the most important horticultural crop grown in this area. Bananas are also the main staple food. Bananas are intercropped with coffee.

Vegetable production is grown by small holders, largely on irrigated channels and on riversides. Early crops come into the market in June and July and the main crop between August and January.

Fruits grown in the region is consumed largely within the region: lemon, guava, avocado, custard apple, peach, mulberry and loquat.

Present Horticulture Production

Apart from those produce listed above, the following are becoming increasingly important: Lettuce, pumpkins, beans, peas, okra, cucumber, capsicum, cauliflower and leeks.
Table 7 shows the aggregate production in 1991/92.

Table 7: Kilimanjaro Horticulture Production,1991/92.

Crop	Tons
Vegetables	
Potatoes	24,000
Tomatoes	12,500
Spinach (Mchicha)	350
Cabbage	13,400
Onions	17,300
Egg plant	415
Carrots	250
Sub-total	68,215
Fruits	
Bananas	105,000
Mangoes (mainly in Pare)	9,400
Avocado	650
Sub-Total	115,050
Total	183,265

Green Beans: A joint venture company between a Tanzanian and Belgium company is currently exporting beans to Belgium by air. Production is carried out by local small farmers and estate farmers under a contract. The venture company is currently investigating market potential for various fruits and vegetables and some of the results so far are worth reporting: Tanzania mangoes were found of great potential to fill a seasonal gap during Christmas and New Year but European markets preferred to go for traditional markets to fill this gap. Plums from Lushoto appeared to have a good market but transport from Lushoto to KIA made them too expensive. Passion fruit from Lushoto and Kilimanjaro were found to have a good market potential but the quantities being produced were found to be too small. Okra has a potential but the variety currently being grown was rejected in favor of a better variety.

Currently, the venture is concentrating only with bean export. The firm has an expatriate production manager, an agronomist and several Tanzanian horticulturalists. Currently, the firm has contract with 11 producers. The Kenyan variety of green beans is grown and farmers who are under contract are supplied with seeds, fertilizers and approved chemicals. Grading takes place at the farm and only top quality produce is exported. A target of 5-10 tones per week is planned, depending on airfreight capacity. Charter flight is under consideration, with likely involvement of the flower producers in Arusha to reduce cost and maximize profit.

An Assessment of Potential and Problems

Kilimanjaro has not yet attained its potential for horticulture production. The region has good soils, climate and availability of irrigation water which are essential for the production of a wide range of horticulture crops. The potential for Kilimanjaro farmers is as follows: Oranges and pineapples grown for the local market which now gets these fruits from other regions to fill unmet demand. Regional trade prospects lies in the production of potatoes, bananas, tomatoes, onions, peas and carrots. Kilimanjaro could also supply tomatoes, mangoes and citrus fruit to the Korogwe plant, particularly, following the improved road network between Moshi and Tanga. Export of vegetables to Mombasa and Nairobi in Kenya now in small quantities, could be increased in volume and quality. Exports of horticulture produce to Europe and the mid East have a particular significance as volumes packaging and quality improves.

Kilimanjaro has not developed a marketing structure conducive to horticulture exports. As airfreight possibilities improve, horticulture production could be developed as a diversification crop on coffee farms and a major crop for improving farm incomes.

COAST AND DAR ES SALAAM REGIONS

The Coast and Dar es Salaam regions have a combination of climatic and environmental factors which make them particularly suitable for various types of horticultural products. Soils bordering the Rufiji and Ruvu rivers are of riverine alluvial with considerable potential although flood control and drainage are important to realize qood results. The average rainfall is around 1000-1300mm on the coastal belt while further inland, rainfall drops to an average of 700mm per annum. The peak rains falls between March and May with short rains from November to February.

Land use and farming systems

The production of horticulture within Dar es Salaam is on small scattered plots, mostly in the form of vegetable gardens. Production is mainly for home consumption and sale to the urban center. The production of vegetables is fragmented and largely confined to the rainy season and sometimes supplemented by irrigation.

Commercial horticulture production is carried out in Kisarawe and Kibaha. The main crop is tomatoes which has a ready market in Dar es Salaam. Kisarawe district is also the main fruit production area and production is concentrated on a few individuals with 20-40 trees.

Present Horticulture Production

Table 8 summarizes horticulture production in the Coast Region in 1991/92.

Table 8: Coast Horticulture Production, 1991/92

District	Crop	Area (ha)	Production
Kisarawe	Oranges, Pineapples Vegetables	487 425 281	5846 4250 843
Rufiji	Oranges Pineapples Vegetables	450 15 237	5850 150 711
Bagamoyo	Oranges Pineapples Vegetables	207 700 150	2691 7000 450
Mafia	Oranges Pineapples Vegetables	63 3 24	819 30 72
Kibaha	Oranges Pineapples Vegetables	182 312 106	2366 3120 318
	Total	3641	34,516

Source: RADO - Coast Region

The production of pineapples totals about 14,550 tons per year. The region has considerable potential because it does not experience cold night temperatures and the fruit is very sweet with high sugar content. This characteristic renders it susceptible to fermentation and rotting after harvest which demands prompt marketing. Several exporters have sent trial shipments to Europe and the fruit has been well received except on size. Obtaining uniformly graded fruit has been a problem because of the large size of small producers.

One large exporter is currently preparing a 1200 hectare farm of pineapples for export to Europe and the middle East. The firm plans to process surplus into concentrate for bulk export.

An Assessment of Potential and Problems

Although the Coast Region has particular advantage in its proximity with Dar es Salaam, horticulture production is not well developed and production is largely seasonal. the scope for further production is wide, particularly in Kibaha and Kisarawe districts.

Currently, the National Milling Corporation operates a juice processing plant in Dar es Salaam known as TANGOLD. The plant is operating at below capacity. Mango, orange and pineapple juices are produced in TANGOLD. Production at the factory follows the seasonal availability of fruits. Mangoes from October to March and oranges from April to August. No effort has been made to take advantage of the seasonal production in other areas of the country. The capacity of the factory is estimated at 8-12 tons of fruit per day or 220 tons per month. With increased production of horticultural produce in the Coast region, the local market stands to gain as well as improving capacity utilization at TANGOLD.

A major problem in the evacuation of horticulture produce has been poor feeder roads, particularly Kisarawe to Dar es Salaam. Lorries are reported to charge high transport fees which make produce from these locations uncompetitive. *A precondition for further horticulture production in the Coast may well be priority efforts to improve feeder roads in the region*.

Dar es Salaam is served by an international airport which handles both local and international flights. Airfreight capacity is estimated at 31 tones per week, largely on passenger flights and up to 115 tones per week on cargo flights. This capacity is small compared with the large and growing number of exporters who would like to airfreight their produce. *Improvements in the cold room facility and larger freight*

capacity are essential for further development of the horticulture industry in Tanzania.

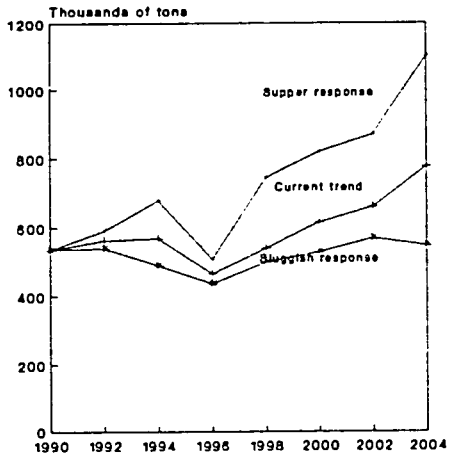
Some exporters are now using the Dar es Salaam port which handles both loose and container cargo to the middle east and the rest of the world. Improvements now being made at the Dar harbor should be valuable in the future development of the horticulture industry in Tanzania.

Supply Projections

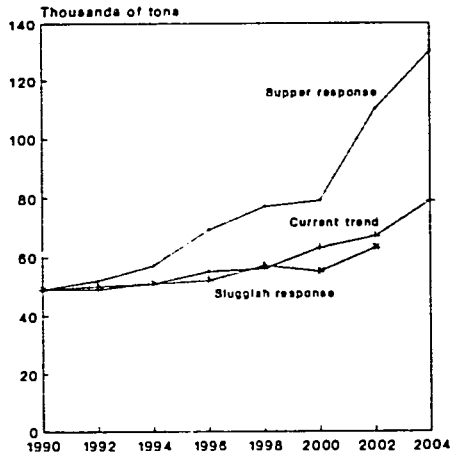
Figures 1 - illustrates supply response projections for some important fruits and vegetables. The "super response" option assumes a major government drive to support the horticulture sector in collaboration with NGOs and other private associations such as TANHOPE as well as improved policy environment particularly further export-import liberalization. The "current trend" option is merely historical trends projected into the future assuming normal weather patterns. The :sluggish response" assumes a lack of support to the sector and a policy environment that extracts rent from the sector without complementary investment in it either through market information, research, extension or promotional facilitation.

FIG. 1: HORTICULTURE SUPPLY PROJECTIONS

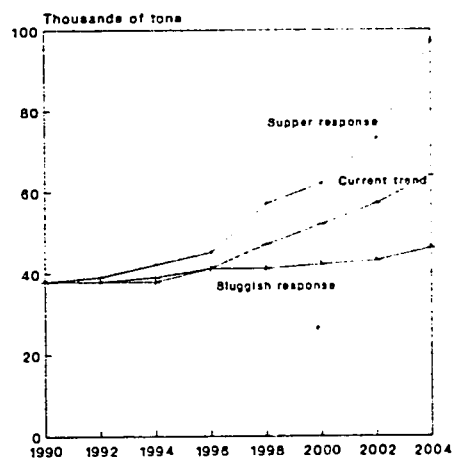
ORANGES



BANANAS



APPLES



MANGOES

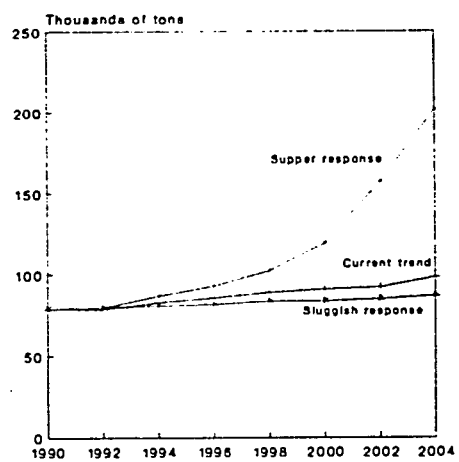
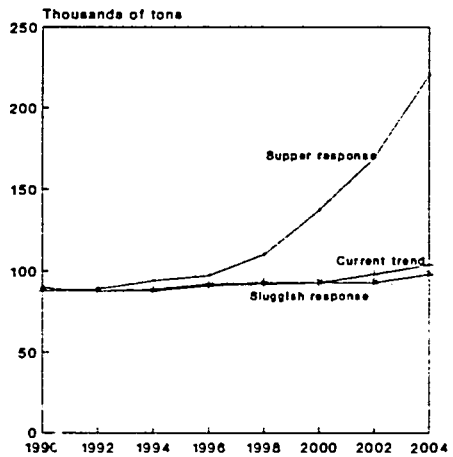
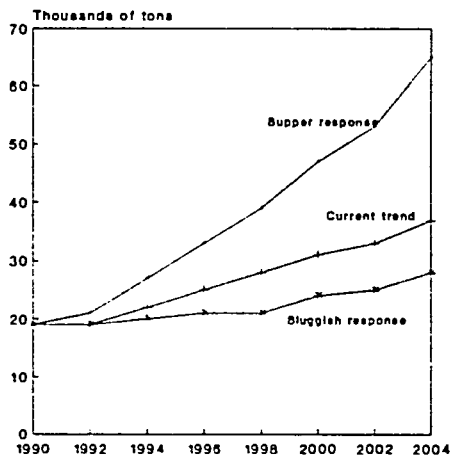


FIG. 1: HORTICULTURE SUPPLY PROJECTIONS

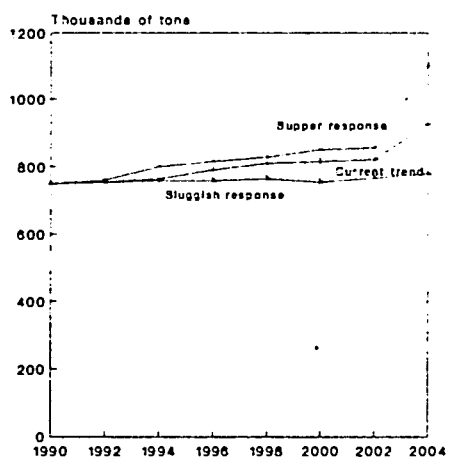
PAPAYA



TOMATOES



ONIONS



PINEAPPLES

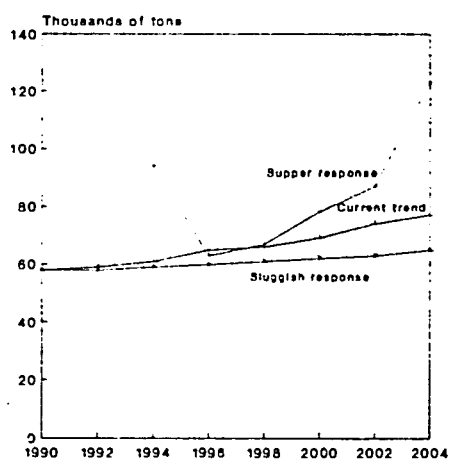
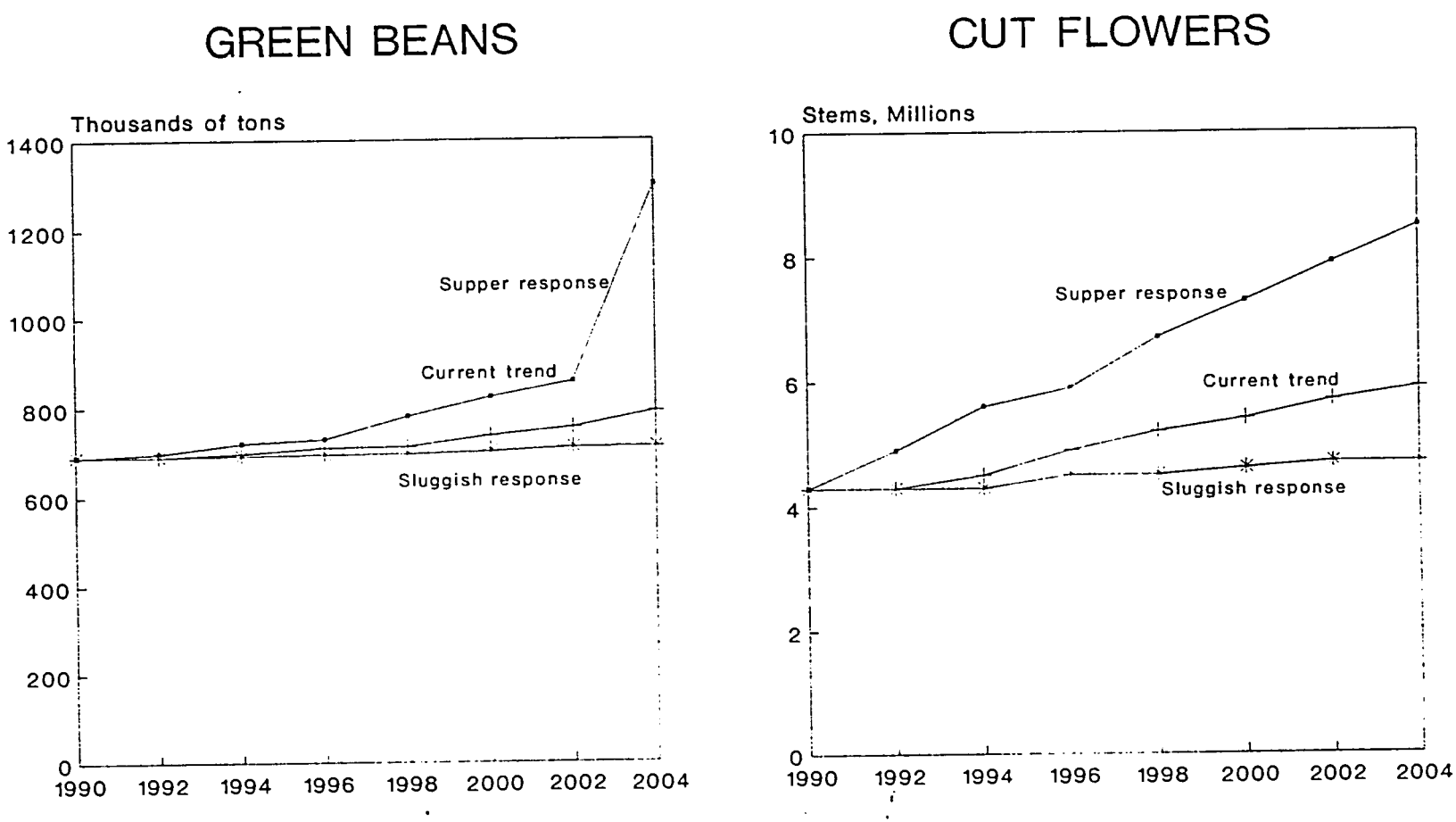


FIG. 1: HORTICULTURE SUPPLY PROJECTIONS



III. DOMESTIC MARKETING OF HORTICULTURE PRODUCE

III. DOMESTIC MARKETING OF HORTICULTURE PRODUCE

Introduction

Information on the internal trade of horticulture crops is scanty and unreliable. There are no known institutions which collect data on various aspects of horticulture marketing. The marketing Development Bureau conducted a couple of market surveys in the 1970's but regular follow-up have not been undertaken. Over 60% of the domestic marketing of horticulture takes place at the village level market centers. Except in Dar es Salaam and urban towns, there are no known wholesalers of horticulture crops. Most of the trade is conducted by small traders using very low technology.

National Demand

The demand for horticulture produce is stronger in urban centres than in rural areas. Urban consumption of vegetables is estimated at 30.6/kilograms per year while in rural areas consumption is at 27.6 kilograms per year. These consumption levels are about 50% of the required minimum international nutritional standards. Tomato is the most important vegetable in the national diet, followed by mchicha (spinach). The rural areas consume a wide range of vegetables, both cultivated and wild but not enough to meet nutritional needs. Urban consumption is concentrated in three main vegetables: tomato, spinach and onion. These account for almost two thirds of the total consumption.

The consumption of fruits is much better in urban centers than in rural areas. Rural households per capita consumption averages 10.7 kilograms per year compared to 21.4 kilograms per year in urban centers. With a standard per capita requirement of 18.7 kilograms per year, rural areas do not meet minimum

requirements for fruit consumption. This is partly explained by the traditional belief that "fruit is food for children". In rural areas almost 50% of the consumption is ripe bananas, followed by mangoes (15%) and papaya (9%). Urban consumption is spread over a wide range of fruits, citrus being the leader in demand followed by ripe banana, mangoes and pineapples.

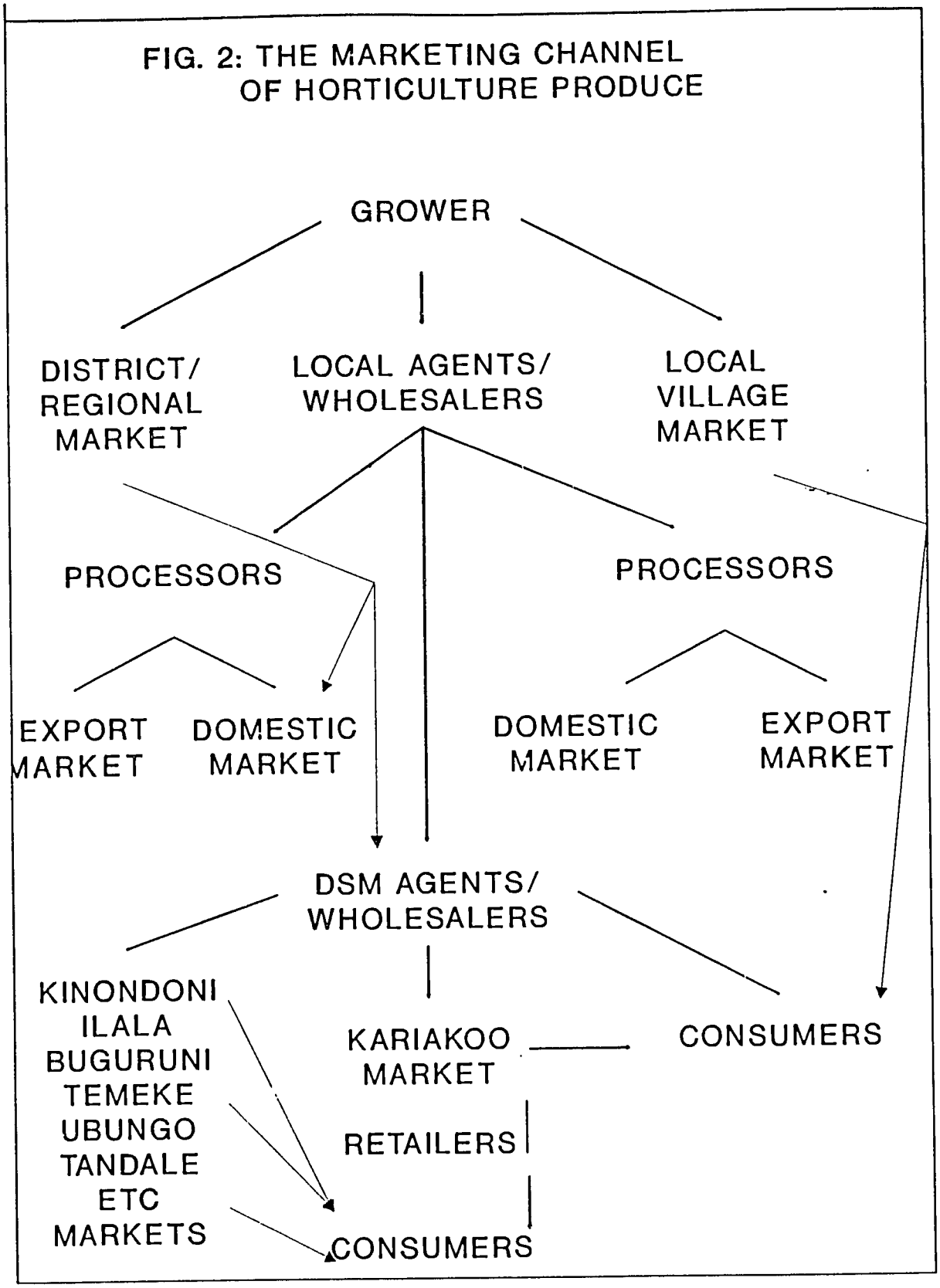
Marketing Channel

Generally, the marketing of horticulture produce moves from the individual farmer to private agents or middlemen or directly to consumers. Figure 2 illustrates the marketing chain for horticulture produce.

In most cases, growers do not sell directly to urban consumers. Most of the farm produce is sold at the village road-side market or village/ward market centre. Retailers buy from these local centres to supply to urban markets.

In some cases, such as in Tanga region, almost 75% of the farmers sell their horticulture crops on the farm or even on the tree before the crop is harvested. The harvest is done by the trader who contracts several farmers so that he/she may have a sizeable consignment. The farmer is paid correspondingly less than if the harvest and initial packing were done by him/her.

FIG. 2: THE MARKETING CHANNEL OF HORTICULTURE PRODUCE



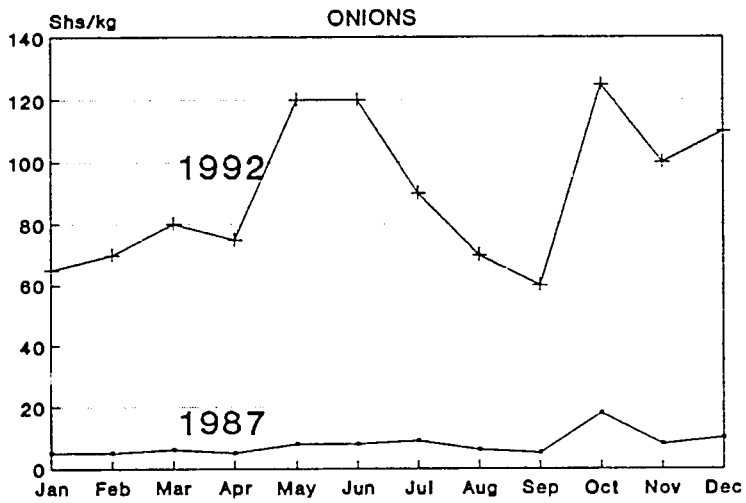
Unlike other urban markets, Kariako market receives almost 50% of their horticulture products from farmer direct deliveries in hired buses and trucks.

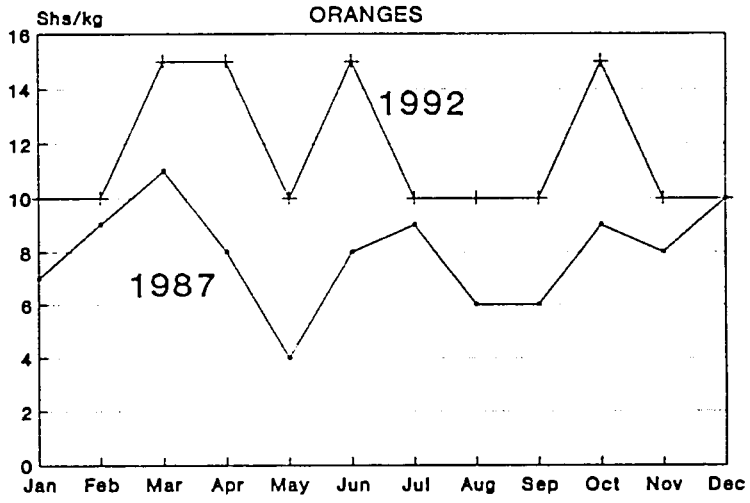
Transport At the village level, most of the transportation of horticulture produce to the village market is done using the family members or simple wooden wheelbarrows and very rarely small one-ton trucks. Transport to urban centers is by the local buses, trucks or bicycles. Transport costs account for over 50% of the horticulture gross value per unit. For example, to hire a 7-ton truck, one-way from Lushoto to Dar es Salaam to deliver oranges to the Kariakoo market costs an average of Tshs. 90,000 (1992 prices). This is about 65% of the value of the entire consignment delivered.

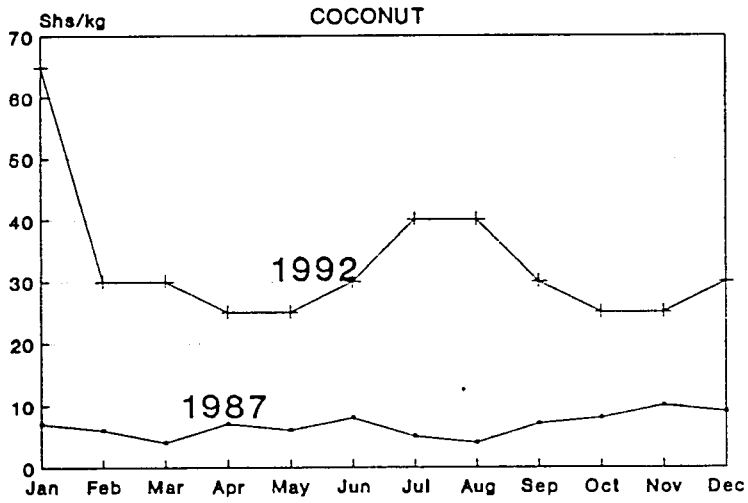
Price Trends

Farm gate prices of horticulture produce are 30-40% of the consumer price. Generally, prices fluctuate according to supply. Prices are lowest during the peak harvest period (See Annex 2). Figure 3 shows the consumer price trends for six most important fruits and vegetables in Tanzania's domestic market: onions, tomatoes, oranges, coconut, cabbages and potatoes. Prices on

FIG. 3: PRICE MOVEMENT OF SELECTED HORTICULTURE CROPS







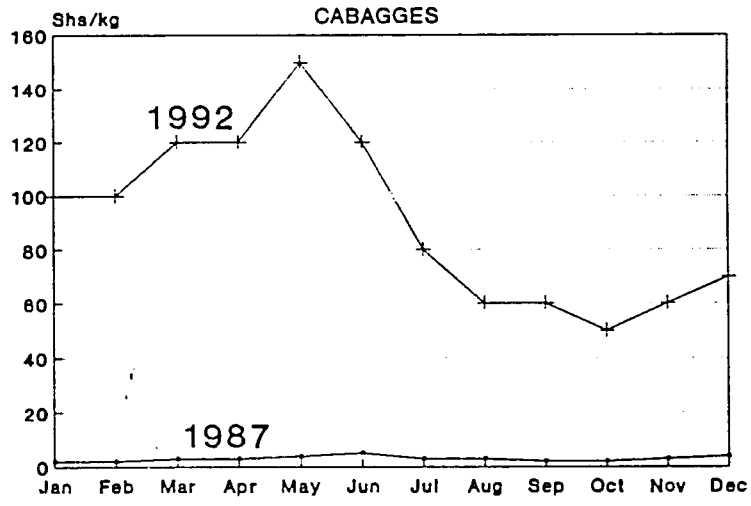
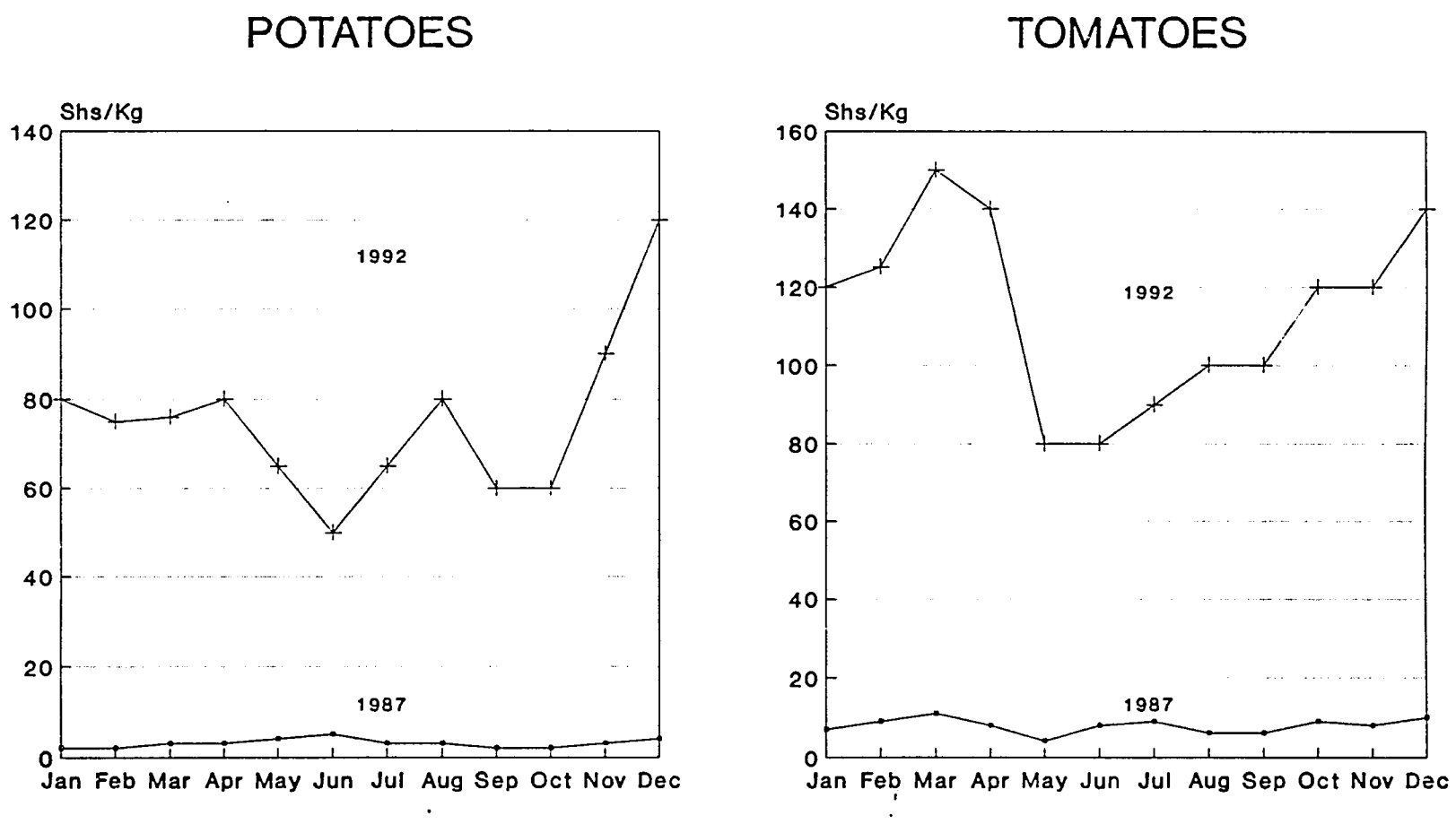


FIG. 3: PRICE MOVEMENT FOR SELECTED HORTICULTURE CROPS



average have jumped by more than 15 times between 1987 and 1992. This is explained by continuing rises in fuel costs which have pushed up transportation costs, loss of value of the shilling due to frequent devaluations and other general increases in the cost of living.

Storage and crop waste

Perhaps the greatest problem facing the horticulture sector is the serious loss of produce in all stages of the marketing chain. Crop spoilage or serious deterioration in quality at the farm level is estimated at about 20% of harvested output. The habiyt of harvesting only when a buyer shows up in some regions account for this large loss - weather, insects and birds are major destroyers of horticulture produce if harvested too late. Sometimes for citrus fruits, these are left to rot on the tree if a buyer does not show up. An effective extension service coupled with the establishment of privately owned processing plants in major producing areas would greatly reduce waste and spoilage.

Spoilage in urban centre markets is equally bad, estimated at 10% of total quantities entering the market for sale. The spoilage and rapid deterioration of quality occurs because the stalls where the produce is sold have no temperature controls and are often exposed to the scotching sun. Improvements in proving shade to the stalls and greater ventilation may reduce the rate of quality deterioration - but in the absent of "supermarket-like" cooling system and temperature, control quality deterioration is likely to continue to exist.

Firms interested in marketing horticulture produce stands to gain by investing in on-farm village storage facilities and transport facilities that are specifically designed for transportation of horticulture produce. The firm is likely to enjoy higher off-season prices and reduce spoilage costs.

IV. TANZANIA HORTICULTURE EXPORT

Additionally, there is need to improve the cartons and crates used to transport the horticultural produce.

Summary

Domestic marketing of horticulture produce is completely decontrolled and follows market demand and supply. Perishability and seasonality of supply determine observed consumer prices, with transport costs the main component in the price structure. Deterioration of quality and wastage are high, demanding improved transportation systems, particularly rural roads, better storage facilities and more secure packing materials. Because of the many small players in the horticulture business, we believe the intense competition has instilled market efficiency and we see no reason to recommend the establishment of support institutional arrangements. Sometimes, putting in place an institution to do the work of market demand and supply functiosn may become an obstacle to the further improvement of the marketing aspects of horticulture produce. Market forces given the chance to operate without much government interference should provide correct signals to producers and consumers of horticulture products.

IV. TANZANIA HORTICULTURE EXPORT

Introduction

In the past six years, Tanzania's exports of horticultural fresh produce has made a major expansionary thrust. This growth is largely explained by the government's effort to liberalize the economy and the major changes made in the country's investment policy - particularly the movement away from government monopoly to private enterprise. Tanzanian exporters have survived major competition from traditional suppliers and have gained valuable experience. Additionally, foreign investors who established production of cut flowers and green beans in the late 1980's have

expanded considerably in the past 12 - 18 months and are likely to be a valuable asset in Tanzania's entry to the export market. In 1992, two new foreign investors have become established in the Arusha - Moshi area and are expanding business rapidly. A joint venture company in the Arusha area plans to grow a wide range of horticulture export crops in 1993. These are good signs and indicate Tanzania's large untapped potential.

Export Volume and Earnings

Recorded export earnings of horticulture products have tippled between 1986 and 1992. The value in 1986 was US$ 680,000, jumping to US$ 1,050,000 in 1990 TO US$ 1,775,000 in 1992. From the survey, it appears the figures are way off from actual export earnings. Estimates of actual earnings shows a rise from $8.6 million in 1986 to US$ 22.3 million in 1992. This could also be an underestimate because some economic observers think that horticultural products make up almost one quarter of the total non-traditional exports. If non-traditional export earnings are estimated at $300 - 400 million in 1992, horticulture produce should contribute much more than the recorded earnings.

On average recorded export volumes have been 1,000 - 1500 tons per year. It is estimated that in 1992, the total will be 2000 tons, rising to 5,000 tons in 1993 and to 7700 tons by 1994. Between 1995 and 1998, export volumes of horticulture produce should be at least 10,000 - 15,000 tons if the current major export drive is sustained.

Market for Tanzania Horticulture Produce

Over 23 countries import Tanzania's horticulture produce. Table 9 illustrates the destination and average prices ruling in those markets. Prices fluctuate according to supply and demand, almost on a daily basis.

Table 9 Export Market Destination and Prices

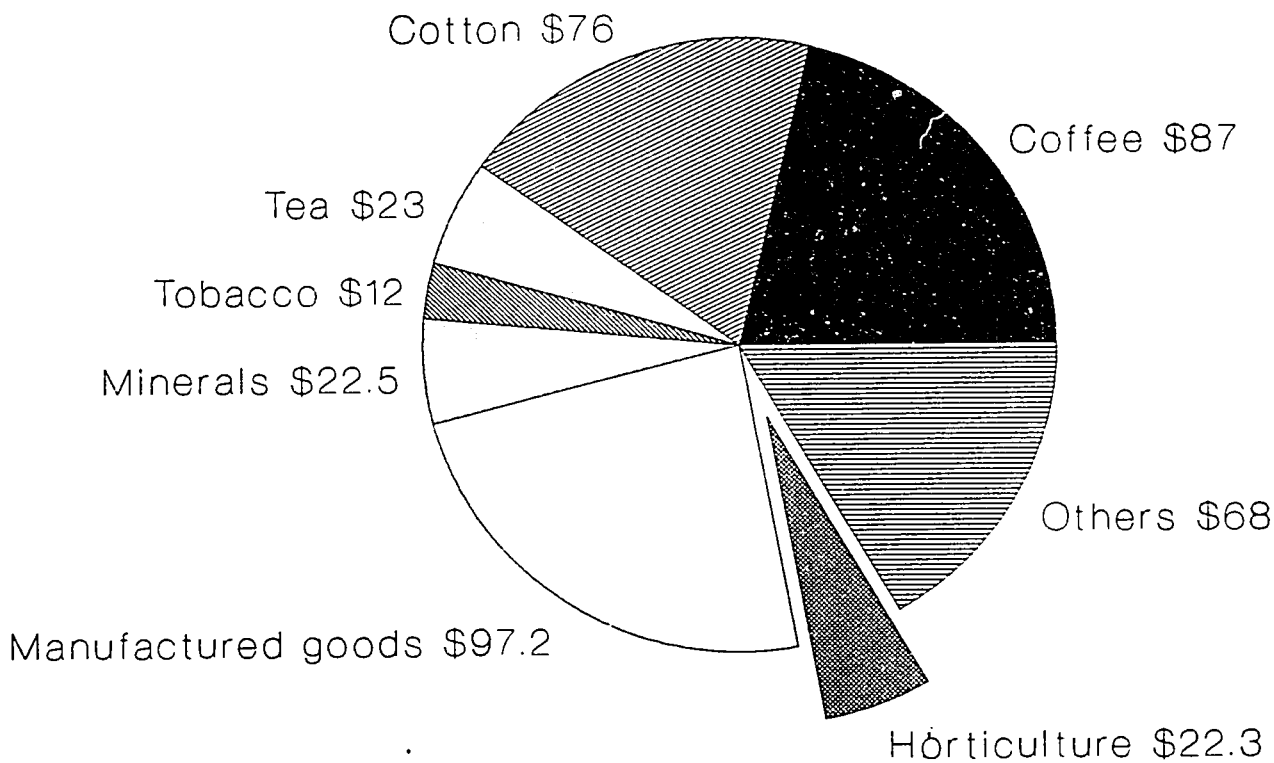
Product	Market/Destination	Average price C&F (June-Dec. 1992) US$ per kg.
Mangoes	Denmark	1.55
Avacadoes	U.K	1.25
Pineapples	Swiss	1.34
Papaya	Denmark	2.75
Okra	U.K.	2.25
Chilies (fresh)	U.K.	2.00
Chilies (Dry)	Middle East	1.50
Fresh green beans		
- French beans	U.K.	2.10
- Bobby beans	U.K.	1.50
Coconuts	U.K.	0.15
Apple	Germany	1.75
Plantain/banana	U.K.	1.15
Sweet potatoes	Swiss	2.00
Passion fruit	U.K.	2.25
Lime	Finland	2.85
Rambutans	U.K.	6.15

Source: Board of External Trade

The current main markets for processed fruits, jellies, purees and paste are: Germany, Belgium and Saudi Arabia.

Among African markets, Kenya is the largest importer. Others include: Zaire, Burundi, Botswana, Seychelles, Comoros, Zambia, Malawi, Ivory Coast and Somalia. Recorded imports of horticulture produce exported to Kenya earned Tshs. 8.5 million in 1991. Unrecorded border trade with Kenya is estimated at Tshs. 15 million during 1992.

FIG. 4: MAJOR TANZANIA EXPORTS, 1992 (Million, US$)



Source: Bank of Tanzania

Table 10: Current Market for Various Horticulture Produce

Product	Destination
Fresh beans/peas	Saudi Arabia, Holland, United Arab Emirates
Pineapples	Germany, France, Italy, Saudi Arabia, Sweden, Holland, Britain, United Arab Emirates, Portugal, Singapore, Kenya, Zaire
Mangoes	United Arab Emirates, Germany, France, Singapore, Kuwait, Holland, Sweden, Belgium
Avacado & Guava	Saudi Arabia, United Arab Emirates, Kenya
Fresh Citrus	Britain, Belgium, Sweden, United Arab Emirates, Saudi Arabia, Germany, Kenya Zaire
Coconuts, Brazil Nuts (Fresh or dried)	United Arab Emirates, Germany, Netherlands, Saudi Arabia, Singapore, Britain.
Processed fruit, tomato juice, vegetable juice	Netherlands, Britain, Belgium
Fresh onions	Kenya, Italy, Canada, India, Britain, Somalia.
Plants/seed/flowers/ fruit & spores for planting	Netherlands, Switzerland, Australia, France, Germany.

Note: Volumes of exports are very low to any of the markets and regularity of supply is still a major problem.

Source of data: Tanzania Customs & Excise extracts.

Export Procedures for Horticulture Produce

For the seasoned exporter, the procedures are fairly

straight forward. But for many starters, these have become a nightmare, showded with bureaucracy, paper work and considerable delays.

Registration The potential exporter must be formally registered either as an individual or company and have a bank account. Once this step is over, the potential exporter will have to apply to the Board of External Trade (BET) for authority to export. If granted, the BET authority to export is then registered with the Bank of Tanzania (BOT). Once this procedure is completed, the exporter will write to his/her own bank (NBC or CRDB etc), requesting them to arrange with a foreign bank regarding retention accounts for produce exported. During this period, the exporter will have to specify whether he/she is applying retention under the SIDA seed Capital Revolving Scheme or the National Scheme which provides for a 50% retention for all exporters of non-traditional commodities.

Observation: These basic registration procedures are relatively simple and are not time consuming. There should be no complaint on these registration procedures.

Exporting: Problems begin when the potential exporter, once registered, wants to effect an individual consignment. Some exporters have expressed frustration at the number of places they have to visit before exporting and the large paper work. Following are the hurdles each exporter meets on his way to export a consignment:

- First exporter obtains a form CD3 from BET or NBC.
- Second, the exporter takes the completed form (CD3) to BET who agree on the value of the produce, and issue an export license for a specific quantity.

- Third, the exporter takes the completed CD3 form to his

Bank, together with the exporters invoice or other evidence of price and the BET license. The Bank certifies that exchange control regulations have been met, gives back pages ½ to the exporter and retains pages 2/3, 3/4 and 4/5 for subsequent action.

- Forth, the exporter prepares his consignment exactly as specified on the CD3 form. Then his consignment is inspected by MALD and a phytosanitary certificate is obtained if the produce meets required standards. After this stage, the consignment is presented to customs officials for clearance. Customs returns the stamped CD3 to the exporters local bank.

- Fifth, the exporters local bank returns the CD3 form, pages 3/4 to Bank of Tanzania. If the exporter is operating through the SIDA seed capital scheme, this becomes a matter of record only. The local bank also advises the foreign bank of the export consignment. The local bank also is supposed to receive details of cash received by the foreign bank. The local bank returns CD3 form pages 5/6 to BOT certifying cash received. The local bank also pays the exporters in Tanzanian shillings. In addition, the local bank is also responsible for maintaining minor accounts of exporters business in the foreign bank so that licenses can be issued for approved imports of the exporter financed through the 50% retention of forex earnings.

These five steps appear simple, but to actually get through them is like walking in a dark thick forest in search of a lost needle and suddenly, you say, here it is, alas! why?

Step two above cannot be completed much in advance of the shipment data since it requires specification of the quantity and of the flight and airway bill number. The quantity exported

cannot be finalized until actual loading of the aircraft. Additionally, some produce may fail to pass phytosanitary clearance or in some cases, a delayed flight may result in withdraw of some produce where quality has deteriorated. But even where everything appear working well, freight space in Tanzania is not guaranteed so that some of the consignments may be off loaded.

RECOMMENDATION: CD3 forms should be completed at the point of shipment exit when amount and quality of produce is verified by customs officials.

The other snag is that the CD3 form also requires knowledge and declaration of the product selling price. This price is impossible to obtain with horticultural produce because of the daily variation in price on account of supply and demand as well as quality considerations. As a result, BET uses indicative prices based on past price movements, and records past price movements, and records the minimum and maximum prices on the export license. While this procedure may work in some circumstances, it may create some problems for rejected or downgraded produce because there are no feedback mechanisms for BET to know the actual price received.

The other major problem is that an export license has to be obtained for each consignment. This is terrible and cumbersome and may discourage potential exporters.

RECOMMENDATION: An exporter should be issued with a blanket license for a period of one year. Such a license should specify the horticulture products to be exported e.g. pineapples, green beans etc. The CD3 form should then be completed at the point of export exit for each consignment.

EXPORT MARKET SUPPORT SERVICES

Several institutions/organizations are involved directly or indirectly in the support of the horticultural industry: The Board of External Trade (BET). The Ministry of Agriculture and Livestock Development (MALD), Bank of Tanzania (BOT), Customs etc. Because horticultural exports are characterized as high input/high output operations which frequently demand sophisticated technology and management techniques, Tanzania's public institutions are ill prepared for this kind of job. Besides, all of these institutions have other responsibilities and are unable to provide adequate support. The review below provides some suggestions for improvement.

Institutional support: MALD is the ministry responsible for agricultural development in the country. This ministry can assist in revamping the horticulture industry through greater allocation of recurrent and development funds in its horticulture section; rehabilitation of horticulture research institutions, particularly its infrastructure and skilled manpower. *In addition MALD should be prepared to provide efficient and permanent phytosanitary inspection service at both Kilimanjaro (KIA) and Dar es Salaam (DIA) airports.*

The other type of support involves removal of duties and sales tax for the inputs meant for the production and export marketing of horticulture products.

Marketing support

The Board of External Trade, Tanzania Trade Centre in London, the National Chamber of Commerce Industry and Agriculture (TCCIA) and the horticulture exporters association (TANHOPE) provide vital support to exporters. Support is given in the form of market information, participation in trade fairs, trade missions and sometimes consultancy services.

RECOMMENDATION: TANHOPE SHOULD ESTABLISH A HORTICULTURE INFORMATION CENTER FUNDED BY CONTRIBUTIONS FROM EXPORTING FIRMS AND A SMALL FEE FROM OTHER USERS

External donor assistance should be encouraged, particularly in facilitating brief visits for potential exporters to the importing country to learn on site quality aspects of competitors and possible other market outlets. ITC, CFTC and GTZ have provided this type of support in the past and the impact has been seen in both improved quality and volume exported.

Airport Infrastructure

Currently Tanzania is served by several international airlines, including British Airways, KLM, Lufthansa, German Cargo, Air France, Swissair, LTU (cargo), Ethiopian Airlines and Gulfair with a combined weekly freight capacity of only 60 tons. These provide valuable horticulture export cargo services in both KIA and DIA. But demand for airfreight capacity exceeds supply. For example , total weekly export volume generated at KIA is now more than 60 tons but only LTU and airfrance are currently accepting cargo at KIA, leaving almost half of the cargo to find other outlets (DIA and Nairobi)

Several improvements in cargo handling at KIA and DIA have to be made in the short and medium-term.

RECOMMENDATION: The new cold rooms for DIA should be installed and commissioned without further delay. Efforts should be made to ensure that the cold rooms are prefabricated units with wide doors sufficient to accept fully-loaded aircraft pallets and each of these rooms should accommodate at least two pallets.

The doors of the cold rooms at KIA are malfunctioning. DAHACO should be advised to replace the doors as soon as possible. In the medium and long-run, existing cold rooms at KIA would have to be replaced with larger cold rooms, twice the size of the new DIA cold rooms. In the meantime, it may be prudent to encourage the establishment of privately owned cold rooms such as those owned and operated by Tanzania Flowers at KIA and the proposed cold rooms by Sunripe, also at KIA.

Currently air freight charges to Europe range between US$ 1.2 per kg. for fruits and vegetables and up to US $ 2.4 per kg. for flowers. These charges, according to many exporters, are excessively high, given that Tanzania is generally regarded as one of the cheap sources of jet fuel.

RECOMMENDATION: The Civil Aviation (DCA) in close cooperation with BET should discuss with the airlines some current disparities in operations and airfreight costs and seek agreement from airlines that Tanzania's air freight requirements will be met at reasonable cost to the exporters.

Packing

Currently packages for horticultured are manufacture products by Kibo Paper Industries. Most of these packing materials are of poor quality.

> RECOMMENDATION: Kibo Paper Industries should make every effort to improve quality and provide export packaging manufactured from raw paper pulp rather than the inferior recycled paper now in use.

Investment Support

Local domestic finance for horticulture producers and exporters is scarce. The government owned lending institutions have restrictive regulations which make borrowing rather difficult. The $25 million IDA funded Agricultural Rehabilitation Export Project managed by CRDB has only recently been permitted to extend eligible projects to include horticulture.

> RECOMMENDATION: The NBC and CRDB should be advised to denominate export project investment loans to borrowers in terms of the currency borrowed under the condition that the borrower repays the loan in the same currency at market interest rates.

EXPORT MARKET ANALYSIS

Market characteristics

Consumption of fruits and vegetables has expanded considerably in the past 20 years. This has come about because of improved knowledge about the nutritional aspect of these

commodities, extremely strong promotional advertizing for new products and competition. In addition, improvements in the technology of production, storage and transport have led to greater availability of fresh produce in developed as well as in some developing countries. For example, temperate fruit such as apples and pears, are now available out of season through supplies from the Southern Hemisphere to the North Hemisphere. Sub-tropical and tropical countries are becoming major suppliers of fruits and vegetables in the world market.

The export market is affected by many restrictive policies, including: tariffs, a reference price system (in the case of EEC), quantitative restrictions (quotas), quality norms and in some instances, export rebates. Much of the internal market system in developed countries is regulated through an interventionist system.

Many of the out-of-season and tropical fruits which Tanzania produces are not affected by restrictive policies practiced by these developed countries. Even minimum quality standards to restrict import of poorer quality, are now unlikely to apply because the market itself *accepts on very high or top quality produce*. Nothing short of perfection is likely to penetrate the developed country market, starting from the produce itself to packaging and labelling.

THE MARKET ACCEPTS ONLY TOP QUALITY PRODUCE

Market Structure

The way the market for horticultural products is structured is almost the same for most developed countries. Much of the

fresh produce is imported "on consignment" - this means the sender/exporter bears all the risks on cost until the produce is sold by the importer to the wholesaler, distributor or other buyer.

For an exporter to obtain regular and assured market through forward contracts, a high level of trust has to be established between the exporter and importer. This trust is built on a solid foundation of performance for several years in terms of quality, consistency and reliability of supply.

> A secure market is achieved only through a high performance record in terms of quality, consistency and reliability.

Several channels exist for different products. For example, small volume exporters supply small independent importers who service wholesalers and as they accumulate a large assortment of produce may sell to distributors or large retail chains. When the volumes of produce involved are large, wholesalers or distributors do their own importing of fruits and vegetables. Sometimes other countries organize a producers marketing board which import the produce and distributes the produce to wholesalers or retail chains. We illustrate with a few examples below:

THE NETHERLANDS

The Netherlands is reputed as the World's main trade center for distribution of fresh fruit and vegetables serving most of Europe. Schipol airport, near Amsterdam, is the major air terminal and Rotterdam has modern port facilities for handling fresh produce brought in by sea from various countries of the

World.

In general, the bulk of produce that is imported such as citrus, bananas, and deciduous fruit, such as plums and peaches are auctioned at the fruit auctions. However, some importer wholesalers prefer bypassing the auctions and sell directly to wholesale distributors, supermarkets, cateres and retailers. A minimum volume of the out-of-season and exotic produce is sold through the auction. There are very few specialist importers of exotic produce in the Netherlands. Exporters from Tanzania may wish to know that the one major supermarket chain in Holland, known as A. Heijn - now also imports some produce directly from suppliers.

The Hollish importer/wholesaler normally works on commission and charges 8-10 percent depending on the product, the volume and regularity of the shipment - the more frequent the shipments, the less are the commission charges

GERMANY

There are three categories of importers in Germany:

- Integrated trade such as the consumer co-operatives e.g. co-operative Agriculture and multiples like Gedelfi.

- Associated trade such as retailers cooperatives like EDEKA and REWE.

- Independence importers/wholesalers.

Category 1 and 2 import directly the high volume items like citrus fruits, deciduous fruits, potatoes and the higher volume exotics. The independents import smaller volumes and distribute

these to the integrated and associated trade as well as to secondary wholesalers. It has been observed recently that companies such as Scipio are becoming more important for the procurement of produce, preparation and distribution to the traders.

In general, the normal importers commission is 8-10 percent of the selling price to the wholesaler. The importer would normally charge the lower percentage for regularly supplied produce of an agreed volume.

FRANCE

Nearly 50% of the fruits and vegetables in France are imported by supermarkets and hypermarkets. Open-air markets and "corner shops" are becoming important, particularly in exotic and off-season produce. Much of the exotic and off-season produce is consumed around Paris and Lyon, and in Southern France.

In general, the majority of importers are also wholesalers who supply central buyers of the chains and supermarkets as well as secondary wholesalers. Rungis near Orly is the preferred airport for air freight produce by most importers/wholesalers. Marseille is the prime port of entry for sea freight and many tons of produce are regularly railed or trucked direct to other European countries.

In France, the importers/wholesalers have strong regional associations. Few supply produce through central buyers or secondary wholesalers on a national scale. As with the Netherlands and Germany, the commission charged by importers ranges between 8-10 percent of the selling price, depending on the range of services provided and the regularity of supply.

UNITED KINGDOM

Large companies import horticultural produce to supply to the wholesalers in Smithfield, Covent Garden, Birmigham etc. Some independents also participate in the importation and wholesaling of horticulture produce.

Supermarkets are becoming increasingly important. These now purchase direct from suppliers and have top-up service for purchase, packaging and distribution of the minor items from smaller and independent importers. Sometimes the exporter appoints a handling agent who receives the imported produce and delivers it to the importer/wholesaler. These agent fees which range between 8-12 percent of the selling price are deducted from the wholesale price before the supplier is paid.

> To win a market in U.K. an exporter must ensure that top quality standards are met in all consignments.

UNITED STATES OF AMERICA (U.S.A)

Although U.S. is not an importer of horticulture produce from Tanzania, prospects for greater trade between the two countries are on the rise. Exporters must meet the health regulations of the Food and Drug Administration (FDA) and the United States Department of Agriculture (U.S.D.A.) for importing food products. Currently, there are no known trade barriers and tariffs for horticulture products imported from Tanzania.

The U.S market is extremely competitive. For a Tanzanian entrant to make a headway, the firm has not only to meet FDA and USDA requirements but also come in with a cheaper product, with better quality.

The U.S. market will accept only high quality products which are blemish free securely packed and well presented.

Because of the long distance between Tanzania and the U.S., it is unlikely that an exporter would attempt fresh produce, but rather develop a specific type of processed fruit juice or concentrate of high export quality.

JAPAN

Japan is becoming one of the largest importers of fruits and vegetables in the world. Demand has tripled over the past five years. Like other developed countries, the Japanese will accept nothing short of top quality produce. JETRO, the Japan External Trade Organization provides information on current government regulations, mandatory standards, certification standards, and other relevant information for prospective exporters to the Japanese market. Interested Tanzanian exporters should visit: JETRO, Dar es Salaam, Extelecoms House, Samora Avenue.

SAUDI ARABIA

Tanzania stands a much better chance to enter the Saudi Arabia market. This country is a net importer of fruits and vegetables. The market is relatively open, with free entry. Government regulation is largely aimed at ensuring fitness of foodstuffs for human consumption. Bananas, citrus and apple dominate Saudi's imports. Recently, mangoes and madarins as well as fruit concentrates have become important. Your competitors are likely to be the current main suppliers: Pakistan, India, Sudan, Egypt and Kenya. But the market is large and if you come in with a cheaper product, better quality supported by regularity

of supply, you may win a spot in this market.

Relevant Data on the Saudi Market

- Saudi Arabia maintains a standard rate of import duty of 7% but many fruits including mangoes and mandarin are exempted.

- Import licenses are not required.

- Shipment of fresh produce must be accompanied with a certificate of origin and health attested by an Arab consulate in Tanzania.

- There are no foreign exchange control regulations.

- Prices fluctuate almost daily but the profit margin is sufficiently high for you to make money.

- Major importers include: sharbatly, Abbar, Zairy and the Arabian Trading company.

MARKET ENTRY TIPS FOR SELECTED TANZANIAN EXPORT OF HORTICULTURE PRODUCE

GREEN BEANS

Background:

- Tanzania has favorable soils and climate for the production of green beans.

- Green beans have high demand all year round in developed countries.

- Tanzanian beans enjoy acceptance in European and Middle East markets.

- Better quality and regularity of supply could assure you a market.

Variety:

- You are better off to start with the varieties most in demand which are: Green beens " PHASEOLUS VULGARIS", Bush blue lake, Cotender, Green Star, Long Tom, Master piece, Primeur and Saxa.

Season of supply

- Do not attempt to supply during the period of MAY to NOVEMBER. During this period Spain, Italy and France produce and supply large quantities in Western Europe and enjoy comparative advantage. If you have to export during that period, go for the Middle East and Eastern Europe.

- Export during the October - June period when the major European suppliers are out of season.

Know your competitors

- Kenya enjoys a well established market in France and U.K. Beans from Kenya are supplied all the year round.

- Senegal supplies to the European market between December and April.

- Burkina Faso supplies between January and March.

Know the quality standards required

- Very fine - width of pod not exceeding 6mm
- Fine - width of pod not exceeding 9mm
- Average - width of pod exceeding 9mm.

Remember: Only fine and very fine beans have a chance of making money for you - because of the high cost of air freight.

- Quality standards for U.S. and E.E.C. demand that the beans be intact, sound, fresh, clean, free of smell, taste or abnormal external moisture.

What about packing?

- Beans are carefully packed in neat rows in ventilated fiberboard cartons. The net weight should be between 2.5kg and 3kg.

- You will need to be extra careful to ensure that only perfect beans are packed for export, because if your beans are down graded, you will receive very low price which may not even cover your freight charges!

- It is advisable to hand pick, hand grade and hand pack to avoid any damage or blemish.

Remember: To get the average price of U.S. $ 3.0 Per kg of fine and extra fine beans, you have to supply top quality produce at a very high level of reliability. Goodluck.

PINEAPPLES

Background:

- Pineapples are well liked all over the world.
- Many developed and Middle East countries have doubled their demand over the past four years.

- Tanzania has potential to enter the export market.

Know the preferred variety: Cayenne is Europe's best choice. You may go for other varieties such as Queen, Red Spanish or Abacaxis, but ensure you supply small quantities, otherwise you will lose money.

Size: Consumers are particularly sensitive to quality and size. Common sizes are 0.9 - 1.3kg and packed 10, 12 or 15 in an attractive carton. More recently, some consumers have moved to heavier fruit up to 3kg - those consumers who prefer greater sweetness and more edible flesh. Pack large sizes in 4, 6 or 8 per carton. The carton should preferably be fiberboard, packed vertically or horizontally to reduce movement during transit and prevent damage to the fruit.

Know your competitors: Ivory Coast is the largest exporter of pineapples and supplies all year around. Kenya, Uganda and Costa Rica are the other major supplies all year round. If you are a new comer, demand for pineapples is largest during Christmas time and the holiday season in July and August. Perhaps you should try your luck during this period.

Remember: Quality, good packing and promotion are essential. To be on the safe side, you may wish to combine fresh export with a juicing plant that produces juice concentrate, also for export.

PAPAYA

Background:

- Papaya are liked by many consumers and the demand has doubled in the past five years.

- Papaya are difficult fruits to bring to the market in top quality

- Tanzania has both the climate and soils most conducive for the production of papaya.

Size:

- The market prefers small sized papaya. These travel better and are less expensive per piece.

Variety

- The market will go for the Hawaian variety. Solo or the Amazon Red.

- One important tip: pick your papaya at the color break stage, that is, when 10 - 15% is yellow at the blossom end. Fruit picked before this critical stage usually fails to ripen properly and is immediately down graded or rejected.

Temperature:

A holding temperature of 7° can give the fruit a shelf life of 1 - 3 weeks from harvest.

Packing:

- Normally ventilated fiberboard cartons are used to pack 8 - 12 pieces weighing 3.5 - 4 kg per piece.

Tip: Pack each fruit individually and/or separate with card dividers to minimize movement in the carton. Fruit should be of one uniform size in each carton.

Your competitor

- The market for papaya is dominated by Brazil who supply all year round.

- Others are Costa Rica in July - December; Ivory Coast, November - April and South Africa, July - December.

MANGO

Background

- The market for mangoes is small but growing.

The future: Mangoes are likely to have a very strong market prospect in the future, particularly mango juice concentrate. An exporter should be well advised to combine fresh fruit export and processed concentrate to maximize available market advantage.

Tropical Fruit Juice Export

Perhaps Tanzania has the greatest chance of success in the export of fruit juices and concentrates. The best prospects are:

- Passion fruit juice: This juice has a flavor preferred for blending with other juices. Popular also in carbonated drinks and for flavoring such delicious foods as yoghurt.

- Mango juice/puree: Important juice, high demand for single-strength drinks and tropic juice blends. Saudi Arabia and other Middle East countries have particular preference for this type of juice. Tanzanian exporters can win a market in these countries. To do so, quality is very important. In addition, the puree has to have a Brix range of 14-20 without much concentration. India supplies in A10 cans but new suppliers are coming up with frozen and aseptic packs.

- Tanzania has potential to enter this expanding business in both fresh fruit or processed juice concentrate.

Variety

No particular variety is dominant. Some prefer the Alphonso variety, others Julie. Others like non-fibrous mango like Haden, Tommy Atkins, Keith and Kent. Other less preferred varieties include: Graham, Irwin, Ruby, Sensation and Zill.

Whichever variety you choose, develcp quality and good image to win a market.

Packing:

Use ventilated fiberboard cartons of 4.5 - 5kg net with 10 -14 fruits. Each fruits should weigh between 250 - 450 grams. The carton should be packed single layer only, be fully lidded to give extra strength when cartons are stacked on pallets.

Your competitors

The U.S.A. and Mexico supply most of the world mango fruit during the spring and summer. (May - October). Others include: Brazil, Venezuela, Peru, Guatemala, Kenya, Israel and South Africa.

- Pineapple juice concentrate. This juice is in high demand, both in Europe and the middle East. Main suppliers are the Philippines, Thailand, Brazil, Kenya and South Africa. Because of the suitable soils and climate for the production of pineapples, Tanzania should be able to come to this market and get a share in the over $ 150 million annual world trade.

- Lime juice: This juice is liked for its concentrate which is used in fruit drinks and cordials. It is normally sold on the basis of its acid content in terms of grams per litre in the range of 400 - 450. Tanzania has particular advantage in the supply of this juice because there exists a lime juicing plant in Mtwara.

V. GENDER ANALYSIS

V. GENDER ANALYSIS

An Overview

In Tanzania, women play a major role in agriculture as producers of food and cash crops. In the study area, many women function as independent horticulture producers and market their own produce. Most horticultural farms are small, typically less than 3 hectares, and depend heavily on women labor. Over 90% of the farm work is done by women. Each household grows food crops, which form 41% of the rural household income, 31% coming from non-agricultural income. In households with marketable horticulture produce, family incomes were found to improve considerably. Horticulture sales appears to increase the family income by an average of 12.5% of the household's annual income. This is partly explained by some women considering fruits and vegetable farms as an "income-generating" activity, much the same as keeping poultry. To the extent that horticulture has began to play a major role in cash income earnings, at least in the study areas, women have acquired a more prominent role in the decision-making process within the household, in part because of their increasing contribution to the family monetary income.

Access to Resources

In the study area we found a general lack of credit to both men and women. Most of the wards and villages do not have formal rural credit channels and the informal methods are biased in favor of men. Another disadvantage for women was lack of control of overall household resources. We found out that many rural women do not control enough cash to be able to hire ploughs or buy seeds, fertilizer or new technology. Similarly, women have unequal access to land ownership resulting from biased inheritance structures. this has tended to undermine the resource base for women's independent farming.

Where women had adequate resources to carry-out horticulture

production, we found also a greater control over the resulting income from their farm work. However, much of this hard-earned income was spent largely for the benefit of the whole household rather than improving the welfare of the women alone. In other areas such as in Kilimanjaro and Mbeya, some men have asserted control over horticulture products which were formerly under women control, depriving the later a regular source of income.

Marketing and Improved Means of Transport

Women participation in the marketing of horticultural produce has increased over the past five years. Women producing fruits and vegetables have began to travel, independently from men, to village and urban market centers. This increased participation in the market economy has led to various positive side effects, including: exposure to urban pricing structures, new long distance buyers, particularly those who cater for the Dar es Salaam market and new ways of preserving their produce from spoilage. Two prominent and successful women have entered the horticulture export market and are doing quite well. Other women interviewed have shown interest to enter the export market.

On the transport side, it appears that men are much more likely to adopt new intermediate forms of transport than women. One reason for this is that most women lack purchasing power relative to men and in some cases, but by no means all, women's acquisition of improved means of transport is circumscribed by notions of cultural impropriety. For example, in some areas of Tanga, very few women ride bicycles with a load of fruits or vegetables because those who do are considered "too liberated" and "acting like men". During the survey, we observed a growing tendency for both men and women to use wheelbarrows, handcarts, ox carts and one-ton pick-ups. These means of transport are likely to alleviate women's load carrying burden.

Extension Services

Samples of farms (420) visited during this study revealed widespread discrimination against women in extension services. Farms with male heads were three times more likely to have been visited by an extension worker compared to those headed by women. Over 70% of the agricultural extension service workers located in the wards and villages are male, which may explain this abnormally. In some areas, male extension officers were afraid of holding lengthy extension training with women because of cultural reasons. However, we did not find major differences in horticulture yields associated with a lower frequency of extension services to female headed farms. Women farmers were found to be as productive and efficient as their male counterparts, and in the case of women exporters, even more aggressive in attaining their goals.

The current national horticulture extension service appears to have a strong bias towards men at the regional, district, ward and village levels. Representation at the MALD headquarters in Dar es Salaam is more even, with 5 extentionists, 2 of whom are women. In order to improve women access to critical horticulture knowledge and inputs that would enhance productivity, we encourage the agriculture ministry to employ and train more women to the national extension services.

Other Implications for Gender

It is not easy to reach conclusions on the nation-wide impact of horticultural commercialization in Tanzania. What we have observed is an economy more diversified in terms of household production patterns and complex roles played by women and men. This diversification has meant, among other things, that women are now working longer and harder than before, almost 1.6 to 2.5 times more than men. At the same time, there is increasing tendency for women to resist men appropriating the new income flows. Women are becoming masters of their own sweat. We believe these are healthy developments, particularly as they contribute to greater equality between men and women and enlarge the later's freedom.

VI. ANNEXES

ANNEX I: HORTICULTURE RESEARCH INSTITUTES

Horticulture crop research is carried out in six centers:

1. Tengeru Horticultural Research and Training Institute (HORT TENGERU)
2. Uyole Agricultural Center (UAC)
3. Sokoine University of Agriculture (SUA)
4. Cholima Agro Scientific Research Center (CASRC), Dakawa
5. Maruku Agricultural Research Institute (ARI Maruku), and
6. Makutupora Viticulture Research and Training Institute (VRTI Makutupora).

RESEARCH CENTER	LOCATION	RESEARCH ACTIVITY	REMARKS
1. HORTI TENGERU	Arusha	• Vegetable seed production • Potato and Vegetable seed research • Citrus research	• Established: 1980 • Has linkage with Cornell University (Vegetable research) • Has released several reports on vegetables, citrus diseases in Tanzania and potato storage
2. Uyole	Mbeya	• Vegetable agronomic research • Seed multiplication (tomato, onion) • Fruit agronomic research (apple, peach, grapes etc)	• Established: 1973 • Publishes results in Uyole Bulletins • Supported by DANIDA
3. Sokoine	Morogoro	• Indigenous vegetables • Tomato variety trials • Banana systematics • Fruit agronomic research • Sweet potato	• Established: 1984 • Released results on cowpeas, amaranths, tomato and cabbage fertilization.
4. CASRC Dakawa	Morogoro	• Hot season vegetables • Vegetable seed production • Rice research	• Established: 1983 • Releases Annual progress reports • Supported by FAO
5. ARI Maruku	Bukoba	• Banana research • Pesticide trials • Coffee research	• Established: 1988 • Releases annual progress reports • Supported by: INIBAP (banana) ICIPE and EEC.
6. VRTI Makutupora	Dodoma	• Grapevine improvement • Viticulture research • Evaluation of fungicides to control mildews and anthracnose	• Established: 1978 • Releases annual progress reports.

ANNEX 2A: ARUSHA REGION - PEAK AVAILABILITY OF FRUITS AND VEGETABLES

Crops/Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Vegetables												
Tomatoes												
Cabbages												
Sweet pepper												
Carrots												
Peas												
Beans												
Cauliflower												
Eggplants												
Onions												

ARUSHA REGION

Fruits												
Mangoes												
Bananas												
Oranges												
Lemons												
Pawpaws												

ANNEX 2B: KILIMANJARO REGION - PEAK AVAILABILITY OF FRUITS AND VEGETABLES

Crops/Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Vegetables												
Tomatoes	■	■							■	■	■	■
Cabbages								■	■	■	■	■
Pepper capsicum									■	■	■	■
Carrots								■	■	■		
Peas					■	■					■	■
Beans					■	■					■	■
Cauliflower												
Eggplants								■	■	■	■	■
Onions							■	■	■		■	■
Okra									■	■	■	■
Cucumber								■	■	■	■	■
Pumkins	■	■	■	■	■							
Spinach									■	■	■	■

Fruits												
Mangoes	▦	▦										
Bananas						▦	▦	▦				
Oranges			▦	▦	▦	▦	▦	▦				
Lemons			▦	▦	▦	▦	▦					
Pawpaws									▦	▦	▦	

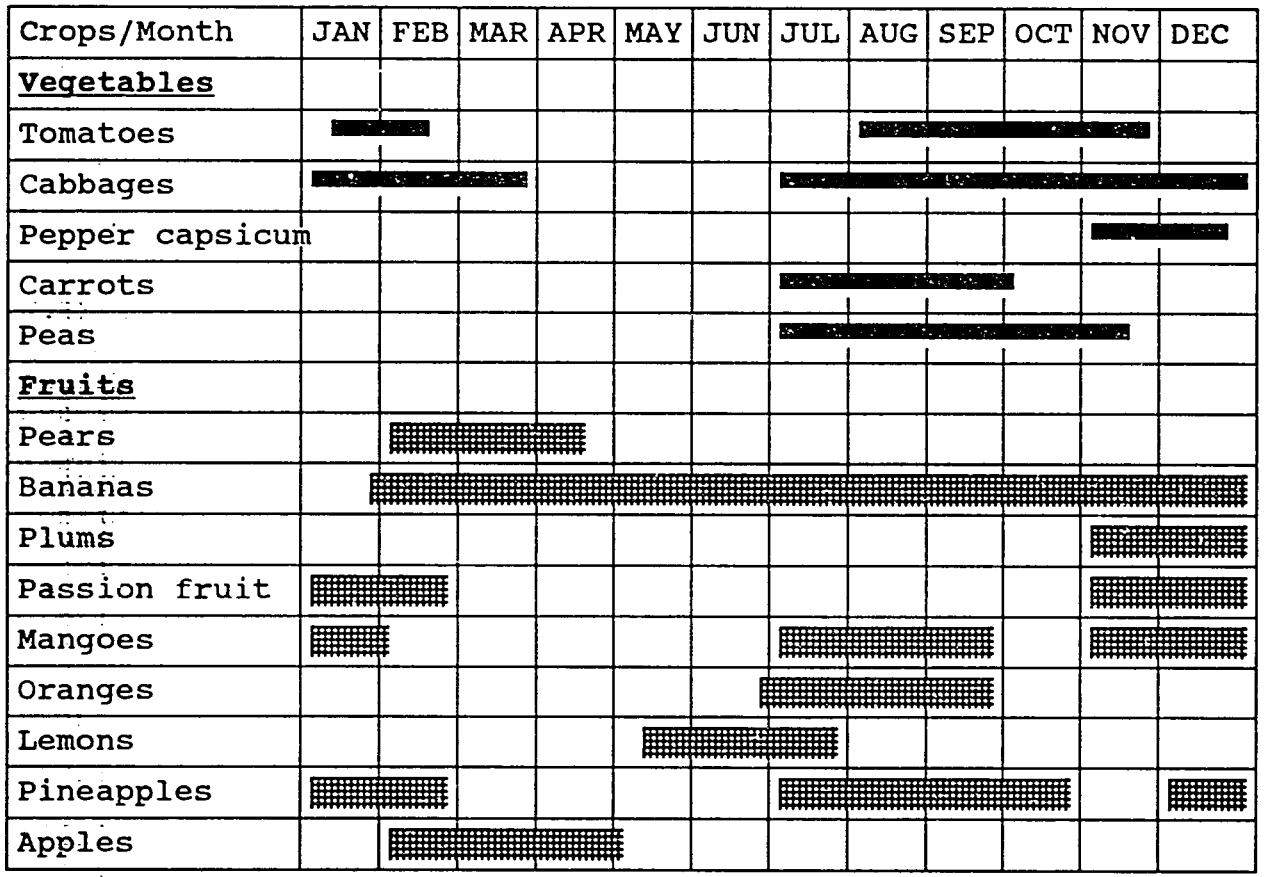
ANNEX 2C: IRINGA REGION - PEAK AVAILABILITY OF FRUITS AND VEGETABLES

Crops/Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Vegetables												
Tomatoes												
Cabbages												
Pepper capsicum												
Carrots												
Peas												
Beans												
Cauliflower												
Eggplants												
Onions												

IRINGA REGION

Fruit												
Mangoes												
Oranges												
Lemons												
Pineapples												
Pears												
Apples												
Quinsis												

ANNEX 2D: TANGA REGION - PEAK AVAILABILITY OF FRUITS AND VEGETABLES



ANNEX 2E: MOROGORO REGION: AVAILABILITY OF FRUITS AND VEGETABLES

Crops/Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Vegetables												
Potatoes												
Cabbages												
Pepper capsicum												
Okra												
Onions												
Beans												
Eggplant												
Fruits												
Mangoes												
Bananas												
Citrus												
Guava												

ANNEX 2F: COAST REGION: AVAILABILITY OF FRUITS AND VEGETABLES

Crops/Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Vegetables												
Tomatoes												
Cabbages												
Onions												
Spinach												
Beans												
Eggplant												
Fruits												
Oranges												
Mangoes												
Bananas												
Tangerines												
Guava												
Lime												
Pineapples												

ANNEX 3: LIST OF HORTICULTURE PRODUCERS/EXPORTERS

FIRM	COMMODITY EXPORTED	REMARKS
DAR ES SALAAM		
1. Sima International P.O. Box 1175 Dar es Salaam	Varieties of fruits and vegetables and dry chilies	Has a farm of about 50 hectares
2. Chrismil Farm Ltd. P.o. Box 1546 Dar es Salaam	Pineapples	Has a farm of about 250 hectares
3. Fresh Food Programme P.O. Box 70611 Dar es Salaam	Vegetables and fruits	Sporadic exporter
4. Interstate Corporation P.O. Box 22717 Dar es Salaam	Fruits and vegetables	Sporadic exporter
5. Dabaga Fruits and Vegetables P.O. Box 1957 Dar es Salaam	Fresh and processed fruits and vegetables	Firm has large future potential
6. Magole Farms Ltd. P.O. Box 21714 Dar es Salaam	Fruits and Vegetables	Sporadic exporter and farmers
7. Tanzania Colt Motors P.O. Box 75 Dar es Salaam	Fruits and Vegetables	Sporadic exporter
8. Global Vegetables P.O. Box 21796 Dar es Salaam	Fruits and Vegetables	Sporadic exporter and farmer
9. M.D. General Investments P.O. Box 70211 Dar es Salaam	Fruits and Vegetables	Sporadic exporter and farmer
10. Bugoy Co. Ltd. P.O. Box 19992 Dar es Salaam	Fruits and Vegetables	Sporadic exporter
11. Sahak Enterprises P.O. Box 7061 Dar es Salaam	Fruits and Vegetables	Sporadic exporter
12. Asta General Enterprises P.o. Box 2 Dar es Salaam	Fruits and Vegetables	Sporadic exporter
13. Hamuni Suppliers P.O. Box 570 Dar es Salaam	Fruits and Vegetables	Sporadic exporter
14. Heleki Enterprises P.O. Box 2128 Dar es Salaam	Fruits and Vegetables	Sporadic exporter
15. Sayari Trading Co. Ltd. P.O. Box 19992 Dar es Salaam	Fruits and Vegetables	Sporadic exporter
16. M. N. Impexport Ltd. P.O. Box 5310 Dar es Salaam	Fruits and Vegetables	Sporadic exporter

17. AL-Waffa Enterprises P.O. Box 16180 Dar es Salaam	Fruits and Vegetables	Sporadic exporter
18. Tropical Foods Ltd. P.O. Box 1461 Dar es Salaam	Fresh and Processed Fruits	Sporadic exporter
19. Kitmeer Traders Ltd. P.O. Box 6261 Dar es Salaam	Fresh and processed fruits	Sporadic exporter with high future potential
20. Miralea Enterprises P.O. Box 4210 Dar es Salaam	Fruits and Vegetables	Sporadic exporter and farmer
21. Tina Farm and Trading P.o. Box 70503 Dar es Salaam	Fruits and Vegetables	Sporadic exporter and farmer
A R U S H A		
22. Tanzania Flowers Ltd. P.O. Box 1156 Arusha	Flowers	Has farm about 60 hectares
23. Gomba Estates Ltd P.O. Box 2617 Arusha	Flowers	Has farm of about 50 hectares
24. Wellgrown exporters P.O. Box 7455 Arusha	Vegetables	Farmer and supplied by smal' holders
25. Salama Estate P.O. Box 7318 Arusha	• Vegetable seeds • Fresh beans	Has farm of about 200 hectares
26. Mringa Estates Ltd. P.O. Box 34 Arusha	Vegetable seeds	Has large potential as exporter
27. Arusha Agro Flora Ltd. P.O. Box 7073 Arusha	Vegetable and Flowers	Joint venture, 75 hectares. Large potential
28. Equatorial Progressive Co. P.O. Box 416 Moshi	Fresh green beans	Farms of 75 hectares and contracts 1000 small scale farmers
29. Usagara Farms Ltd. P.O. Box 4067 Zanzibar	Fruits and Vegetables	Sporadic exporter and farmer

ANNEX 4: HORTICULTURE PROCESSING COMPANIES

Factory/Company	Type of product processed	Installed capacity	Remarks
1. Muheza DDC Canning	Peaches, pears, pineapples, oranges, lemon tomatoes	200 tons/day	Operates at less than 50% installed capacity supply to local market
2. Dabaga Fruit canners	Tomato paste and sauce, chilly sauce, fruit juices, fruit syrup, backed beans, green peas fruit jam vinegar	15 tons/day	Has large potential for expansion. Supplies local and export market
3. Tropical Foods Co. Ltd.	Squashes & juices, jams and syrup, tomato puree/ sauce, vinegar, jells/faluda	25 tons/day	Has potential for expansion supply local and export market
4. Lushoto DDC Canning Factory	Jams & syrup squashes and juice, tomato puree/sauce	200 tons/day	Operates below 40% capacity supply to local market
5. Vitamin Foods	Fruits juices/squashes, fruit jam, tomato products	15 tons/day	Supply largely for local market
6. Tangold Ltd.	Squashes and juices, syrup, tomato puree/sauce	3 tons/day	Supply to the local market
7. Food Canners	Cordials (lemon, orange, pineapples) black current, canned fruits (mango, peaches, pears), syrups, tomato products jams, vinegars	500 tons/day	Supply to domestic market, Exports planned in the future
8. Mbeya DDC Canning Factory	Squashes and juices, pineapples, syrups, tomato puree/sauce	100 tons/day	Operates at less than 50% capacity. Supply for the local market
9. Sunvita	Squashes and juices, jams and syrups, tomato puree/sauce	10 tons/day	Supplies the local market. Has potential for export.

ANNEX 5: LIST OF PROMOTIONAL INSTITUTIONS IN SUPPORT OF THE HORTICULTURE INDUSTRY IN TANZANIA

1. COLEACP: This is a non-profit making organization based in Paris, France. It is funded by the European Commission to facilitate the supply and marketing of fresh produce from ACP countries. In general, COLEACP acts as a liaison organization between the European community and EEC importers and ACP exporters of fresh and processed horticultural produce. COLEACP supplies trade information, training, technical aid and market research promotion services. More information can be obtained from the EEC offices in Dar es Salaam.

2. INTERNATIONAL TRADE CENTER (ITC)
ITC is a United Nations institution based in Geneva. It provides technical assistance to Developing Countries in export marketing and development. More information can be obtained at the UNDP offices in Dar es Salaam. However, the following information is particularly relevant of horticulture exporters: ITC has a market news service publication which contains information on fresh produce exports fruit juices and flowers. Their information is collected weekly or after every two weeks and covers markets in North America, Europe and Asia. BET is currently a subscriber and interested exporters may wish to read this newsletter - particularly on the most current average prices for horticulture products.

3. THE COMMONWEALTH SECRETARIAT (CS)
CS has an export market division which supplies marketing assistance to developing country exports. CS funds and provides technical assistance to exporter selling missions organizes buyer/selling missions, organizes buyer/seller meetings and undertakes market surveys, more information can be obtained through the Ministry of Labour and Manpower Development.

4. THE AFRICA PROJECT DEVELOPMENT FACILITY (APDF)
APDF with an office in Nairobi, provides assistance in undertaking feasibility studies, drawing up business plans and sometimes supplying qualified experts through AMSCO- the African Management Services Company. More information can be obtained through the Ministry of Finance, Dar es Salaam.

5. FTHDP (Franco/Tanzania Horticulture Development P:oject-Sokoine University Morogoro.)

   This project assists small farmers in Mgeta to improve horticulture production and marketing. This project is supported by the French.

6. Trade Facilitation Office (Canada)
56 Rue Sparks Street
Suite 500
Ottawa, Ontario KIP 5AQ

7. Import Promotion Office (Denmark)
Danish Chamber of Commerce
Borsen
DK-1217 Copenhagen K

8. PDODEC-IMPORT (Finland)
Toolonkatu 11
SF-00100 Helsinki

9. Services des Relations Geographiques
et des Invitations-SRGI (France)
Center Francais du Commerce
Exterieur (CFCE)
10, Avenue d'Iena
F-75783 Paris Cedex 16

10. Bundesstelle fur Aussenhandelsinfomation (Germany)
Blaubach 13
P.O. Box 108007
D-5000 Cologne 1

11. Japan External Trade Organization
JETRO (Japan)
2-5 Toranomon 2-Chome,
Minato-Ku,
Tokyo 105

12. Center for the Promotion of Imports from developing countries - CBI
(Netherlands)
5th Floor
P.O. Box 30009
NL-3001 DA Rotterdam

13. Instituto Nazionale per il commercio
Estero-ICE (Italy)
Via Liszt 21
P.O. Box 10057
I-00144 Rome-EUR

14. Yugoslav Chamber of Economy (Yugoslavia)
Terazije 15/23,
P.O. Box 47
Yu-11001 Belgrade

15. The Developing Countries Trade
Agency-DECTA (united Kingdom)
69 Cannon Street
London EC4N 5AB

16. Office Suisse d'Expansion Commerciale
OSEC (Switzerland)
4, Avenue de l'Avant-Poste, P.O. Box 1128
CH-1001 Lausonne

17. IMPOD-Import Promotion Office for Products from Developing Countries
(Sweden)
Nybrogatan 6, 2nd Floor
P.O. Box 5028
S-102 41 Stockholm

18. Polish Chamber of Foreign Trade (Poland) 4, Ul. Trebacka
P.O. Box 361
00-950 Warsaw

19. Russia Chamber of Commerce and Industry
6 Kuibysheva Street
GSP 103684
Moscow

20. Export-Import Bank of the United States (USA)
811 Vermont Avenue, N.W.
Washington D.C. 20571

21. United States Trade and Development Program
Regional Director, Africa
Room 301-State Annex # 16
Washington, D.C. 20523

22. Overseas Private Investment Corporation (OPIC)
1615 M Street NW, Washington, D.C. 20527

ANNEX 6: **TROPICAL FRUIT AND VEGETABLE IMPORTERS/AGENTS/WHOLESALERS**

1. United Kingdom

Evans Gray & Hood Ltd
Berkshire House
168-173 High Holborn
London W1V 7 AF

Bombay Emporium Ltd
Radiant House
Pegamoid Road
London N18

Kiril Mischeff Ltd
Broadwall House
21 Broadwall Road
London SE1

2. United States

A. M. Beebe Company
50 California Street
Suite 950
San Francisco
California 94111

Iberia Foods Corporation
195-217 Liberty Avenue
Brooklyn
New York 11207

International Flavours &
521 West 57th Street
New York 10019

Mira International Foods
716 Clinton Street
Hobken
New Jersey

R J R Foods
360 South Acacia Avenue
Fullerton
California 92634

La Fe Tropical Fruits Inc
615 South West Avenue
Miami
Florida

Nationwide of Chicago
360 East North Avenue
Northlake
Illinois 60164

3. Netherlamds

Eurocitrus BV
Albustraat 5
P. O. Box 227
4900 AE Costerhout

International Flavours &
Fragrances BV
Bevenheuveleweg 60
5048 An Tilburg

Go Tan BV
Spoorstraat 57
Kesteren

Asian Food Specialities
Sloterweg 192
Badheuvedorp

BV Lucullus
Neuweweg 114
Wormer

4. Switzerland

Stutzer AG
Seminarstrasse 28
8057 Zurich

International Flavours &
Fragrances
Europastrasse 15
5600 Lenzburg AG

Migros
157 Limmatstrasse
Case Postale 226
8031 Zurich

Coop Suisse
Thiersteinerallee 14
Case Postale 1285
4002 Basel

5. France

SA La Pulpe
M.I.W. Rungis
14 rue de Seminaire
95416 Rungis

ETS Courrier SA
21-29 av. Gaston Monnaisean
92113 Clichy

G. Soreall
62 rue Motiere
94200 Ivry-sur-Seine

Fauchon (importer/sholesaler/
retailer)
26 Place de la Madeleine
Paris

6. Federal Republic of Germany

Wachsmath and Krogmann
Mundsburger Damm 6
2000 Hamburg 22

Deutsche Staudt GmbH
Monckebergstrasse 27
2000 Hamburg 1

Wilheim Philip GmbH
Frauenbergstrasse 2
8355 Hengersberg

Von Lind & Co
Gansemarkt 21-23
2000 Hamburg 36

J Heimerdinger
Neuer Wall 34
2000 Hamburg 36

7. Japan

Mitshubishi Corporation
3-1 Marunouchi 2-Chome
Cyiyoda-Ku
Tokyo

7. Japan

Mitshubishi Corporation
3-1 Marunouchi 2-Chome
Cyiyoda-Ku
Tokyo

Sunyo-Do Co. Ltd.
1-3-21 Nihonbashi-Horidomecho
Chuo-Ku
Tokyo 103

Mitsui & Co. Ltd
1-21-Ohte-Machi
Chiyoda-Ku
Tokyo

Marubeni Shokoryo
Marushoka Soko Building
3-3-2 Higashi-Shinagawa
Shinagawa-Ku
Tokyo

Kokubu (K & K) Ltd
1-1-1 Mihonbashi
Chuo-Ku
Tokyo

Sumitomo Corporation
3-24-1 Kanda-Nishikicho
Chiyoda-Ku
Tokyo

C Itoh Ltd
5-1 Kita-Aoyama 2-Chome
Minato-Ku
Tokyo

Annex 7A: TEMPERATURE REQUIREMENTS FOR FRESH FRUIT AND VEGETABLES DURING TRANSPORT

Product	Maximum loading temperature		Recommended transport temperature	
	°F	°C	°F	°C
Apples	No recommendation		37-50	+ 3-+16
Apricots	36	+ 2	32-36	0-+ 2
Bananas	54	+12	54-55	+12 +13
Beans, green Carrots,	Transport not recom		ended beyond 4 days	
winter	68	+20	32-68	0-+20
Cauliflower	39	+ 4	32-39	0-+ 4
Charries Transp	ort not recommended		beyond 3 days	
Cocumbers	50	+10	45-50	+ 7-+10
Grapes	43	+ 6	32-43	0-+ 6
Lemons and grape fruit	54-59	+12-+15	46-59	+ 8-+15
Lettuce	39	+ 4	32-39	0-+ 4
Mandarins	46	+ 8	36-46	+ 2-+ 8
Melons	46-50	+ 8-+10	39-50	+ 4-+10
Onions	59	+15	30-59	- 1-+15
Oranges	50	+10	39-50	+ 4-+10
Peaches	38	+ 3	32-38	0-+ 3
Pears	38	+ 3	32-38	0-+ 3
Peas in pod	transport not recommended beyond 4 days			
Pineapples	50	+10	50-52	+10-+11
Plums	38	+ 3	32-38	0-+ 3
Potatoes	-	-	41-68	+ 5-+20
Strawberries	Transport not recommended beyond 2 days			
Tomatoes (turning)	59	+15	50-59	+10-+15
(ripe)	Transport not recommended beyond 4 days			

Source: Abbot, J.C.: Marketing Fruit and Vegetables, Rome, 1970

Annex 7B: Recommended Storage Condition and Expected Storage Life for Fresh Fruit

Product	Temperature		Relative Humidity	Expected storage
	°F	°C	Percent	
Almonds in shell	32-45	0-7	60-70	
Apples	30-39	-1-4	85-95	10-12 months
Applicots	30-32	-1-0	85-90	3-8 "
Avocados	41-55	5-13	85-90	1-4 weeks
Bananas (green)	53-58	11.5-14.5	90-95	2-4 "
(coloured)	56-61	13-16	85-90	10-20 days
Bilberries	30-32	-1-0	85-90	5-10 "
Blackberries	30-32	-1-0	90	2-3 weeks
Black currants	30-32	-1-0	90	5-7 days
Cashew apples	32-35	0-1.5	85-90	1-2 weeks
Cherries	30-32	-1-0	85-90	4-5 "
Chestnuts	32	0	70	1-4 "
Coconuts	32	0	80-85	8-12 months
Cranberries	36-40	2-4.5	90	1-2 "
Figs	30-32	-1-0	90	1-3 "
Gooseberries	32	0	90	7-14 days
Grapes	30-32	-1-0	85-90	2-3 weeks
Grapefruits	40-60	4.5-15.5	85-90	3 "
Guavas	45-50	7-10	85-90	3-4 "
Lemons (green)	52-58	11-14.5	85-90	1-4 months
(coloured)	39-50	4-10	85-90	3-6 weeks
Limes	46-50	8-10	85-90	3-8 "
Litchi fruit	32-35	0-1.5	85-90	5-11 "
Loganberries	32	0	90	7 days
Mandarins	39-45	4-7	85-90	3-12 weeks
Mangoes	45-50	7-10	85-90	4-7 "
Mangosteens	39-42	4-5.5	85-90	7 "
Melons	32-50	0-10	85-90	1-7 "
Honeydew	59-70	15-21	70-80	2-6 months
Watermelon	36-40	2-4	85-90	2-3 weeks
Neetarines	30-32	-1-0	85-90	3-7 weeks
Nuts (chestnuts)	32	0	70	8-12 months
(others)	45	7	70	1 year
Oranges	30-45	-1-7	85-90	1-6 months
Passion fruit	42-45	5.5-7	80-85	4-5 weeks
Papaya	39-50	4-10	85-90	2-5 "
Peaches	30-34	-1-1	85-90	1-8 "
Pears	29-35	-1.5-1.5	85-90	1-7 months
Pineapples-green	50	10	90	2-4 weeks
-ripe	40-50	4.5-10	85-90	2-6 "
Plums	31-34	-0.5-1	85-90	2-8 "
Pomegranates	34-36	1-2	90	2-4 months
Quinces	34-39	0-4	90	2-3 "
Raspberries	32	0	85-90	3-5 days
Red currants	32	0	90	2-3 weeks
Strawberries	32	0	85-90	1-5 days

Source: Recommended conditions for cold storage of perishable produce 196 Institute international du froid, Paris.

Citrus fruits — Guide to storage

0 INTRODUCTION

Citrus fruits are divided into five groups which differ from each other in their behaviour during transport and should therefore be considered separately from the point of view of storage conditions. The groups are the following :

- oranges;
- mandarins (tangerines) and their hybrids;
- lemons;
- grapefruits and their hybrids;
- limes.

Citrus fruits undergo little change after harvesting. They have no climacteric phase, and should therefore be harvested ready for consumption.

Peel colour is not always an indication of maturity; there is not necessarily a direct relation between colour and degree of ripeness.

The keeping life of the fruit depends on several factors, including the following :

- ecological conditions;
- agrotechnical factors (nature of rootstock, size of fruits, method of pruning, etc.);
- harvesting conditions (time of picking, condition of fruit at harvest);
- degree of maturity and treatments during storage;
- keeping temperature;
- relative humidity of the store.

The longer the fruits remain on the trees after they have reached edible condition, the shorter the time they can be kept after harvest. However, growth regulators can be used to enhance the keeping quality of late harvest fruit.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the conditions required for good keeping of the following groups of citrus fruits during their storage with or without refrigeration, in stores or in various transport equipment (such as containers, railway cars, trucks or ships) :

- oranges : *Citrus sinensis* (Linnaeus) Osbeck;
- mandarins : *Citrus reticulata* Blanco;
- Lemons : *Citrus limon* (Linnaeus) N.L. Burman;
- grapefruits : *Citrus paradisi* Macfadyen;
- limes : *Citrus aurantifolia* (Christmann) Swingle.

Detailed information concerning cultivars in these different groups is given in annexes A and B.

2 REFERENCES

ISO/R 750, *Fruit and vegetable products — Determination of titratable acidity.*

ISO 2169, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement.*

ISO 2173, *Fruit and vegetable products — Determination of soluble solids content — Refractometric method.*

3 CONDITIONS OF HARVESTING AND PUTTING INTO STORE

3.1 Varieties (Cultivars)

This International Standard concerns fresh fruit intended for storage and belonging to the varieties listed in annex A.

3.2 Harvesting

The fruits should be harvested when they have reached the stage of maturity that makes them fit for consumption. Harvesting may be temporarily interrupted when weather conditions (rain, etc.) are likely to have an adverse influence on the keeping qualities.

Fruit collected from the ground is often infected with *Phytophthora*, and it is therefore recommended that dropped fruit should not be harvested.

The maturity criteria usually considered are the following :

- juice content, expressed as a percentage by mass (the juice content may vary slightly as a result of the conditions and duration of storage);
- flavour;
- acidity and/or the ratio :

$$\frac{\text{soluble solids content (ISO 2173)}}{\text{acidity expressed as anhydrous citric acid (ISO/R 750)}}$$

The values to be adopted for these last two criteria depend on the varieties under consideration, and on ecological

conditions. They should therefore be considered only in relation to the variety and to a well-defined area of production. Reference should be made to the specialized documents that have been published on the subject in the different areas of production.

3.3 Quality characteristics for storage

3.3.1 *Condition of fruit at harvesting*

Fruits intended for storage should be clean, firm, and without blemishes (damage caused by pickers' fingernails, insect punctures, bruises, etc.); there should be no evidence of fungal or physiological disorders. They should retain their calyces except in damp regions where fruits are liable to stem end-rot.

Ethylene degreening is not advisable for fruit intended for long storage. This treatment hastens the physiological development of the fruit and shortens its keeping life. If it has been carried out, this fact shall be brought to the attention of prospective purchasers. Ethylene-degreened fruit may be packed without stem-ends.

3.3.2 *Treatment of fruit*

3.3.2.1 After a first sorting in order to remove leaves, trash and defective fruits (such as those that are damaged or heavily infected with *Phytophthora*), the fruits are preferably washed by spraying (which reduces the risk of infection) or by sprinkling or soaking in tanks. They are then rinsed and brushed and receive a fungicidal treatment. This should be applied as soon as possible after harvesting. For fruit picked with a high degree of turgidity, treatment should be delayed for 24 h after picking. Lemons and limes are not always washed.

The fungicidal treatment is carried out with a solution or a suspension of a fungicidal product and, in the case of infection by *Phytophthora*, can include a heat treatment carried out by dipping the fruit in a treating solution or water for 3 to 5 min, at a temperature varying between 45 and 48 °C. This treatment is effective when carried out shortly after rains and infection in the grove.

Fungicidal treatments must conform to the regulations applying in each of the countries concerned. They must not leave visible deposits on the fruits.

The fungicidal treatment is generally followed by rinsing in order to ensure that the fungicide residues after treatment do not exceed the limits authorized.

A certain period of exposure to air before washing and fungicidal treatment renders the skins less turgid and less subject to bruising, which may arise during subsequent handling (as any bruising may lead to rotting, this procedure must only be followed in the case of fruit from areas of production in a dry climate); as a general rule, this period should not exceed 24 h.

3.3.2.2 After treatment, the fruit can be covered with a wax in order to replace the natural coating of the fruits which is partly or entirely removed by washing and brushing. By way of example, emulsions of carnauba wax, beeswax, extracted or paraffin waxes, and polyethylene-based wax may be used for this purpose. An approved fungicide may be incorporated into the wax (for example, orthophenylphenol, benzimidazol).

The amount of wax can be increased if long storage is contemplated (contents up to 140 mg per kilogram of fruit – maximum authorized amount – have been recommended).

A second sorting is usually carried out after treatment and is followed by size grading. These operations should be carried out very carefully to avoid damage to the skin of the fruit.

3.3.2.3 It is advisable that information on the surface treatment used be made available to prospective purchasers.

3.4 Putting into store

Citrus fruits should be put into store immediately following the end of the treatment of the fruits.

The fruits can be stored unwrapped or wrapped in tissue paper (wraps), which may be impregnated with diphenyl. Wrapping prevents damaged fruits from spreading contamination to neighbouring fruits and diminishes loss of mass of fruits during transport and storage. Papers impregnated with fungicide can be replaced by porous substrates impregnated with fungicides which are placed between the layers of fruit.

Fruit is placed (in layers or loose) in wooden, plastics or large metal frame and wire containers, or in corrugated cardboard cartons. The fruits should be pressed lightly together in order to prevent movement (after it has settled) during transport, but not so tightly as to cause bruising. The lids should press lightly on the fruit, without causing damage. The boxes should be handled with care.

4 STORAGE CONDITIONS[1)]

4.1 Storage without refrigeration

Good quality fresh fruit can be stored immediately after harvesting at the place of production in well-ventilated premises at temperatures varying between 10 and 18 °C.

1) For definitions and measurement of the physical quantities affecting storage, see ISO 2169.

4.2 Refrigerated storage

Refrigerated storage can be carried out with or without pre-cooling.

4.2.1 *Pre-cooling*

Pre-cooling is recommended when the fruit is to be kept for long periods and final temperature should be reached within a maximum of 3 to 4 days.

The following conditions should be applied :

- the pre-cooling temperature adopted is that for keeping;
- air-circulation ratio : 100 to 200;
- relative humidity : to be kept as high as possible (of the order of 90 %).

4.2.2 *Short-, medium-, and long-term refrigerated storage*

4.2.2.1 TEMPERATURE

Storage temperature depends, among other factors, on the species and variety of the fruit, the area of production, the physiological condition, the degree of ripeness and the anticipated length of keeping.

The following table gives, for information, the recommended temperatures according to varieties and areas of production.

Some species of fruit have a temperature limit for long keeping below which deterioration of the fruit occurs. However, if a short-term storage only is being contemplated, the limiting temperature or even one somewhat lower may be used in order to reduce the risks of fungal damage. As an example, grapefruit may be kept at 9 to 10 °C for 4 to 6 weeks or at 5 to 6 °C for 4 to 6 weeks for grapefruits late in the season.[1)]

4.2.2.2 RELATIVE HUMIDITY

The relative humidity should be maintained between 85 and 90 % throughout the storage period.

4.2.2.3 AIR CIRCULATION

An air-circulation ratio of 25 to 50 is recommended throughout the storage period.

4.2.2.4 FRESH AIR CHANGE

Fresh air change should be continuous, at a rate of once or twice per hour according to the storage temperature, in order to prevent accumulation of carbon dioxide (of the order of 0,2 to 1,0 %).

4.3 Keeping life

This depends on several factors such as variety, ecological and phytosanitary condition, date of harvesting, damage from harvesting or resulting from handling, treatment at harvesting, care in handling, and keeping temperature. Examples of periods of keeping are given in the table of recommended temperatures, which are likely to vary considerably.

1) For varieties which are relatively unaffected by cold, a treatment of 10 to 12 days at 0 °C may be applied in order to kill the fruit fly in fruit that is already infested.

TABLE – Recommended temperature

Cultivars	Country of production	Refrigerated storage					
		Short-term		Medium-term		Long-term	
		Temperature °C	Weeks expected	Temperature °C	Weeks expected	Temperature °C	Weeks expected
Oranges							
Camargo	Brazil					+ 2	12
	Rep. of South Africa					+ 4	10
Valencia late	Rep. of South Africa					+ 4,5	10 to 14
	Australia					+ 2,5 to + 7	10 to 14
	U.S.A. (California)					+ 2. to + 7	6 to 8
	Spain	+ 10 to + 12	4	+ 8 to + 10	8	+ 2	14 to 16
	U.S.A. (Florida)					− 1 to + 1	8 to 12
	Israel	+ 2 to + 10	6	+ 2 to + 4	6 to 10	+ 2	10 to 14
	Morocco	+ 4 to + 6	4	+ 2 to + 4		+ 2 to + 3	8
	U.S.A. (Texas)					0	
	West indies					+ 7	
Mossambi	India	+ 15 to + 18	3 6*			+ 1 to + 2	12 to 16
Navel	Spain	+ 10 to + 12	2	+ 6 to + 10	6	+ 2 to + 3	10 to 12
	Morocco	+ 6	4	+ 4	6	+ 3	8
Castellana	Spain					+ 1	10 to 12
Salustiana	Spain	+ 10 to + 12	2	+ 6 to + 10	6	+ 2	16
Shamouti	Israel, Lebanon	+ 4 to + 15	4	+ 4 to + 8	4 to 6	+ 4 to + 5	6 to 8
Verna	Spain	+ 10 to + 12	4	+ 6 to + 10	8	+ 2	14 to 16
Washington Navel	Australia					Early : + 4,5 to + 5,5 Late : + 4,5 to + 7	
	U.S.A. (California)					+ 2 to + 7	5 to 8
	West Indies					+ 7	
	Rep. of South Africa					+ 4,5	4 to 8
Mandarins							
	Australia					+ 7	
	India	+ 15 to + 18	2 3*			+ 5 to + 7	3 to 6 8 to 10*
	Israel	+ 17	2			+ 5 to + 8	4
Clementines	Morocco	+ 8	2	+ 6	3	+ 4 to + 5	4
	Spain					+ 4 to + 5	4 to 6
Clemnules	Spain					+ 4 to + 5	4 to 6
Satsuma	Spain	+ 10 to + 12	1 to 2	+ 6 to + 8	3	+ 4	8
Lemons							
Green lemons	Rep. of South Africa					+ 11	12 to 16
	Israel	+ 10 to + 17	6	+ 13 to + 14	6 to 12	+ 12 to + 16	13 to 14
	New Zealand						14
	U.S.A. (California)	+ 12 to + 13	3			+ 12 to + 13	13 to 20
Coloured lemons						+ 0 to + 5	3 to 6
	Israel	+ 8 to + 17	4	+ 10 to + 14	4 to 6	+ 13 to + 14	6 to 8
	New Zealand						10 to 14
Grapefruit							
	Australia					+ 9 to + 10,5	
	Israel	+ 8 to + 15	4	+ 8 to + 12	4 to 6	+ 10 to + 12	6 to 12
						+ 8 to + 10	10
	India					+ 7 to + 9	12
	U.S.A.					+ 10 to + 15	4 to 12
	Rep. of South Africa					+ 11	12 to 14
Limes							
	U.S.A. (Florida)					+ 4 to + 10	3 to 8
						+ 10	3 to 4
Yellow	India	+ 15 to + 18	5 days 2*			+ 11 to + 13	7
Green	India	+ 15 to + 18	5 days 2*			+ 11 to + 13	8

* Waxed fruits.

ANNEX A

LIST OF CULTIVARS AND THEIR SYNONYMS

A.1 ORANGES

A.1.1 Sub-group of "Navels"

A.1.1.1 Washington Navel : Washington, Bahia Navel

A.1.1.2 Thomson Navel : Thompson Navel, Thomson, Thomson's Navel, Navel Nice

A.1.1.3 Leng Navel

A.1.2 Sub-group of "Fine-Blonds" (of low seeds type)

A.1.2.1 Shamouti

A.1.2.2 Cadenera : Cadena Fina, Cadena Sin Hueso, de la Cadena, Castellana, Cornice de la Cadena Fina, Précoce de Valence, Précoce des Canaries, Rharb, Espagne sans pépins, Valence sans pépins, de Valence

A.1.2.3 Maltaise blonde : Petite Jaffa

A.1.2.4 Hamlin

A.1.2.5 Vernia, Verna

A.1.2.6 Valencia late

A.1.2.7 Salustiana

A.1.2.8 Mossambi/Sathgudi

A.1.3 Sub-group of "Common-Blonds" (seeded)

A.1.3.1 Marrs Early

A.1.3.2 Parson Brown

A.1.3.3 Pineapple

A.1.4 Sub-group of "Semi-bloods"

A.1.4.1 Maltaise sanguine : Maltaise demi-sanguine, Portugaise, Portugaise sanguine, Portugaise demi-sanguine

A.1.4.2 Grosse sanguine or Double fine améliorée : Sanguine ovale double fine, Washington sanguine

A.1.4.3 Double fine : Ovale de Sangre, Rojo oval, Ampollar, Sanguine ovale double fine, Double fine, Sanguine double fine

A.1.4.4 Sanguinelli

A.1.5 Sub-group of "Bloods"

A.1.5.1 Moro

A.1.5.2 Tarocco

A.1.5.3 Ruby Blood

A.2 MADARINS

A.2.1 Sub-group of True Mandarins

A.2.1.1 Mandarin group : Mandarine d'Algérie, Mandarine de Blidah, Mandarine de Boufarik, Mandarine de Bougie, Mandarine de Nice, Mandarine de Valence, Mandarine d'Australie, Mandarine Dupre, Mandarine de Paterne, Mandarine Avana, Mandarine Dai-Dai, Mandarine Ba-Hamed, Mandarine Beladi, Mandarine Beledi, Mandarine Effendi, Mandarine Youssef, Effendi, Mandarine Willow-Leaf, Mandarine Willow-Leaved

A.2.1.2 Oneco

A.2.2 Sub-group of "King and Tangors"

A.2.2.1 King of Siam : Mandarin King of Siam

A.2.2.2 Temple : Mandarin Temple

A.2.2.3 Murcott

A.2.2.4 Ellendale Tangor

A.2.3 Sub-group of "Satsumas" : Unshiu

A.2.3.1 Satsuma Wase

A.2.3.2 Satsuma Owari

A.2.4 Other sub-group of Mandarins

A.2.4.1 Clementine, Clemenules, Monreal

A.2.4.2 Wilking : Mandarin Wilking

A.2.4.3 Dancy : Dancy Tangerine

A.2.4.4 Robinson : Robinson Tangerine

A.2.4.5 Santra

A.2.4.6 Som Keaw-arn

A.3 LEMONS

A.3.1 **Sub-group "Eureka"**

A.3.1.1 Eureka

A.3.1.2 Villa Franca

A.3.2 **Sub-group "Vernia"**

A.3.2.1 Vernia Berna

A.3.3 **Sub-group "Everbearing"**

A.3.3.1 Quatre saisons

A.3.3.2 P.S.P. : P.S.P. sans pépins

A.3.4 **Sub-group "Probable Hybrids"**

A.3.4.1 Meyer

A.3.5 **Sub-group "Lisbon"**

A.3.5.1 Lisbonne

A.3.5.2 Sicilian, Bearss

A.4 GRAPEFRUITS

A.4.1 **Sub-group "Blond Grapefruit"**

A.4.1.1 Marsh Seedless (seedless)

A.4.1.2 Duncan (seeded)

A.4.1.3 Maccarty (seeded)

A.4.2 **Sub-group "Pink and red Grapefruit"**

A.4.2.1 Foster (seeded)

A.4.2.2 Thompson
A.4.2.3 Pink Marsh
A.4.2.4 Ruby Red
} (seedless)

A.4.2.5 Burgundy

A.4.3 **Sub-group of "Tangelos"**

A.4.3.1 San Jacinto

A.4.3.2 Sampson

A.4.3.3 Minneola

A.4.3.4 Orlando

A.4.3.5 Seminole

A.4.3.6 Wakiwa

A.4.3.7 Nova

A.5 TRUE LIMES

A.5.1 West Indies Lime (Key lime) : Lime mexicaine, "Mexican lemon", Citron Gallet, Kaghzi Nibbu

A.6 LARGE-FRUITED LIMES

A.6.1 Persian (Tahiti) : Bearss

ANNEX B

LIST OF PRINCIPAL COMMERCIAL CULTIVARS AND PRODUCING COUNTRIES[1)]

Cultivar (principal designation)	Producing countries
B.1 ORANGES	
B.1.1 Sub-group of "Navels"	
Mossambi	India
Navel	Republic of South Africa, Algeria, Australia, Brazil, Spain, Greece, Israel, Morocco, U.S.A.
Navelate	Spain
Navelina	Spain
B.1.2 Sub-group of "Fine-Blonds" (of low seeds type)	
Hamlin and various blonds	Algeria, Brazil, Greece, Morocco, U.S.A.
Ovale	Italy
Peira	Brazil
Salustiana	Spain, Morocco
Shamouti	Cyprus, Israel, Turkey
Tomango	Republic of South Africa
Valencia late	Republic of South Africa, Algeria, Australia, Brazil, Cyprus, Spain, Greece, Israel, Morocco, Tunisia, Turkey, U.S.A.
Vernia	Spain, Morocco
B.1.3 Sub-group of "Common-Blonds" (seeded)	
Various Parson Brown, Pineapple	Spain, Italy, Greece, Republic of South Africa, U.S.A. (Florida, Texas)
B.1.4 Sub-group of "Semi-Bloods"	
Maltese	Algeria, Tunisia
Sanguinello	Spain, Italy, Morocco
Washington blood (improved double fine)	Algeria, Morocco, Tunisia
B.1.5 Sub-group of "Bloods"	
Moro	Italy
Ruby	U.S.A.
Common bloods	Algeria, Spain, Greece, Italy, Morocco
Tarocco	Italy
Washington blood	
B.2 MANDARINS	
Santra	India
Satsuma	Spain, Japan, Turkey, Israel
Clementine	Algeria, Spain, Morocco, Tunisia, Israel
Monreal	Algeria, Spain, Morocco, Tunisia, Israel
Wilking	Morocco, Israel
Som Keaw-arn	Thailand
True Mandarins	Algeria, Spain, Greece, Italy, Israel, Japan, Tunisia, Turkey, U.S.A.

1) Non-restrictive list.

Cultivar (principal designation)	Producing countries
B.3 LEMONS	
Eureka	Australia, Republic of South Africa, Israel, Morocco, U.S.A.
Vernia	Spain
Interdonato	Greece, Italy, Turkey
Monachello	Greece, Italy, Turkey
Lisbon	Spain, Israel, U.S.A.
B.4 GRAPEFRUITS AND HYBRIDS	
Marsh Seedless	Republic of South Africa, Cyprus, Israel, Morocco, U.S.A.
Pink Marsh	U.S.A.
Various tangelos	Republic of South Africa, West Indies, U.S.A.

Cultivar (principal designation)	Producing countries
B.5 LIMES	
Kaghzi Nibbu	India
West Indian	West Indies
Mexican	Mexico, Near-East, Thailand, U.S.A.
Sweet Lime	Near-East
Tahiti (Persian)	U.S.A. (California, Texas)

Fresh pineapples — Guide to storage and transport

0 INTRODUCTION

Fresh pineapples produced in regions far from places of consumption should be kept in the cold.

The degree of ripeness at harvest time, which determines the duration of storage, should be chosen according to the duration of transport and marketing operations. This duration varies considerably; hence the clause dealing with the ripeness of the pineapples cannot have a general application.

The external coloration of the pineapples is not a safe criterion for ripeness and it is necessary to give a criterion for actual ripeness.

The condition of the pineapples on arrival at the warehouse (physiological condition, soundness, injuries) has a direct bearing upon the behaviour during storage, which justifies the detailed recommendations made on this subject.

1 SCOPE AND FIELD OF APPLICATION

This International Standard describes the conditions for the successful keeping, with or without the aid of artificial cooling, of fresh pineapples, *Ananas comosus* (Linnaeus) Merrill, during storage between the place of production and the place of consumption and during maritime transport.

2 REFERENCE

ISO 2169, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement.*

3 CONDITIONS FOR HARVESTING AND PUTTING INTO STORE

3.1 Varieties

The products covered by this International Standard are fresh fruits, intended for storage and belonging to the following cultivars :

- Cayenne lisse (type and Hilo)
- Baronne de Rotschild
- Queen (Natal Queen, Ripley Queen, MacGregor, Comte de Paris, Alexandra)
- Abacaxi (Sugarloaf, Eleuthera, Pernambuco)
- Red Spanish (Singapore, Spanish, Cabezona)

This list is not restrictive.

3.2 Harvesting

The degree of ripeness of fresh pineapples should be determined in terms of their physiological condition[1] and the number of days which will elapse between harvesting and sale to the retailer.

Three degrees of *apparent* ripeness can be distinguished, according to the outside coloration of the fruit, namely :

- degree of ripeness 1 : with the beginning of the orange-yellow coloration at the base of the fruit, which is called *fruit on the turn*;
- degree of ripeness 2 : the orange-yellow coloration having developed from the lower quarter to halfway up the fruit, which is called *half-ripe fruit*;
- degree of ripeness 3 : the orange-yellow coloration having extended from halfway to the whole of the fruit, which is called *ripe fruit*.

The coloration is not a safe criterion for the actual ripeness of pineapples.

The actual ripeness of pineapples is determined by examining the state of the flesh in a cross-section of the fruit at its largest diameter perpendicular to the vertical axis.

The earliest stage for storage corresponds to the degree of apparent ripeness 1.

Fruit of the Cayenne lisse variety which has gone beyond the optimum stage of ripeness has a cross-section with translucent areas covering more than half the surface of the section (excluding the surface of the core). The optimum stage for storage is defined by the degree of apparent ripeness 2 or 3 according to the keeping time, the colour of the flesh and the extent of the translucent zone in the cross-section of the fruit.

1) The physiological condition of the fruit is defined by its suitability at the time of harvest for reaching the req[illegible]tate of ripeness for consumption, at the point of retail sale, after normal storage or transport.

3.3 Qualitative characteristics for storage

The pineapples should be whole, clean and firm, with a crown and a portion of the stem without bracts, well set, with well-developed eyes.

They should not show signs of over-exposure to the sun, or deep cracks, even if healed, or unhealed shallow cracks.

They should be free from apparent physiological disorders or apparent cryptogamic disorders, and from visible insects (ants, etc.). However, scale insects (*Dysmicoccus brevipes*) which are not damaging to crops from temperate countries are tolerated in small numbers.

They should not have unhealed injuries or recent bruises, as pineapples are very sensitive to bruises, which systematically bring about decay in storage.

The flesh should not have numerous large brown patches appearing around the ovarian cavities on a cross-section of the fruit.

The fruit should not have a "hedgehog" shape, i.e. protuberant eyes, for cultivars other than the "Queen" group.

The part of the stem remaining attached to the fruit should have a length of between 10 and 30 mm and its cross-section should shown a clean cut which should be disinfected by an agreed fungicide (for example powder based on benzoic acid). Shallow lateral injuries of the stem should also be disinfected.

Pineapples can be stored without their crown or with reduced crowns, provided that the base of the crown on the fruit is well healed and that it does not show bruises or decay.

3.4 Putting into store

The fruit should be put into storage as quickly as possible after harvesting.

The interval between cutting the fruit and putting it into a refrigerated or ventilated enclosure (pre-cooling room, ship's hold, freight container, etc.) should be, if possible, less than 24 h and should not in any case exceed 48 h.

After harvesting and packing, if the pineapples are waiting for a means of land transport to take them to the port of embarkation, they should be placed in the shade and in a well-ventilated area.

At the port of embarkation, the time during which the vans or trucks loaded with pineapples stand waiting before the fruit is put into the ship's hold should be reduced to a minimum, the vehicles standing in the shade.

3.5 Method of storage

Fresh pineapples should be stored in packages which protect them effectively against injuries and bruises caused by knocks during handling. They are generally :

- either packed horizontally with protective elements in wooden boxes, chip baskets or board cases;
- or packed vertically in cardboard cases by means of an appropriate device.

As far as possible, pineapples of the Cayenne lisse variety, which are particularly susceptible to bruising, should not come into contact with the vertical walls of the packages.

4 OPTIMUM STORAGE AND TRANSPORT CONDITIONS [1]

(in the case of artificial cooling)

The storage and refrigerated transport of fresh pineapples comprise two stages : cooling, and keeping at the storage temperature.

4.1 Cooling

Cooling of the pineapples should be carried out as quickly as possible. This can be achieved by means of

- a refrigeration plant with a capacity of 800 to 930 W per tonne of pineapples;
- a cooling-air temperature of approximately 8 °C, without going below 8 °C;
- an air-circulation ratio from 80 to 100;
- stacking of the packages containing the pineapples in a regular pattern, sufficiently close together to promote the maximum flow of air over the product;
- an effective air-circulation system (eliminating short-circuits of external air).

4.2 Keeping at storage temperature

4.2.1 *Temperature*

After cooling, the storage temperature of pineapples should be + 7,5 to + 8 °C. This temperature is that of the atmosphere of the enclosure, measured at the coldest point (air leaving the refrigerator evaporator).

Any higher temperature leads to a decrease in the keeping time.

4.2.2 *Relative humidity*

The surface of the cold batteries of the air coolers should be so designed that, once the cooling of the pineapples is completed and the temperature stabilized, a relative humidity of 90 % is maintained at the coldest point of the refrigerated enclosure.

1) For definitions and measurement of the physical quantities affecting storage, see ISO 2169.

4.3 Air circulation

4.3.1 *Air circulation ratio*

A ratio of 80 to 100 is recommended during cooling. It may be reduced by half during transport after the end of cooling.

The recommended system of ventilation is that with a vertically ascending or descending air flow in series with a uniform distribution of air over the intake end output surfaces.

4.3.2 *Rate of air change*

The recommended rate is one air change per hour. This rate may be reduced by half during the cooling period.

4.4 Storage life

The storage life of the pineapples depends on the degree of ripeness; it is between 10 days and 1 month from the time of harvesting.

ANNEX

WASTAGE IN STORAGE

Wastage of pineapples in storage is due to the following causes :

– too low a storage temperature : temperature below + 7 °C, with darkening of the centre of the pineapple and breakdown of the tissues;

– internal darkening caused by a physiological disorder resulting from unfavourable climatic and ecological factors;

– rotting caused by bruises arising from poor handling between harvesting and storage or from defective packaging;

– translucent flesh with the smell of alcoholic fermentation, resulting from storage of pineapples harvested when over-ripe;

– internal decay arising from a fungal infection (*Thielavopsis paradoxa, Fusarium, Penicillium*). This wastage should not be considered as directly attributable to the storage. The fungal infection is produced because the fungus has found a way in through an injury, through a bruise or through the part of the stem which has not been disinfected at the harvesting or packaging stage.

Onions — Guide to storage

1 Scope

This International Standard gives recommendations for the storage, with or without the use of artificial refrigeration, of onions of the species *Allium cepa* Linnaeus, intended for long-term conservation and consumption in the fresh state.

Information on the limits of application of this International Standard are given annex A.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2169:1981, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement.*

3 Conditions of harvesting and putting into store

3.1 Cultivars

It is necessary to choose onions of cultivars recognized as being well suited for keeping.

NOTE 1 Onions of late cultivars are generally chosen.

3.2 Harvesting

The onions should be harvested when 65 % to 75 % of the green leaves have turned yellow, the necks have become soft and the leaves are drooping, and the bulbs are covered with well-differentiated outer scales signifying that they are in a state of physiological rest.

The onions should be harvested in such a way that they are neither bruised or otherwise damaged.

The stem should be cut so that it does not exceed 4 cm after drying (see 3.4).

3.3 Quality characteristics

Qualitative inspection of onions for conservation is strongly recommended.

It is necessary to choose onion bulbs of good quality, meeting the following requirements: sound, free from mechanical injuries, well covered by outer scales, well dried, ripe and homogeneous.

The onions should be free from foreign odour.

Bulbs having floral stems, or which are not covered by outer scales, which are double, triple, too large, too small, deformed, or not fully mature, should not be stored.

3.4 Various treatments before storage

To avoid sprouting, approved phytosanitary inhibitors may be applied if their use is not restricted.

Before storage, the onions should be dried to eliminate excess external moisture and moisture in the outer scales, the rootlets and the neck.

If natural drying is not possible, a suitable method of artificial drying should be used, for example exposure to a current of warm dry air for a period of 4 days up to a maximum of 8 days, depending on the moisture content. The air temperature may be up to a maximum of 30 °C and the relative humidity should, if possible, be from 60 % to 70 %. The rate of air flow may be from 2 m^3/min to 2,5 m^3/min per cubic metre of bulbs. Ventilation should be effected either with fresh air from outside the store or with a mixture of outside and inside air, with different rates of air change for the two different types of ventilation. Alternatively, the internal air may simply be

recirculated in closed circuit, in which case the recommended air circulation ratio is from 40 to 50 per hour.

Drying has been achieved when the moisture content of the outer scales reaches 12 % to 14 %. At this moisture content, bulbs rustle when handled.

To avoid risk of damage to the onions in transport, it is recommended that drying be carried out at the storage site, in a room specially equipped to carry out this treatment.

Artificial drying should be carried out directly after harvesting, while the onions are in a state of physiological rest, because subsequent treatment with warm air (up to 30 °C) promotes sprouting.

3.5 Putting into store

Stores for keeping onions should be refrigerated or provided with an air-ventilation system with distribution of air through the floor, and should be perfectly dry, clean and disinfected. Filling of stores should be carried out quickly, without exceeding a period of 7 days to 8 days.

It is necessary to avoid storage of onions with other vegetables or fruits to which their particular taste and odour may be transmitted. Storage of onions and garlic in the same store is, however, permissible.

The onions should be put into store as soon as possible after drying, if this has not been carried out in the store. In the case of storage in bulk, if the onions are not completely dry it is necessary to start ventilation immediately, without waiting for the store to be completely filled.

3.6 Method of storage

The onions may be stored in bulk, in packages on pallets, in box pallets, in crates, in sacks or in containers. Onions packed in sacks may be stored for only a short period of time.

In the case of storage in bulk, the maximum storage level should be of the order of

a) 2 m to 2,5 m, for storehouses with natural ventilation, and

b) 3,5 m to 4,5 m, for storehouses with forced ventilation,

the exact level being dependent on the resistance of the bulbs to crushing.

To avoid damage, packages should be stacked 5 to 7 tiers high, and a gap of 15 cm to 20 cm in the proximity of the side walls and of 5 cm to 8 cm between the stacks of packages should be provided to ensure the free circulation of air.

4 Optimum storage conditions[1)]

4.1 General

For the conservation of onions, the temperature and humidity conditions are varied according to

a) the technological phase of conservation;

b) the specificity of the cultivar;

c) the storage system;

d) the storehouse itself, i.e. whether it possesses an ambient-air ventilation system or uses artificial refrigeration.

The temperature and moisture conditions should be maintained constant throughout the storage period. The maximum allowable variations in temperature and relative humidity are $\pm$ 1 °C and $\pm$ 5 % respectively.

Conservation factors should be controlled every day. Quality control of onions should be carried out every 7 days to 10 days to verify the phytosanitary and behavioural state of the product.

4.2 Temperature

4.2.1 Optimum temperature

Long-term storage of onions may be achieved at various temperatures, according to the storage system used and the resistance of the cultivar to low temperatures, as follows:

a) storage at ambient temperature in stores without artificial refrigeration (with natural or forced ventilation);

b) storage at a temperature of 0 °C $\pm$ 1 °C for cultivars with moderate resistance to cold;

c) storage at a temperature of -1 °C to $-2,5$ °C (i.e. the onions are almost frozen) for cultivars with good resistance to cold.

4.2.2 Control of temperature conditions

4.2.2.1 Control using cold ambient air

Air from outside the storehouse may be introduced whenever the temperature outside is less than that inside.

1) For the definitions and measurement of the physical quantities affecting storage, see ISO 2169.

To avoid the risk of frost damage to the onions, air having a temperature of less than −3 °C shall not be introduced into the storehouse. The ventilation and insulation system should be such that the required temperature may be maintained for as long as outside conditions are favourable.

4.2.2.2 Control using artificial refrigeration

In this case, air circulation takes place in a closed circuit. It is recommended that the air be renewed at regular intervals throughout the storage period.

4.3 Relative humidity

To help prevent the development of mould and the appearance of roots, a constant relative humidity of 70 % to 75 % is recommended.

4.4 Air circulation

To obtain constant temperature and relative humidity, it is necessary to set very strict requirements for the air-circulation system.

Two different types of air circulation may be distinguished.

4.4.1 Closed-circuit circulation

The objective of this type of circulation is to promote cooling of the onions to maintain their temperature uniform, and to remove from the packages gases and volatile compounds resulting from the metabolic processes of the onions.

An air-circulation ratio of 20 to 30 per hour is recommended both for systems using cold ambient air and for systems using artificial refrigeration.

4.4.2 Air renewal

The high density storage of onions produces an accumulation of carbon dioxide due to the respiration of the onions. It is necessary to eliminate this by introducing fresh air at regular intervals throughout the storage period. The air-circulation system should provide a rate of air change of 20 to 30 per hour.

4.5 Storage life

When using cooling with ambient air, the storage life may vary from 3 months to 7 months according to the cultivar and the climatic conditions in the country or region in which the onions are stored.

When using artificial refrigeration, the expected storage life may be up to 9 months.

4.6 Operations during and at the end of storage

The onions should not be handled if they exhibit crystals of ice. Precautions should also be taken to avoid any risk of freezing of supercooled onions during handling.

To avoid all traces of moisture on the surface of the bulbs, when the onions are taken out of storage, it is recommended that the onions are kept for approximately 24 h at an intermediate temperature. Then conditioning and packaging of onions for delivery may proceed.

5 Other conservation processes

Chemical sprouting inhibitors may be used in countries where their use is not restricted. In the case of onions destined for export after storage, account should be taken of the restrictions on the use of chemical inhibitors in force in the importing country.

Interesting results have also been obtained with the use of ionizing radiation of the order of 6 000 rad to 10 000 rad. This conservation technique is, however, subject to restrictions in certain countries.

6 Summary of recommended storage conditions

The technological phases and their duration, and the corresponding conditions that should be effected, are indicated in table 1.

Table 1 — Summary of storage conditions for onions

Technological phase		Duration days	Temperature °C	Relative humidity max. %	Ventilation rate h/day
Drying		4 to 8	External air or warm air (3 max.)	70	18 to 20
Cooling		10 to 14	+ 2 to − 2	75	16 to 20
Storage	under ambient conditions	90 to 210	Ambient air (− 3 min.)	75	6 to 8
	under artificial refrigeration	180 to 270	− 1 to + 1[1] − 1 to − 2,5[2]		

1) For cultivars having a moderate resistance to cold.

2) For cultivars having a good resistance to cold.

Annex A
(informative)

Limits of application

This International Standard provides guidance of a very general nature only. Because of the variability of the product according to the time and place of cultivation, local conditions may make it necessary to define other conditions for harvesting or other physical conditions in the store.

This International Standard does not apply unreservedly, therefore, to all cultivars in all climates, and it will remain for each specialist to be the judge of any modifications to be made.

Moreover, this International Standard does not take into account the role played by ecological factors, and wastage during storage is not dealt with.

Subject to the restrictions arising from the fact that onions are living material, the application of the guidelines contained in this International Standard should enable much wastage in storage to be avoided and thus should enable long-term storage to be achieved in most cases.

Avocados — Guide for storage and transport

0 INTRODUCTION

The avocados should be chilled in the preclimacteric phase to obtain a storage life of more than 1 week after the date of harvesting.

In any particular production area the harvesting period may vary from one year to the next, depending on the ecological conditions.

With the green fruit varieties (which are the most numerous) the colour and texture of avocados change very little at the end of growth on the tree. In practice with these varieties there are no visual indications of the state of ripeness at harvesting time and they are often harvested on an empirical basis.

Avocados which are harvested prematurely have a disagreeable flavour after ripening. They should be harvested after reaching sufficient physiological development to give them a satisfactory taste after ripening.

Avocados give off considerable amounts of carbon dioxide, particularly in the climacteric phase. This fruit is very sensitive to the accumulation of carbon dioxide as well as of ethylene. In current transport practice it is recommended that particular attention should be paid to renewing the atmosphere.

The state of the avocados when put into store (state of health, wounds, etc.) affects the keeping time : this is the reason for recommendations being made on this subject.

1 SCOPE AND FIELD OF APPLICATION

This International Standard lays down the conditions for successful storage of avocados, *Persea americana* Miller (*Persea gratissima* Gartner), in the preclimacteric phase during the storage period

— either in a cold or refrigerated transport vehicle (wagon, truck or ship),

— or, exceptionally, in a refrigerated enclosure in a warehouse (or in a refrigerated warehouse).

2 REFERENCE

ISO 2169, *Fruits and vegetables — Testing of physical conditions in cold stores.* [1]

3 CONDITIONS OF HARVESTING AND PUTTING INTO STORAGE

3.1 Varieties

The products covered by this International Standard are fresh fruits intended for storage and belonging to the following cultivars :

Antilles group	Peterson — Fuchs — Pollock — Waldin — Simmonds — Black Prince
Guatemalan group	Anaheim — Benick — Chica — Dickinson — Itzanna — Edranol — Linda — Nabal — Taylor — Trapp-Schmidt — Wagner
Antilles and Guatemalan hybrids group	Bonita — Booth 1 — Booth 3 — Booth 7 — Booth 8 — Choquette — Collinson — Fairchild — Hickson — Lula — Hall
Mexican and Guatemalan hybrids group	Fuerte — Mac Arthur
Mexican group	Duxe — Ettinger — Taft — Topa Topa — Zutano

This list is not restrictive.

3.2 Harvesting

The degree of maturity of the avocados when harvested shall be determined in relation to the likelihood of producing satisfactory fruit after ripening and in relation to the likelihood of their remaining in the preclimacteric phase during the normal period of storage in a refrigerated enclosure.

Avocados picked prematurely do not ripen normally. They have a rubbery texture, a bitter taste and an unpleasant after-taste.

1) At present of the stage of draft.

3.2.1 *Criteria of maturity*

The following criteria are generally taken into account in deciding whether the fruit is sufficiently mature for harvesting :

- start of colour change in coloured varieties;
- slight lightening of colour in the green fruit varieties (taking fruits which are not over-exposed to the sun); this slight variation in colour is difficult to assess;
- size of the fruit, characterized by its largest diameter (using circular gauges) or its mass;
- number of days to obtain softening of the avocado kept between 20 and 25 °C; this time should be between 4 and 7 days;
- oil content for avocados with a high oil content (Fuerte for example);
- avocados should not wrinkle after reaching maturity (wrinkles appear after premature harvesting);
- falling fruit is a sign of the end of harvesting, particularly in the case of seed avocados.

The content in the pulp of dry extract, of reducing sugars or of phenolic compounds cannot be used as criteria of maturity.

3.2.2 *Checking of the degree of maturity with a view to storage*

This check is carried out by examining the following criteria :

- for varieties with coloured fruits (Collinson, Hass, Topa Topa, etc.), examination of the colour;
- for varieties with green fruits, firmness of the pulp;
- for all varieties, size of the fruit, characterized by its largest diameter or its mass, depending on the varieties;
- for all varieties, weakness of the stalk at the insertion with the fruit (the degree of maturity is too far advanced for storage when the stalk cannot hold the mass of the fruit without becoming detached).

3.3 Quality characteristics for storage

Avocados shall have a stalk 1 to 2 cm long.

The place where the stalk is cut shall be clean to avoid damaging neighbouring fruit.

Avocados shall be free from any signs of attack by fungi and insects, from open wounds, and from the effects of excessive exposure to direct sunlight.

Old wounds on the fruit which are well covered with scar tissue may be tolerated provided that they are few in number.

3.4 Putting into storage

The avocados shall be put into store as quickly as possible after harvesting.

The period between the harvesting of the fruit and its entry into a refrigerated enclosure shall not exceed 48 h.

3.5 Method of storage

After harvesting and packing, when avocados are awaiting transportation by land or sea, they shall be placed in the shade in a well-ventilated place.

Avocados shall be stored in packages which will protect them efficiently against wounds and damage as a result of impacts during handling.

Usually they are arranged in one or more layers of fruit of the same size in a corrugated cardboard box with perforations in the side walls and the lid, or in a wooden case allowing good ventilation.

The fruit may be wrapped separately in paper and shall be protected, for example, by fibre within the package, to avoid contact with the sides of the package and between the individual fruits. The packages shall be sufficiently strong to protect the avocados, which cannot support pressure without deteriorating.

4 OPTIMUM CONDITIONS OF STORAGE AND TRANSPORT

The storage and refrigerated transport of avocados consist of two phases : cooling, and keeping at the storage temperature.

4.1 Cooling

The cooling of the avocados shall be carried out as quickly as possible, and this may be achieved by means of

- a refrigerated installation with a refrigeration power of 700 to 930 W[1] per tonne of avocados;
- a cooling air temperature of 7 to 12 °C, according to the the temperature of storage (see 4.2.1);
- an air circulation ratio of 80 to 100;
- homogeneous and regular packing or stacking, allowing uniform circulation of the cooling air through the contents of the store;
- an efficient air circulation system (without short-circuits of external air).

1) 600 to 800 kcal/h.

4.2 Keeping at storage temperature

4.2.1 *Temperature*

After cooling, avocados shall be kept at the temperature of the atmosphere of the refrigerated enclosure, which depends on the variety and is indicated below.

Some varieties of the Antilles group, including Waldin, should be kept at 10 to 12,5 °C; however, Fuerte variety avocados (Mexican and Guatemalan hybrids group) may be kept at 4,5 °C for 3 weeks without deleterious effect.

The recommended temperature for storage of the other varieties is 7 °C; if the temperature is lower than 5 °C during storage, subsequent ripening becomes abnormal and avocados no longer have the desired eating qualities.

A higher temperature leads to a decrease in storage life.

The temperature shall be measured at the coldest point of the enclosure, i.e. at the outlet of the air from the cooler. If the stacks of packages are readily accessible in the store, it is recommended that the temperature be measured within the packages of avocados.

4.2.2 *Relative humidity*

The cold batteries of the air coolers shall be designed to obtain a relative humidity of 85 to 90 %. See ISO 2169.

4.2.3 *Air circulation*

The recommended air circulation system is the vertical ventilation system with uniform air distribution on the suction surface and on the discharge surface, with an air circulation ratio of 80 to 100.

4.2.4 *Air change*

The recommended rate of air change is one change per hour. The air change shall be carried out continuously because avocados have a high rate of respiration (see annex).

4.2.5 *Storage life*

The storage life of the avocado depends on the cultivar and its degree of maturity at the start of storage. It is between 2 and 4 weeks.

4.3 Storage incompatibility

Vegetable foodstuffs which give off ethylene (tomatoes, etc.) may initiate or accelerate the ripening of the avocados. There is a storage incompatibility between avocados and these foodstuffs.

Conversely, avocados which have started to ripen release ethylene which may act on foodstuffs affected by ethylene (bananas, for example).

ANNEX

WASTAGE IN STORAGE

Wastage of avocados in storage may be caused by the following :

– too low a storage temperature, with abnormal ripening resulting in rubbery texture, browning of the pulp, bitter and disagreeable taste;

– ripening during the storage caused by the presence of ethylene in the atmosphere of the store, or by the presence of avocados which are too ripe at the beginning of storage;

– rotting at the base of the stalk (anthracnose);

– rotting arising from wounds;

– deterioration of avocados caused by too high a content of carbon dioxide in the store as a result of insufficient renewal of air. The carbon dioxide content should not exceed 3 %.

Mangoes — Guide to storage

0 Introduction

The mango (*Mangifera indica* L.) is indigenous to the Assam-Burma region, and innumerable varieties are cultivated. It is a seasonal crop and highly perishable. Fruits picked at the proper stage of maturity can be kept in the fresh state for hardly a week under normal conditions. It is therefore necessary that fruits be kept under proper conditions to prolong their life for human consumption or processing.

Some guidelines for storage of the more usual varieties of mangoes are given below. It is hoped that these guidelines will prove helpful in increasing shelf life and in preventing wastage.

1 Scope and field of application

This International Standard describes methods for obtaining conditions for the successful storage of the more usual varieties of mangoes, for table purposes and for processing into various products.

2 References

ISO 750, *Fruit and vegetable products — Determination of titratable acidity*[1].

ISO 2169, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement.*

ISO 2173, *Fruit and vegetable products — Determination of soluble solids content — Refractometric method.*

3 Conditions of harvesting and putting into store

3.1 Harvesting

3.1.1 Mangoes should be picked at the stage of full maturity. In the case of mangoes to be stored for later processing into pickles, picking should be carried out just prior to maturity. The principal criteria which may be used to determine the optimum stage of maturity for harvesting are as follows :

a) Firmness, judged by a fruit pressure tester; the fruit should be firm.

b) Skin colour, the stage when the deep green colour of the skin is just beginning to become lighter. For pickles, green fruits are preferable to maintain acidity.

c) Age, expressed as the number of days elapsed since full flowering.

d) Total soluble solids content, measured by a refractometer at 20 °C (see ISO 2173), or at room temperature and applying the corresponding temperature correction.

e) Acidity, measured by titrating the mango juice with an alkaline solution (see ISO 750).

f) Flesh colour.

g) Relative density.

3.1.2 These criteria may vary from variety to variety and, for a given variety, from region to region. Some of the physical, chemical, and organoleptic characteristics of the varieties are given below.

3.1.2.1 Variety Alphonse, Badami (India)

a) Physical characteristics

Skin colour : Olive green, with prominent white specks, white waxy bloom.

Development stages of shoulders at stem end :

1) Not developed

2) Partly developed

3) Well developed

NOTE — Stages 2) and 3) are preferred for harvesting.

Mass of individual fruit : Over 200 g

Texture : Firm

Flesh colour : Cream

1) At present at the stage of draft. (Revision of ISO/R 750-1968.)

b) Chemical characteristics

Total soluble solids content : 8 ± 1 % (*m/m*)

Acidity (expressed as malic acid) : 3,5 ± 0,2 % (*m/m*)

The above characteristics are also applicable to the Peter variety.

3.1.2.2 Variety Carabao (Philippines)

a) Physical and organoleptic characteristics

Fruit size : Medium to large, mass about 240 g.

Shape : Oblong with blunt apex and rounded base, slightly flattened but with full cheeks, beak rather indistinct and variable, sometimes coinciding with the apex.

Skin : Smooth, yellow and thin.

Flesh : Yellow, very tender and melting.

Flavour : Very delicate, aromatic and spicy.

Fibre : Medium coarse, but short and confined almost entirely to the edge of the seed.

b) Chemical characteristics (stage of optimum eating quality)

Total soluble solids content : 6,5 % (*m/m*)

Titratable acidity : 2,5 % (*m/m*)

3.1.2.3 Commercial mango varieties cultivated in Egypt

See table below.

3.2 Quality characteristics for storage

Fruit to be put into storage should be sound, free from blemishes, bruises or obvious physiological disorders, and free from any visible sign of fungal or bacterial attack. It should be clean, and free from traces of water and dirt.

3.3 Various treatments before storage

3.3.1 The practice of pre-ripening should be forbidden.

3.3.2 Fruits should be dipped in a wax emulsion containing fungicide in a suitable concentration and dried in a current of hot air, in order to delay ripening.

3.4 Putting into store

3.4.1 After harvesting, the fruits should be put into the store as soon as possible since harvested fruits ripen quickly.

3.4.2 The fruits should be packed in cartons, wooden crates or wood and cardboard boxes.The number of fruits packed in each container depends on the dimensions of the fruit and on the capacity of the containers. Cartons should be provided with round holes for adequate ventilation. Boxes may have six holes in both top and bottom, three holes in each shorter side, and six holes in each longer side. The size of holes may be about 30 mm. Store the boxes in the shade, in a rat-proof room.

3.5 Method of storage

The container should be of such a nature and so arranged in the store as to permit free circulation of air. It should be such as to avoid crushing and damaging of fruits at the bottom by the weight of the fruits on top. As an indication, storage densities of 250 to 300 kg per cubic meter of usable space are considered suitable. The use of box pallets may, however, increase the storage density by approximately 10 %.

4 Optimum conditions of storage[1)]

4.1 Without refrigeration

4.1.1 Temperature and relative humidity

Mangoes may be stored in well-ventilated premises at a temperature of 30 ± 2 °C. The relative humidity should be between 60 and 85 %.

Table

Variety / Characteristic	Himdi	Pairi	Tymour	Company	Zebda
Fruit size	Medium	Medium	Medium-large	Medium-large	Large
Shoulders	Not developed	Not developed	Partly developed	Not developed	Not developed
Skin colour	Light green	Green, with reddish cheek	Olive green, with white waxy bloom	Light green	Olive green, with white waxy bloom
Texture	Firm	Firm, little juice	Firm	Firm	Firm with few fibres

1) For definitions and measurement of the physical quantities affecting storage, see ISO 2169.

4.1.2 Storage life

Variety	Storage life days	
Badami	12 to 16	until ripened to an edible state
Neelum	8 to 12	
Peter (Raspuri)	8 to 12	
Malgoa	8 to 12	
Totapuri	16 to 20	

4.2 Refrigerated storage

4.2.1 Pre-cooling

Pre-cooling is recommended when the fruit is to be kept for long periods, and the final temperature should be reached within a maximum of 3 to 4 days.

The following conditions shall be applied :

a) pre-cooling temperature : 30 ± 2 °C;

b) air-circulation ratio : 100 to 200;

c) relative humidity : 90 %.

4.2.2 Storage

4.2.2.1 Temperature

The annex gives the recommended temperature for some varieties.

4.2.2.2 Relative humidity

The optimum relative humidity for storage is between 85 and 90 %.

4.2.2.3 Air-circulation

There should be a uniform distribution of air within the cold-store, the rate of mixing being sufficient to keep the spatial difference in temperature and humidity within reasonable limits. An air-circulation ratio between 20 and 30 is recommended.

4.2.2.4 Air change

Mangoes stored in densely packed form have the effect of producing an accumulation of carbon dioxide and heat due to respiration; if the cold store is sufficiently gas-tight, some means of ventilation for changing the atmosphere should therefore be provided.

4.2.3 Storage life

The annex gives the expected storage life for different varieties under the storage conditions mentioned above.

4.2.3.1 It is necessary in every case that the storage is not prolonged beyond limits compatible with the maintainance of good quality.

4.2.3.2 It is essential to draw samples of the fruits periodically so as to allow detection of any deterioration which may be taking place during storage.

Annex

Recommended optimum conditions for cold storage of mangoes (relative humidity 85 to 90 %)

Variety	Recommended temperature °C	Expected storage life weeks
Carabao (Philippines)	9 to 10	4 to 5
Alphonse & Totapuri (of Sudan)	> 13	–
All Egyptian varieties except Company	10	2 to 3
Company (Egypt)	10	4 to 5

Sweet pepper — Guide to refrigerated storage and transport

1 Scope and field of application

This International Standard specifies a method for the storage, over short durations, of sweet peppers (*Capsicum annum* L.) for direct consumption, in refrigerated storehouses and during refrigerated transport.

It is not applicable to sweet peppers for industrial processing. The limits of application of this International Standard are defined in annex A.

2 Conditions of harvest and putting into store

2.1 General

Sweet peppers shall be harvested in cool and dry weather. Only those fruits at a suitable stage of maturity, i.e. those of shape, stage of development and normal colour for the variety, shall be harvested. They may also be harvested at the stage of physiological maturity (red).

2.2 Quality characteristics

Selection and sorting shall be carried out immediately after harvesting. Sweet peppers intended for storage shall be sound, clean, turgescent, well developed, without surface moisture, free from unhealed injuries and from damage due to frost (frostbite) and sunburn.

2.3 Storage

Sweet peppers shall be stored as quickly as possible after selection and sorting. Before storage, they should be kept for a few hours in a cool place.

When quality graded and sized, each package shall contain only peppers of the same variety or commercial type and the same grade and size.

Packages shall be handled carefully, in order that the surfaces of the peppers are not damaged.

The packages shall be stacked in such a manner as to ensure uniform air circulation through the stacks.

3 Conditions for storage

3.1 Temperature

The recommended temperatures for storage of Romanian and Hungarian cultivars of sweet peppers are given in annexes B and C respectively. For other cultivars, green peppers should be stored at 7 to 8 °C and red peppers at 4 to 6 °C.

NOTE — The fruit is sensitive to overcooling, which may cause damage.

3.2 Relative humidity

Relative humidity is a factor of great importance for maintaining the turgidity of the fruits.

It is recommended that the relative humidity of the air is between 90 and 95 % in storage spaces.

If the relative humidity of the air falls below 90 %, the turgidity of the fruits may be preserved by covering the piles of boxes with polyethylene sheets which should be raised for 1 to 2 h each day for ventilation purposes.

3.3 Air circulation

The ventilation system used in storage spaces shall ensure constant and uniform temperature and relative humidity.

3.4 Period of storage

The recommended periods of storage of Romanian and Hungarian cultivars of sweet peppers are given in annexes B and C respectively. For other cultivars, the period of storage varies between 10 and 30 days, according to the variety, degree of maturity, climatic conditions and culture system.

3.5 Operations during and at the end of storage

As sweet peppers are perishable, it is recommended that the quality of fruits be checked every 2 to 3 days and that those fruits showing signs of loss of turgidity, or damage caused by disease or insects, be immediately removed.

4 Conditions for transport

4.1 Quality characteristics

Sweet peppers intended to be transported shall be of high quality. They shall correspond to the requirements of 2.2.

4.2 Temperature

Before loading, it is recommended that the peppers be pre-cooled. If the temperature of the fruits exceeds + 18 °C to + 20 °C, they should be rapidly cooled to + 8 °C.

After loading, the temperature conditions during transport depend on the duration of transport as follows :

Duration of transport (days)	Temperature °C
3 to 5	+ 5 to + 8
6 to 10	+ 8
11 to 14	+ 8 to + 8,5

Red peppers may be transported at + 4 °C to + 6 °C.

Cooling slowly in the transport vehicle is conducive to deterioration.

4.3 Packing

For the transport of sweet peppers, use fibreboard, wooden or plastics containers.

4.4 Relative humidity

During transport, the recommended relative humidity is 80 to 90 %.

4.5 Ventilation

The method of storing the peppers in boxes, and the method of stacking in the transport vehicle, shall provide adequate ventilation in order to assist the removal of heat from the mass of produce.

Annex A

Limits of application

This International Standard gives general recommendations.

In view of the great number of varieties and culture systems of this species, this International Standard may be adapted for specific varieties and for the respective pedoclimatic areas.

The recommendations of this International Standard apply only to the storage of sweet peppers over short durations.

Annex B

Romanian cultivars of sweet peppers

Type	Cultivar	Temperature °C	Duration of conservation days
Sweet pepper	Du Danube	+ 7 to + 8	20 to 25
	Bruisma Wonder	+ 7 to + 8	20 to 25
	Export Jaune supérieur Jaune de Banat Favoritul pietei	+ 7 to + 8	10 to 15
Tomato pepper	Rotunda Bucuresteni Superb Urias dulce	+ 4 to + 6	40 to 45
Langs pepper	Lung romanesc Kapia Zlaten medali	+ 4 to + 6	45 to 50

Annex C

Hungarian cultivars of sweet peppers

Type	Cultivars	Temperature °C	Duration of conservation days
Green pepper	White : Cecei Keszthelyi Soroksári Góliát Fehérözön White-green : Szentesi Green : California Wonder Danube Propa	+ 8 to + 9	14
Tomato paprika	Szentesi Pallagi Szarvasi 11	Green : up to 8 to 9 Red : up to 4 to 6	14 35

Tomatoes — Guide to cold storage and refrigerated transport

1 Scope

This International Standard gives guidance on the operations to be carried out before and the conditions to be met during the cold storage and refrigerated transport of tomatoes [*Lycopersicon lycopersicum* (L.) Karsten ex Farw., syn. *Lycopersicon esculentum* Miller nom. cons., syn. *Solanum lycopersicum* L.], for maintaining quality and avoiding deterioration.

These recommendations are not applicable to tomatoes intended for industrial processing.

2 Preparation of tomatoes intended for refrigerated transport and cold storage

2.1 Harvesting

Tomatoes should be harvested in dry weather. Their ripeness at harvest, which is identified by the colour of the tomatoes (see table 1), should be appropriate for the intended duration and conditions of transport, the intended use of the tomatoes and the required duration of storage.

The colour of tomatoes is thus the most important criterion for establishing the harvesting time. The destination and the time at which the fruits will be presented on the market should also be taken into consideration.

Tomatoes should be conditioned, packed and dispatched or stored as soon as possible after harvesting, with a delay not exceeding 12 h.

2.2 Quality

Tomatoes intended for transport or a short period of storage should comply with technical quality standards and specifications established for inland markets or food exportation in the country concerned.

Tomatoes should be conditioned carefully and size graded. They should be sound and clean, have a firmness characteristic of their degree of maturity and be free from excessive surface moisture.

The presence of the peduncle is optional; it depends on the destination of the fruits and does not constitute a condition necessary for successful transport or cold storage. It is important to ensure that the degree of ripeness of a lot of tomatoes is as uniform as possible and therefore the range in colour should not exceed two adjacent degrees on the colour chart (see table 1).

2.3 Packing

Tomatoes intended for cold storage and refrigerated transport may be packed in various types of packages (for example, wooden, fibreboard or plastic materials), provided that the pressure exerted on the fruits does not lead to a reduction in quality during transport or storage. It is considered that for both transport and storage, the total depth of tomatoes packed in layers should not exceed 20 cm.

Good air circulation around and through the packages should also be provided.

2.4 Pre-cooling

If the tomatoes are to be kept under refrigeratio · ıtil they are marketed, they should be pre-cooled.

After the tomatoes have been harvested, con ditioned and packed, they should be pre-cooled t a temperature that differs by no more than 2 °C fron the optimum transport or storage temperature.

To avoid water vapour condensation on the produc pre-cooling of the transport vehicle is also rec ommended.

3 Loading into refrigerated vehicles or cold stores

Tomatoes should be loaded into the transport v hicle or into the cold store as soon as possible, b not later than 24 h, after harvesting.

The quality of the tomatoes is markedly impaired if the temperature of the fruit rises to above 25 °C for even a few hours.

If the optimum temperature range shown in table 1 and in table 2 cannot be maintained, the temperature should be between 6 °C and 25 °C, but the tomatoes should not be held at a temperature outside the optimum range for more than 12 h.

It is recommended that any one transport vehicle or cell is filled with tomatoes of the same degree of ripeness and the same grade and size.

Packs containing tomatoes shall be handled carefully.

If mechanized loading/unloading operations are used in the store, it is recommended that the packs are palletized and secured. When the packs are put into store, it is important to allow for good air circulation.

4 Optimum conditions during refrigerated transport and cold storage[1)]

4.1 Temperature

The optimum temperature to be used during the refrigerated transport and cold storage of tomatoes depends on the degree of ripeness of the tomatoes, the intended duration of transport and storage, and the conditions of distribution. In general, the riper the tomato, the lower the storage temperature it can withstand.

Table 1 specifies recommended storage temperatures as a function of the degree of ripeness of the tomatoes.

Table 1 — Optimum storage temperature in terms of ripeness

Degree of ripeness[1)]	Temperature °C
1	12 to 13
2	10 to 12
3	9 to 10
4	8 to 10
5	6 to 8

1) 1, turning; 2, light pink; 3, pink to light orange; 4, orange to light red; 5, red.

Table 2 specifies recommended temperatures in transport vehicles as a function of the degree of ripeness of the tomatoes and the duration of transport.

If it is necessary to complete the ripening of the tomatoes before distribution, it is recommended that they be kept at a temperature of at least 18 °C but not more than 25 °C for at least 12 h.[1)]

Table 2 — Optimum temperature in transport vehicles in terms of ripeness and duration of transport

Degree of ripeness[1)] at loading	Duration of transport			
	2 days to 3 days		4 days to 6 days	
	Temperature during transportation °C	Degree of ripeness[1)] after transportation	Temperature during transportation °C	Degree of ripeness[1)] after transportation
1	12 to 14	4	12 to 14	5
2	12 to 14	4	12 to 14	5
3	10 to 12	5	10 to 12	5
4	8 to 10	5	6 to 8 8 to 10	5 5
5	8 to 10	5	6 to 8 8 to 10	5 5

1) See table 1.

1) See also ISO 3659:1977, *Fruits and vegetables — Ripening after cold storage.*

4.2 Relative humidity of air

The relative humidity of the air should be maintained constant at (90 ± 3) %.

4.3 Circulation of air

The air circulation in transport vehicles and in cold stores should be such that the appropriate temperature and relative humidity are maintained constant and uniform.

4.4 Duration of storage in cold stores

The maintenance of the quality of tomatoes stored under the conditions of temperature and relative humidity specified varies as a function of the ripeness of the fruits, the storage temperature, the vehicle used for transportation and the cultivar.

Tomatoes are able to maintain their quality under the conditions specified for a period of 7 days to 21 days.

5 Operations to be carried out during storage, at the end of storage and in transport vehicles

During storage, regular quality control of the stored tomatoes is recommended. At the end of a period of storage or transport, the tomatoes should be pre-warmed to avoid condensation of water vapour on the surface of the fruits.

Apples – Guide to cold storage

1 SCOPE AND FIELD OF APPLICATION

This International Standard describes methods for obtaining conditions for the successful cold storage of apples.

The limits of application of this guide are given in the annex.

2 REFERENCE

ISO 2169, *Fruits and vegetables – Physical conditions in cold stores – Definitions and measurement.*

3 CONDITIONS OF HARVESTING AND PUTTING INTO STORE

3.1 Harvesting

The principal criteria used to determine the optimal state of ripeness for harvesting are as follows[1] :

– the ease of picking (the fruit is picked when it is easily separated from its spur; this is not, however, an objective criterion);

– the colour (period of change from green to yellow), which is judged with the aid of standard tables;

– the age of the fruit, expressed as the number of days that have elapsed since full flowering.

These criteria are not universally valid; for a given variety they vary from one region to another and it is for the grower to decide on his own criteria for picking , on the basis of experience.

3.2 Quality characteristics for storage

Fruit put into cold storage should be sound, free from bruises or obvious physiological disorders, and free from any visible sign of fungal or bacterial attack. It should be clean and free from traces of water in the liquid state.

3.3 Various treatments before storage

The practice of pre-ripening should be forbidden, as it is the source of much wastage in storage.

3.4 Putting into store

The fruit should be put into the cold immediately after harvesting.

3.5 Method of storage

The packages should be of such a kind, and so arranged in the cold store, as to permit free circulation of air. As an indication, storage densities of 200 to 250 kg per cubic metre of usable space, for apples in cases, are considered as maxima that should not be exceeded.

The use of box pallets makes possible an increase of 10 to 20 % in storage density.

4 OPTIMUM STORAGE CONDITIONS[2]

4.1 Temperature

Most varieties of European origin keep in the neighbourhood of + 4 °C; a lower temperature is harmful. Apples of American origin, on the other hand, keep well at 0 °C. There are exceptions : for example the Jonathan variety at 0 °C is sometimes affected by the internal browning which is characteristic of low-temperature disorders.

Table 1 gives the recommended temperatures for different varieties entering into international trade. In controlled-atmosphere storage, the storage temperature is sometimes higher, as shown in table 2.

4.2 Relative humidity

The optimum relative humidity for storage of apples is 90 %.

4.3 Air circulation

There should be a uniform distribution of air within the cold store, the rate of mixing being sufficient to keep the spatial differences in temperature and humidity within reasonable limits. Such devices as carbon filters and air washers, to remove volatile organic products of metabolism, are of doubtful value since such gases have no significant physiological effects at the recommended temperature of storage.

1) Tests for the hardness of the flesh, and for the presence of starch, can also be used.

2) For definitions and measurement of the physical quantities affecting storage, see ISO 2169.

If the apples are being stored in air, and the cold store is sufficiently gas-tight for carbon dioxide to accumulate, some means of ventilation should be provided.

4.4 Storage life

Table 1 gives the expected storage life for different varieties entering into international trade, under the storage conditions mentioned above.

It is necessary in every case that the storage is not prolonged beyond limits compatible with the maintenance of good quality.

It is also essential to draw samples of the fruit periodically so as to detect immediately the appearance of wastage during storage. Table 1 shows the susceptibility of these varieties to such wastage.

5 ADJUNCTS AND OTHER METHODS OF KEEPING

5.1 Controlled-atmosphere storage

The following gas mixtures are most frequently recommended[1] :

1)	carbon dioxide	5 %
	oxygen	2 %
	nitrogen	93 %
2)	carbon dioxide	10 %
	oxygen	10 %
	nitrogen	80 %
3)	carbon dioxide	0 %
	oxygen	3 %
	nitrogen	97 %
4)	carbon dioxide	5 to 8 %
	oxygen	12 to 15 %
	nitrogen	difference to 100 %

These compositions are given by way of illustration, and it will be for the experts in each country to give any necessary advice on any other kinds of composition, according to the particular requirements of each variety, as regards the content of carbon dioxide or of oxygen in the atmosphere, or on account of particular local conditions.

Table 2 summarizes, for certain varieties, the gas mixtures which have given the best results, and also the recommended temperature and the expected storage life.

5.2 Storage in plastics packages

The use of certain types of plastics films known to be suitable for contact with food products permits losses in mass during storage to be reduced considerably. Interesting results have been obtained in this way by lining boxes of apples with plastics film or by covering a certain quantity of cases with a plastics tarpaulin.

1) The following similar compositions have also been recommended :

– In Australia :	carbon dioxide	2 to 3 %
	oxygen	2 to 3 %
	nitrogen	94 to 96 %
– In New Zealand :	carbon dioxide	2 %
	oxygen	3 %
	nitrogen	95 %

TABLE 1 – Storage in air

Variety	Recommended temperature °C	Expected storage life months	Susceptibility to wastage during storage
Reine des Reinettes	+ 4	3	– susceptible to internal low-temperature browning below + 2 °C
Cox's Orange Pippin	+ 3 to + 4	3	– bitter pit – internal low-temperature browning below + 3 °C
Belle de Boskoop	+ 3 to + 4	5 to 6	– scald – internal low-temperature browning below to + 3 °C
Jonathan	+ 2 for one month + 1 for the succeeding month and thereafter at 0	4 to 5	– internal low-temperature browning – Jonathan spots – internal browning due to ageing
	+ 3 to + 4	3	
Canada Reinette	+ 4	4 to 5*	– bitter pit – internal low-temperature browning – browning due to ageing
	+ 7	4	
Richared	0	6	
Clochard's Reinette	+ 2	7 to 8	– insufficient colour at temperatures below + 5 °C
	+ 5	5 to 6	
Golden Delicious	- 1 to 0	7	– only for fruits coloured at harvesting
	+ 2 to + 4	5	– soft scald – lenticel rot
Mans Reinette	0 to + 1	7	– late scald – lenticel rot
	+ 3 to + 5	5 to 6	
Stayman Winesap	0 to + 2	4 to 5	– very susceptible to scald and disorders due to fungi
Winesap	0 to + 2	5 to 6	
Red Delicious	0 to + 2	6	– disagreeable flavour after 6 months' storage
Starking (Delicious Red)	0 to + 2	5 to 6	
Winter Banana	+ 2 to + 3	4 to 5	
Calville Blanc	+ 4	5	– bitter pit
Ontario	+ 4	5 to 6	– very susceptible to scald – internal browning at temperatures below + 2 °C
Blenheim Orange	+ 3 to + 4	2 to 3	
Bramley's Seedling	+ 3 to + 4	3 to 4	
Laxton's Superb	+ 3	3 to 4	
Mac Intosh	0 to + 1	4 to 5	– susceptible to internal browning limited to small spots in the seed cavities
Morgenduft = Imperatore	0 to + 2	5 to 7	– scald – lenticel rot
Abbondaza	+ 2 to + 4	4 to 6	– internal low-temperature browning
Rosa di Caldaro	+ 2	5 to 6	– internal low-temperature browning

* The storage life of apples grown at altitude might be prolonged to 6 or 7 months.

TABLE 1 (*concluded*)

Variety	Recommended temperature °C	Expected storage life months	Susceptibility to wastage during storage
Renetta Champagne	0 to + 2	7 to 8	– spots
Granny Smith	0	5	– scald – core browning
Sturmer Pippin	+ 2 to + 3	6	– scald – internal browning

TABLE 2 – Controlled-atmosphere storage

Variety	Recommended temperature °C	Recommended mixtures		Expected storage life months
		Carbon dioxide %	Oxygen %	
Bramley's Seedling	+ 3 to + 4	8 to 10	11 to 13	6 to 8
Cox's Orange Pippin	+ 3 to + 4	5	2,5	4 to 5
		0	2	5
Golden Delicious	0	10	10	7 to 8
		5	2	
		2	3	
Jonathan	+ 3	0	3	6
	+ 3,5	9	12	
		7	13	
	+ 4	6	15	
		8	12	
Starking (Delicious Red)	0	5	3	6 to 8
	+ 3	0 to 3	3	
Laxton's Superb	+ 4,5	10	2,5	6 to 7
		6	14	
Mac Intosh	+ 3,5	5	3	
		7	14	
Winston	+ 2 to + 3	7	13	8 to 9
Belle de Boskoop	+ 4	5	2	6 to 8
Richared	0	5	2	6 to 8
		10	10	6 to 7
Stayman Winesap	0	5	2	6 to 8
Winesap	0	5	2	6 to 8
Sturmer Pippin	+ 2 to + 3	2	3	8
		5	3	
		5	5	
		7	7	
Rome Beauty	0	2	3	7

ANNEX

LIMITS OF APPLICATION – ECOLOGICAL EFFECTS AND DEFECTS ARISING DURING STORAGE

A.1 LIMITS OF APPLICATION

This International Standard provides guidance of a very general nature only. Because of the variability of the fruit according to the time and place of cultivation, local circumstances may make it necessary to specify other conditions of harvesting or other physical conditions in the store.

These recommendations do not apply unreservedly, therefore, to all varieties in all climates, and each specialist will himself decide on any modifications to be made.

Moreover, this International Standard does not take into account the role played by horticultural factors, and wastage during storage is not dealt with. The importance of these two subjects has not been forgotten, but the influential factors (i.e. ecological or agrotechnical factors) are not very well understood; moreover, the origin of many of the most frequent physiological disorders of apples is still uncertain, as are often the appropriate means of combating them. It has therefore seemed difficult to prepare International Standards on these two points.

Nevertheless it has seemed useful to give, in this annex and for purposes of record, a few recommendations which appear sufficiently well founded in the present state of knowledge.

Subject to all possible restrictions arising from the fact that fruits are living material and may vary considerably, the application of the recommendations contained in this International Standard and this annex should enable much wastage in cold storage to be avoided and storage for a satisfactory period to be generally achieved.

A.2 INFLUENCE OF ECOLOGICAL FACTORS

The generally unfavourable influence of certain ecological and agrotechnical factors is now better known.

Under these conditions, and since it is also necessary to supply the market from the first weeks after harvesting, it is desirable not to put into cold storage at all (or only for a short period) fruit of which the unfavourable ecological background is liable to make good keeping a matter of delicate balance. This applies especially to

- fruit of large size;
- fruit from young trees;
- fruit from trees which are lightly loaded or closely pruned;
- fruit from trees which have been too heavily manured or treated with unbalanced fertilizer, particularly if the nitrogen content is too high;
- fruit harvested during a rainy period.

It should also be pointed out that after a cold, damp summer, keeping is delicately balanced and, finally, that irrigation should be carried out with care and that any excess is detrimental to keeping.

A.3 DEFECTS ARISING DURING STORAGE

Generally distinction is made between damage of cryptogamic origin and damage of physiological origin.

A.3.1 Cryptogamic damage

Disorders originating from micro-organisms (whether parasites entering through wounds or latent parasites) are very numerous.

There are hardly any means of combating these, other than preventive measures concerned with

- care in all handling operations;
- sorting of sound from unsound fruit immediately before putting them into the cold store;
- preliminary disinfection of the cold store and packages;
- frequent disinfection of sorting rooms;
- systematic removal of sources of contamination in the orchard (cankers, rotten fruit, etc.);
- use of packages impregnated with antiseptics, if not prohibited.

The use of fungicidal aerosols has been recommended. Certain countries have, however, prohibited these.

A.3.2 Physiological damage

Table 3 classifies the most important data relating to the most frequent disorders.

The data are very general and may not apply to particular local conditions.

Specialists can amplify this table by investigations, in particular, of Jonathan spots, withering, brown heart, and internal browning in the form of small spots between the seed cavities.

TABLE 3 – Storage of apples – Physiological disorders

Designation and description of the disorder	Horticultural factors (ecology, date of harvesting) and factors relating to conditions in cold store provoking or revealing the disorder	Remedies, preventive measures	Susceptible varieties
Frost Glassy appearance of the flesh and epidermis, general softening	– Lowering of temperature below the freezing point	– Prevent the lowering of temperature	
Internal low-temperature browning The flesh acquires a brown colour, and finally the epidermis becomes brown	– Excess of nitrogenous fertilizer – Large fruit and fruit from poor harvest – Long duration of storage at critical temperature (apples at 0 °C instead of + 4 °C)	– Raise the storage temperature for susceptible varieties	– Ontario – Belle de Boskoop – Cox's Orange Pippin – Reine des Reinettes – Jonathan – Canada Reinette – Sturmer Pippin
Internal browning due to ageing The flesh becomes brown, more or less dark; it is dry and mealy	– Late harvest – Delay in placing in the cold store – Large fruit and fruit from poor crops – Glassiness during harvesting – Too long duration of storage	– Storage should not be continued when the risks of internal browning are considerable	– Jonathan – Canada Reinette
Scald Browning of epidermis, in bad cases over the whole area	– Premature harvesting – Large fruit – Insufficient changing of the atmosphere	– Thorough and frequent ventilation of the cold store – Use of controlled atmosphere (use of chemical products or of oiled paper may also be mentioned)	– Ontario – Stayman Winesap – Mans Reinette – Richared – Belle de Boskoop – Starking (Delicious Red) – Granny Smith – Sturmer Pippin
Bitter pit Small depressed spots of irregular shape, dark green in colour changing to brown	– Mineral imbalance in the soil and the tree – Large fruit and fruit from lightly loaded trees – Premature harvesting	– Spraying of orchard with calcium nitrate or calcium chloride (red varieties) First treatment : two weeks after fall of petals (0,5 % solution), then every fortnight	– Cox's Orange Pippin – Canada Reinette – Calville
Internal cork Small brown spots below epidermis. Small brown spot may occur anywhere in the flesh and in the core zone. When the deficiency is acute the fruit is markedly distorted	– Lack of boron	– Application of borax to the orchard (30 kg per hectare) or spraying by sodium pentaborate in the preflcwering stage and at the setting of young fruit (0,02 % solution)	– Canada Reinette – Belle de Boskoop – Granny Smith – Jonathan – Sturmer Pippin – Mac Intosh
Water core Translucent appearance of the flesh, starting at medium depth, continues towards the periphery and then towards the heart	– Hot period accompanied by heavy rains or irrigation	– Suspend the cold storage – Do not continue storage too long	– Delicious – Stayman Winesap – Mans Reinette – Jonathan
Soft scald Light chestnut depressed spots forming a nearly continuous band round the fruit	– Excess of nitrogen – Influence of cold and damp weather – Delay in placing in the cold store – Keeping at too low a temperature	– Use a higher storage temperature	– Golden Delicious – Jonathan – Winter Banana

Green bananas — Guide to storage and transport

0 Introduction

Bananas should be stored, before transport from the exporting country to the place of consumption and throughout the period of transport, in the green condition and, therefore in the preclimacteric phase.

A banana is said to be in the preclimacteric phase when the process of ripening has not yet been initiated.

Harvesting of bananas takes place throughout the year in tropical and sub-tropical regions having considerable variations of an ecological and climatic kind. It follows that the state of dimensional development (fullness) of the banana does not afford a precise criterion of its degree of ripeness. A thin banana (in a period of drought) may be in an advanced degree of ripeness.

Moreover, the degree of ripeness to be chosen depends on the duration of transport, which varies considerably (from a few days to 3 weeks).

The producer should time the cutting of the bananas so that the degree of ripeness (as estimated from their fullness) is compatible with the transport envisaged. The time of cutting therefore depends on two distinct factors : the duration of refrigerated transport and the physiological state of the banana. For this reason the recommendations for the degree of ripeness (see 2.1) cannot be universally applicable and can be only of a general nature which serve as a pointer to the producer, who has to decide on his own criteria for cutting.

As regards examination for ripeness, a bunch of bananas may be likened to a bunch of grapes with fruit in different states of ripeness, and it is therefore essential to specify with what fruit the check is to be carried out.

The state of the bananas (state of health, wounds, etc.), when they enter the store, has an influence on the storage life, and this is the justification for making recommendations on this subject.

The same applies to the precautions to be taken between harvesting the bananas and putting them into the store. The high temperature of the producing areas and exposure to sunlight can appreciably reduce the storage life.

The term *cultivar* is used to indicate that the varieties of bananas entering into commerce are cultivated varieties.

Anti-fungal treatments of the ends of the main stalk or ends of the cushions have not been mentioned, because it is not possible to indicate treatments which are recognized beyond dispute.

1 Scope and field of application

This International Standard describes conditions for the successful keeping, with or without artificial cooling, of green bananas, *Musa* sp., in the preclimacteric phase during storage before transport from the place of production to the place of consumption and during maritime transport.

2 Conditions of harvesting and putting into store

2.1 Harvesting

The degree of ripeness of the banana at harvesting should be determined as a function of its firmness and the number of days elapsing between harvesting and putting into the ripening room. It should not be too advanced, in order that the bananas may remain in the preclimacteric phase until they are put into the ripening room in normal conditions of transport.

2.1.1 Criteria of ripeness

The criteria of ripeness most generally used in practice are :

— the fullness, which is a dimensional criterion;

— the colour of the flesh, which is a criterion of the physiological state and is assessed by means of a conventional colour scale enabling a numerical value to be obtained;

— the firmness of the flesh, which is a criterion of the physiological state and is measured by means of a spring penetrometer (with a cylindrical end 4 mm in diameter, and a spring which is reduced in length by 100 mm under a force of 24,5 N);

— the characteristic odour of the flesh of the banana in the preclimacteric phase.

These criteria are not universally valid and, for each cultivar grown in the same way, they can vary from one region to another, and the producer should decide on his own criteria for cutting.

2.1.2 Examination for degree of ripeness

Examination for the degree of ripeness of a bunch of bananas should be carried out by using the representative fruit found in that part of the bunch which is in the most advanced state of ripeness, i.e. in the first or second hand reckoned from the largest end of the main stalk. The representative fruit is the centre fruit of normal shape in the inside row of the first or second hand. The degrees of ripeness of the fruits of the first and second hand can be considered as equal.

2.2 Quality characteristics for storage and transport

The bananas should be free from signs of attack by fungi, bacteria, insects or animal pests, and should be free from parasites. They should not be injured by fungal or physiological diseases.
In order to avoid the development of fungal diseases during storage, the fruit should be clean. It should not be stained with sap and the fruit stalks should be intact. The main stalk of the bunches should not show marks of sunburn and its two sections should be fresh, clean, and without smears, tears or breaks.

The bananas should be free from evident marks of rubbing, scraping, bruising or sunburn.

Removal of the pistils should be carried out in those producing areas where the climate and conditions of cultivation favour the development of rot. It should be carried out on the tree itself if the size of the banana tree allows this.

2.3 Putting into store

The bananas should be put into cold store for long journeys, or into ventilated store for short journeys, as soon as possible after harvesting. The interval between cutting the bunch and putting it into a refrigerated or ventilated enclosure (pre-refrigeration room, storage room or ship's hold) should be less than 24 h if possible, and should not in any case exceed 48 h.

After harvesting and packaging, if the bananas are awaiting land transport to the port of embarkation, they should be put in the shade and in a well ventilated place.

At the port of embarkation, the waiting time of lorries or wagons loaded with bananas, before transfer to the ship's holds, should be reduced to the minimum and the vehicles should be in the shade.

2.4 Method of storage

Green bananas should be stored :

- in hands or portions of hands (clusters) in cartons;
- in bunches, in bags of perforated polyethylene;
- in bunches, enclosed in a protective mattress which allows gas exchange and has a thermal conductance sufficient to ensure satisfactory cooling (straw, paper, etc.);
- in uncovered bunches, arranged in bulk. This method of storage should be carried out with very great care in order to avoid damaging the bananas, which would lead to deterioration during transport and ripening.

3 Optimum storage and transport conditions (with artificial cooling)

Refrigerated storage and transport of green bananas comprises two phases : cooling and storage.

3.1 Cooling

3.1.1 Rate of cooling

Cooling of the bananas should be carried out as rapidly as possible. It depends on the following factors :

- the power of the refrigeration plant (of the order of 700 to 800 calories per hour per tonne of bananas). With a central refrigeration plant, and loading of the banana vessel divided between two days, it is possible to apply the whole of the refrigerating power of the vessel to the first half of the cargo from the start of refrigeration and to dispose of more than 1 000 calories per hour per tonne of bananas;
- the air circulation ratio[1] in each ventilation section;
- the uniformity and speed of the air circulation across the load;
- the surface of each package in contact with the cooling air;
- the efficiency of ventilation (effect of external and internal short-circuits of the air);
- the mode of packaging (polyethylene wrappers or cardboard boxes of different kinds);
- the method of storage (compact or in stacks);
- the method of loading the banana vessel (continuously or in 2 days with an interval of 12 h at night).

1) *Air-circulation ratio* is defined as the ratio of the volume of air passed in 1 h by the fans to the volume of the empty chamber.

3.1.2 Temperature

The temperature of the bananas is lowered from 25 to 30 °C, which is that of the bananas on loading into the ship's holds, to the practical storage temperature (see 3.2.1).

3.1.3 Relative humidity

The relative humidity of the air at the delivery side varies whilst the bananas are being cooled because the working range of the cold batteries is not stable. It increases at the end of cooling, when it should lie between 85 and 90 % at the entry of the delivered air into the banana compartments.

3.1.4 Air circulation

An *air circulation ratio* of 80 to 100 per ventilation section (collection of compartments, usually two, depending on the same fan or fans) is recommended.

The ventilation system recommended is that with vertically ascending or descending air in series (two compartments superimposed and separate by a slatted floor), with a uniform distribution of air over the surface at the suction side or the delivery side. Each compartment is traversed by all the air delivered by the fans and consequently its air circulation coefficient is double that of the ventilation section.

The rate of air change[1] recommended is one change per hour, but it may be reduced to half a change per hour during cooling in order not to retard this.

3.2 Storage

3.2.1 Temperature

Throughout the period of maritime transport, after cooling of the bananas, it is necessary to ensure that the practical storage temperature of the delivery air is maintained at the value adopted. This is achieved by adding to the critical storage temperature (the temperature which induces damage to the bananas due to cold) a safety margin sufficient to take account of unavoidable temperature fluctuations arising fom the refrigeration plant and its operation (+ 0,2 to + 0,5 °C for a refrigeration plant using brine; + 0,5 to +0,7 °C for a direct expansion plant).

The critical temperature for bananas is not constant, its value depending on the cultivar considered, on the degree of maturity of the crop, its sanitary state, and the duration of the maritime transport.

The following values are given as indications only :

Cultivar	Period of storage days	Critical temperature[2] °C
Gros Michel	12	12
Lacatan	11 to 13	14,4
Poyo (Robusta)	14	12
Grande naine (Giant Governor)	14	12
Petite naine (Dwarf Cavendish)	16	12

3.2.2 Relative humidity

The surface of the air coolers should be designed so that a relative humidity of 85 to 90 % is obtained at the cold point of the refrigerated enclosure in the stabilization period when the cooling of the bananas is completed.

3.2.3 Air circulation

During storage, the air circulation ratio may be reduced to half after the end of the cooling period.

The recommended rate of air change is one change per hour.

3.2.4 Ripening

Ripening of the bananas during storage should be avoided by all possible means. Ripening is accompanied by an increase in the production of carbon dioxide and by the production of ethylene, which is liable to trigger the ripening of the adjacent bananas.

Experience in storage shows that with an efficient ventilation system, ensuring continuous sweeping of all parts of the load by the air circulating in the holds of banana vessel, and with continuous changes of fresh air, carbon dioxide and ethylene can be removed without any action on the adjacent fruit.

The occurrence of an abnormal percentage of [illegible] bananas on discharge of the banana vessel arises from four causes which should be avoided :

- keeping at ambient temperature at the port of arrival;
- loading of bananas at too advanced a stage of ripeness;
- defects in ventilation;
- defects in the refrigeration plant.

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1) The *rate of air change* is the ratio of the volume of outside air introduced into the refrigerated enclosure in 1 h to the volume of the empty enclosure.

2) *Critical temperature* is the temperature from or below which, for a given period of storage, physiological disorders are produced or it is not possible to obtain normal ripening when the product is taken out of storage.

Pears — Guide to cold storage

1 SCOPE AND FIELD OF APPLICATION

This International Standard describes methods for obtaining conditions for the successful cold storage of varieties of pears obtained from *Pyrus communis* Linnaeus until their use in the fresh state.

The limits of application of these methods are given in annex A.

2 REFERENCES

ISO 2169, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement.*

AGRI/WP 1/EUR.STAN.1, *Apples and pears* (revised European Standard, recommended by the Working Group on standardization of perishable goods of the Economic Commission for Europe).

3 CONDITIONS OF HARVEST AND PUTTING INTO STORE

3.1 Harvesting

The practical criteria of ripeness most frequently used for defining the best time for harvesting are[1] :

— the basic colour of the outer skin[2], which is judged with the aid of a standard table;

— the hardness of the flesh, which is estimated by means of a spring penetrometer;

— the ease of picking;

— the presence of starch in the flesh of the fruits; this can be checked by treating a cross-section of the fruit with an iodine-potassium iodide solution.

These criteria are not universally valid; for a given variety they vary from one region to another and it is for the grower to decide on his own criteria for picking, on the basis of experience.

Exact timing of the date of harvesting is more important for early varieties than for late varieties (for example Passe Crassane).

The fixing of the time of harvesting has greater importance for controlled-atmosphere storage than for storage in air.

3.2 Quality characteristics for storage

Fruits put into store shall be of quality "extra" and "I", the characteristics of which are defined in AGRI/WP 1/ EUR.STAN.1.

Fruit put into cold store should be sound, free from bruises or physiological disorders and free from any visible sign of fungal or bacterial attack. It should be clean and free from any trace of water in the liquid state.

3.3 Putting into store

The fruit should be put into the cold store as soon as possible after harvesting, the temperature being lowered to a value suitable for the variety.

3.4 Method of storage

The fruit should be handled with care. The packages should allow free circulation of air. Storage densities of about 250 kg per cubic metre of usable space are recommended for a stack of pallets.

The use of box pallets facilitates an increase of 10 to 20 % in storage density.

4 OPTIMUM CONDITIONS OF STORAGE

4.1 Temperature

The pears should be kept at as low a temperature as possible, subject only to avoiding the risk of freezing. In general, the best results are obtained at −1 to +0,5 °C.

1) The number of days after flowering is also used sometimes as a criterion for harvesting.

2) The basic colour should be distinguished from the red anthocyanin pigmentation, the intensity and extent of which vary according to the variety and, to some extent, with exposure to sunlight.

A difference of 1 °C in storage temperature has a profound effect on the time for which the pears can be kept. It has been shown that, during cold storage, the freezing-point of the fruit falls slightly; it is on this account that, for Williams' Bon Chrétien pear, it has been possible to recommend a method of keeping based on progressive lowering of the temperature (0 °C; −0,3 °C; −0,8 °C; −1,5 °C). This procedure has enabled the storage life to be appreciably prolonged, but it is difficult to carry out since it is not possible to maintain a large bulk of fruit at a sufficiently uniform temperature in a cold store.

The course of development of the fruit during storage depends on the choice of storage temperature. When the temperature of the cold store is low (0 °C, −1 °C) the pears change very little during their period in the cold and it is necessary to submit them to a complementary ripening process at a higher temperature when they leave the cold store. On the other hand, from a certain temperature (+3 °C for Doyenné du Comice pears, +4 °C for Passe Crassane), ripening is slow but can be completed in storage.

Some varieties ripen completely at higher temperatures only if the preliminary period at low temperature has not been too long (for example Comtesse de Paris, Doyenné du Comice, Kaiser, Abbé Fetel, Louise Bonne d'Avranches and Williams' Bon Chrétien).

In certain areas, the variety Passe Crassane ripens normally at higher temperature only if it has previously undergone a sufficiently long period in the cold (of the order of 11 weeks at 0 °C). The duration of ripening may be shortened by treatment of the fruit with suitable substances (ethylene). Ethylene is effective only at the beginning of the storage period. The gas is generally used at concentrations of 1 to 2 ‰, the treatment being carried out at a temperature of +18 to +25 °C and at a relative humidity in the neighbourhood of 90 %.

An accidental rise in storage temperature can initiate ripening, which continues when the fruit is again exposed to the cold.

Finally, certain varieties (for example Curé) do not withstand cold conditions well, and storing them at low temperature is sometimes responsible for the appearance of more or less widespread internal browning.

Table 1, of annex B, gives the temperatures recommended for a number of varieties.

4.2 Relative humidity

Pears may generally be stored at a relative humidity of the order of 90 %. If the atmosphere is drier, the fruit develops a stronger taste and aroma, but the losses in mass are greater.

4.3 Air circulation

It is recommended that the air circulation ratio be 20 to 30 (see ISO 2169), or that a ventilation of 80 to 100 $m^3/t/h$ be used.

4.4 Storage life

Table 1, of annex B, gives the expected storage life under the conditions mentioned above, for a number of varieties. Storage should not be prolonged beyond limits compatible with the maintenance of good quality.

Samples of fruit should be taken in such a way as to detect the appearance of any wastage.

4.5 Operations at the end of storage

Table 1, of annex B, gives the varieties which should undergo a complementary ripening after cold storage.

5 ADJUNCTS AND OTHER KEEPING PROCESSES

5.1 Controlled-atmosphere storage

The following gas mixtures are most frequently recommended :

a)	carbon dioxide	5 %
	oxygen	2 %
	nitrogen	93 %
b)	carbon dioxide	7 to 10 %
	oxygen	10 to 13 %
	nitrogen	80 %
c)	carbon dioxide	7 to 10 %
	oxygen	5 %
	nitrogen	85 to 88 %

These compositions are given only as a guide, and it is for the experts in each country to give any necessary advice on other kinds of compositions according to the particular requirements of each variety, as regards the content of carbon dioxide or of oxygen in the atmosphere or on account of particular local conditions.

It should be noted that the storage disorders called "brown heart" and "hard heart" result from the presence of an excess of carbon dioxide in the atmosphere. It is necessary to avoid the use of mixtures with a high carbon dioxide content for storing varieties known to be susceptible to these disorders (for example Doyenné du Comice, Beurré Bosc, Williams' Bon Chrétien).

Table 2, in annex C, summarizes, for certain varieties, the gas mixtures which have given the best results, and also the recommended temperature and the expected storage life.

5.2 Storage in plastics packages

The use of certain types of plastics films which are known to be suitable for contact with food products permits losses in mass during storage to be reduced considerably and, in certain cases, the storage life in the cold to be prolonged (at 0 °C, it has been possible to keep Doyenné du Comice pears in polyethylene packages for 18 weeks).

Encouraging results have been obtained by lining cases of pears with plastics film.

ANNEX A

LIMITS OF APPLICATION

This International Standard provides guidance of a very general nature only. Because of the variability of the fruit according to the time and place of cultivation, local circumstances may make it necessary to specify other conditions of harvesting or other physical conditions in the store.

This International Standard does not apply unreservedly, therefore, to all varieties in all climates, and each specialist will himself decide on any modifications to be made.

Moreover, this International Standard does not take into account the role played by horticultural factors, and wastage during storage is not dealt with. The importance of these two subjects has not been forgotten, but the influential factors (i.e. ecological or agrotechnical factors) are not very well known; moreover, the origin of many of the most frequent physiological disorders of pears is still uncertain, as are often the appropriate means of combating them. It was therefore considered difficult to prepare recommendations on these two points.

Nevertheless, it was considered useful to give, in annex D, a few recommendations which appear sufficiently well founded in the present state of knowledge.

Subject to all possible restrictions arising from the fact that fruits are living material and may vary considerably, the application of the guidance contained in this International Standard should enable much wastage in cold storage to be avoided and long-term storage to be achieved in most cases.

ANNEX B

TABLE 1 – Storage in air

Variety	Recommended temperature °C	Expected storage life	General remarks
Docteur Guyot	0 to +1	3 to 4 weeks	Complementary ripening necessary
Williams' Bon Chrétien	−1 to 0	9 to 11 weeks	Complementary ripening necessary Susceptible to scald Ripens between +10 and +24 °C only
Beurré Bosc	−1	14 to 28 weeks	Susceptible to brown heart
Beurré Clairgeau	−1 to −0,5	18 to 20 weeks	Complementary ripening necessary Susceptible to scald Susceptible to brown heart
Beurré Diel	+2 to +3	8 to 12 weeks	
Curé	0 to +1	16 to 20 weeks	5 months maximum
Louise Bonne d'Avranches	+2 to +3	6 weeks	Tendency to shrivelling
	−1 to 0	12 weeks	
Doyenné du Comice	−1 to 0	8 to 12 weeks	Complementary ripening necessary Does not ripen further after 2 1/2 months at +1 °C In certain areas does not ripen normally after 2 to 3 months at 0 °C
	+2 to +3	6 weeks	Ripens at this temperature Susceptible to scald
Épine du Mas	0 to +1	12 to 16 weeks	
Beurré Hardy	0	12 to 20 weeks	Complementary ripening necessary
Passe Crassane	0	20 to 22 weeks	Does not ripen normally in some areas unless previously stored in cold conditions (11 weeks at 0 °C)
	+4	about 17 weeks	
Comtesse de Paris	0	20 to 22 weeks	Does not ripen normally after too prolonged a period in the cold
Packham	+2 to +3	8 weeks	
	−1 to 0	18 to 20 weeks	
Conference	0 to −1	24 to 28 weeks	
Comtesse de Charnoux	−0,5	8 to 20 weeks	Complementary ripening necessary
Abate Fetel	0	10 to 12 weeks	Does not ripen normally after 3 months of storage

ANNEX C

TABLE 2 – Controlled-atmosphere storage

Variety	Temperature °C	Recommended mixtures		Reference	Expected storage life
		Carbon dioxide %	Oxygen %		
Williams' Bon Chrétien[1]	−1 to 0	4 5	2 5	France	24 weeks
		2 to 4	2	Germany	16 to 20 weeks
		5	16	Australia	
		5 to 10	2,5	USA	
		5	5	Canada	
Beurré Bosc	0	5	16	Australia	22 weeks
Beurré Diel	0	10	10	Switzerland	
Doyenné du Comice	0	5	2 to 3	United Kingdom	Not very satisfactory
		10	10	Switzerland	
Beurré Hardy	0	10	10	USA	
Passe Crassane	+1	5 to 10	5	France	28 to 32 weeks
	0	10	10	Switzerland	
	6 to 8	10	2 to 10	Italy	
Packham	0	5	16	Australia	

1) The controlled-atmosphere storage of Williams pears is delicately balanced, as it entails the need to harvest fruit, intended for this kind of cold storage, at exactly the right time.

In some countries, such as the United Kingdom, controlled-atmosphere storage is no longer recommended for this variety.

ANNEX D

ROLE OF THE GROWER AND WASTAGE DURING STORAGE

D.0 INTRODUCTION

The following recommendations on the role of the grower and on wastage during storage are, as in the main text, of a very general nature. It therefore rests with specialists to amplify them, if necessary, in a manner appropriate to their national varieties.

D.1 ROLE OF THE GROWER (Influence of ecology and method of cultivation)

The generally unfavourable influence of certain ecological and agrotechnical factors is now better known.

Under these conditions, and since it is also necessary to supply the market from the first weeks after harvesting, it is desirable not to put into cold storage at all (or to put in only for a short period) fruit of which the unfavourable ecological background is liable to make good keeping a matter of delicate balance. This applies especially to

- fruit of large size;
- fruit from young trees;
- fruit from trees which are lightly loaded or closely pruned;
- fruit from trees which have been too heavily manured or treated with unbalanced fertilizer, particularly if the nitrogen content is too high;
- fruit harvested during a rainy period.

It should also be pointed out that after a cold, damp summer, keeping is delicately balanced, and finally that irrigation should be carried out with care and that any excess is detrimental to keeping.

D.2 WASTAGE IN STORAGE

In general, a distinction is made between cryptogamic and physiological disorders.

D.2.1 Cryptogamic disorders

Disorders originating from micro-organisms (whether parasites entering through wounds, or latent parasites) are very numerous. There are hardly any means of combating these, other than preventive measures concerned with :

- care in all handling operations;
- sorting of sound from unsound fruit immediately before putting them into the cold store;
- preliminary disinfection of the cold store and packages;
- frequent disinfection of sorting rooms;
- systematic removal of sources of contamination in the orchard (cankers, rotten fruit, etc.);
- use of packages impregnated with antiseptics, if not prohibited.

The use of fungicidal aerosols has been recommended. Some countries have, however, prohibited these.

D.2.2 Physiological disorders

Table 3 classifies the most important data relating to the most frequent disorders.

The data are very general and may not apply to particular local conditions.

Specialists may amplify the table by investigations, in particular, of withering and of brown heart.

TABLE 3 – Physiological disorders

Designation and description of the change	Horticultural factors (ecology, date of harvesting) and factors relating to conditions in the cold store provoking or revealing the disorder	Remedies, preventive measures	Susceptible varieties
Frost Glassy appearance of the flesh and epidermis, general softening.	– Lowering of temperature below the freezing point	– Prevent the lowering of temperature	
Brown heart Dark brown zone in the neighbourhood of the core. Fissures appear later.	– Late harvesting – Delay in putting into cold storage – Excessive concentration of carbon dioxide	– Avoid high contents of carbon dioxide	– Beurré Bosc – Beurré Clairgeau
Internal browning due to ageing The flesh becomes brown, more or less dark; it is dry and mealy.	– Late harvesting – Delay in putting into cold storage – Large fruit and fruit from poor harvest – Too long duration of storage	– Storage should not be continued when the risks of internal browning are considerable	– Passe Crassane – Clapp's Favorite – Williams
Scald Browning of epidermis, over whole area in bad cases.	– Premature harvesting – Large fruit – Insufficient changing of the atmosphere	– Thorough and frequent ventilation of the cold store – Use of controlled atmosphere – The following may also be mentioned : use of chemical products and oiled paper	– Williams'[1] Bon Chrétien – Beurré Clairgeau – Doyenné du Comice – Packham – Curé – Beurré Hardenport

1) It should be mentioned that scald on Williams' Bon Chrétien pears is not of the same kind as that found on apples or on other varieties of pears, and that the preventive measures suggested are therefore not suitable for the Williams variety and for certain other varieties of pears.

Asparagus — Guide to storage

1 Scope and field of application

This International Standard describes methods for obtaining conditions for the successful keeping of shoots of the species *Asparagus officinalis* Linnaeus intended, after storage, either for direct consumption or for industrial processing.

2 Reference

ISO 2169, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement.*

3 Conditions of harvesting and putting into store

3.1 Harvesting

The asparagus shoots should be harvested at a development stage corresponding to the quality requirements specified in the relevant product standard.

3.2 Quality characteristics for storage

Asparagus shoots intended for storage should appear fresh, and should be clean, sound, firm, smooth, well formed, and free from bruises and visible damage caused by insects or diseases. The heads or tips should be closed.

Shoots of bleached asparagus should be fully etiolated.

According to the cultivar, the head or tip and sometimes the shoot may be white, pale yellow or lilac. The shoots of green asparagus should be uniformly green.

3.3 Putting into store

The asparagus shoots should be free from earth and other foreign matter. They may be washed if necessary. They should be put into store as soon as possible after harvesting. It is recommended that, to the extent permitted by the prevailing technical conditions, an initial refrigeration be effected to cool the asparagus shoots from field temperature to 7 °C, before they are put into store. This temperature is a transition to subsequent storage at a lower temperature. Efficient pre-cooling can also be obtained using cold water or ice water; the asparagus shoots should not remain in water for more than 1 h.

Before storage, the asparagus shoots should be layered in boxes, without bundling; they should be put into store in this state (for example, 12 kg of shoots should be put into boxes of 15 kg capacity).

4 Optimum storage conditions[1)]

4.1 Temperature

Asparagus is a vegetable liable to be damaged by refrigeration; therefore, storage temperature and intended time of storage have to be carefully related.

During storage, the optimum temperature limits for keeping are from + 1 °C to + 2 °C. The minimum of + 1 °C is recommended because fluctuation of temperature may reach 0,5 °C, and practical experience has shown that shoots stored at a temperature below 0,5 °C are likely to be damaged.

If the intended period of storage is 10 days or shorter, the asparagus shoots may be kept successfully at 0,5 °C. However, at this temperature the period of 10 days should not be exceeded because of the likelihood of damage.

4.2 Relative humidity

The relative humidity should be kept at 90 to 95 %.

4.3 Air circulation

The boxes and the way in which they are stacked should allow the temperature and relative humidity to be maintained constant and uniform, within the limits mentioned in 4.1 and 4.2, by air circulation.

4.4 Storage life

It is recommended that asparagus shoots be stored for as short a period as possible. According to the cultivar, the quality and the temperature, the asparagus shoots should not be stored for longer than 10 to 20 days (time required for refrigerated transport and for distribution included).

1) For definitions and measurement of the physical quantities effecting storage, see ISO 2169.

Carrots — Guide to storage

1 Scope and field of application

This International Standard describes methods for obtaining conditions for the successful conservation, with or without artificial cooling, of carrots of varieties of *Daucus carota* Linnaeus.

It applies only to carrots produced for storage during the winter.

See also the limits of application given in the annex.

2 Reference

ISO 2169, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement.*

3 Conditions of harvesting and putting into store

3.1 Harvesting

For storage purposes, it is recommended that carrots originating preferably from late sowing should be selected. The carrots should be harvested in good time and should not be overmature. The tops should be cut off at the level of the crown, without damaging the roots.

If harvesting is carried out in wet weather, the carrots should be dried for just as long as necessary before storage, avoiding excessive dehydration which adversely affects keeping.

Cultivation in soils which are too rich in assimilable nitrogen may adversely affect the keeping quality of the carrots during the storage period.

3.2 Quality characteristics for storage

Carrots intended for storage should be firm, sound, not run to seed, not frozen, free from abnormal external moisture, unwithered, whole, and free from bruises.

If carrots are harvested from heavy, wet soil, it is practically impossible and even inadvisable to remove the adhering earth mechanically. General experience has shown that carrots keep better with the earth adhering. Washing before storage is not recommended, whereas after storage there is no objection to washing and this may even be necessary.

3.3 Putting into store

The carrots should be put into store as soon as possible after being harvested.

Carrots should not be put into storage with other fruit and vegetables which produce ethylene.

3.4 Method of storage

The carrots may be stored in box-pallets, boxes or bags, or in bulk. If they are stored in bulk, the height of the layer of carrots should be specified according to the hardness of the variety of carrot, the quality of the lot and the condition of the ventilation device. The maximum recommended height is 2 to 3 m. In the case of bags, the maximum height is 3 m.

Perforated plastics films may be used, either as internal linings of boxes or for covering stacks of boxes.

4 Optimum storage conditions[1)]

4.1 Temperature

The storage temperature should be kept between 0 and + 5 °C. The optimum keeping temperature is between 0 and + 1 °C.

4.2 Relative humidity

In refrigerated chambers where the temperature is maintained between 0 and + 1 °C, the relative humidity should be maintained at 95 to 98 %; in chambers provided with fans (without artificial cooling), where the temperature varies from + 1 to + 5 °C, the relative humidity should be maintained at 90 to 95 %.

4.3 Air circulation

The air circulation should make it possible to keep the temperature and relative humidity constant and uniform within the limits mentioned in 4.1 and 4.2. The circulation should be particularly vigorous, i.e. 100 to 120 $m^3/(t \cdot h)$, when the carrots are stored in bulk and the height approaches the maximum value specified.

4.4 Storage life

The expected storage life is from 4 to 6 months.

1) For definitions and measurement of the physical quantities affecting storage, see ISO 2169.

Garlic — Guide to cold storage

1 Scope and field of application

This International Standard describes a method of cold storage allowing conditions to be obtained for the successful keeping of garlic (*Allium sativum* Linnaeus) intended for consumption in the fresh state.

The limits of application of the method are given in the annex.

2 Conditions of harvesting and putting into store

2.1 Harvesting

Garlic intended for storage should be harvested when the tips of the leaves begin to turn yellow and the mass of the bulb no longer increases. The bulbs should be well formed, physiologically at rest, the protective exterior scale being dry and of characteristic colour.

Harvesting should be carried out during dry weather, over a short period of time.

2.2 Quality characteristics for storage

Only those varieties (cultivars) of garlic suitable for long-term keeping should be stored. Garlic intended for cold storage should be of good commercial quality. It should be clean, dry, whole, firm, ripe but not sprouting, and healthy, with a dry exterior scale, and should be free from all field- and store pests (nematodes and mites).

2.3 Various treatments

After harvesting, the garlic should be dried. This operation is begun in the fields and is continued in the stores. Disinfection of the bulbs with methyl bromide (bromomethane) is permissible only for garlic to be used for seed.

2.4 Putting into store

With the exception of onion, garlic should not be stored with other produce. The stores should be filled within a short period of time.

2.5 Method of storage

Garlic should be packed for storage in cases (boxes), box pallets (boxes which can be stored on pallets), metal mesh containers or sacks which can be stored on pallets.

Sacks should be filled in a manner that ensures air circulation. The packages should be whole, clean and disinfected. Box pallets or sacks on post pallets may be stacked up to five or six high, whilst, in the case of boxes which can be stored on pallets, stacking may be up to 8 or 9 high, leaving spaces to allow the circulation of air in all directions.

A space of about 1,50 m should be left both below and above the stacks.

3 Optimum storage conditions

3.1 Temperature

Garlic should be dried in the store at 20 to 30 °C for 8 to 10 days. The temperature should then be reduced to 0 °C and this temperature should be maintained throughout the period of storage, variations not exceeding ± 0,5 °C.

3.2 Relative humidity

During drying, and subsequently during storage, the relative humidity of the air should be maintained between [illegible].

3.3 Air circulation

Air circulation should be maintained permanently to ensure a homogeneous temperature.

3.4 Storage life

The storage life varies with the variety (cultivar) and method of cultivation from 130 to 220 days. The condition of the stored produce should be checked every 7 to 10 days.

3.5 Operations at the end of storage

When removed from the coldroom, the garlic should be gradually rewarmed to avoid condensation forming on the surface of the product.

If required, the garlic should be sorted according to quality.

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Peaches — Guide to cold storage

1 SCOPE AND FIELD OF APPLICATION

This International Standard describes methods for obtaining conditions for the successful cold storage of varieties of peaches (peaches, nectarines and clingstone peaches) obtained from *Prunus Persica* Sieb. and Zucc. immediately after picking until their use in the fresh state.

The limits of application of these methods are given in annex A.

2 REFERENCES

ISO 2169, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement.*

AGRI/WP 1/EUR.STAN.6, *Peaches* (revised European Standard, recommended by the Working Group on standardization of perishable goods, of the Economic Commission for Europe).

3 CONDITIONS OF HARVEST AND PUTTING INTO STORE

3.1 Harvesting

It is difficult to characterize the degree of maturity for harvesting. The practical criteria of maturity most frequently used for determining the best time for harvesting are :

- the basic ground colour[1] of the outer skin;
- the hardness of the flesh, estimated by means of a spring penetrometer;
- the age of the fruit from full flowering.

These criteria are not universally valid; for a given variety they vary from one region to another and it is for the grower to decide on his own criteria for picking, on the basis of experience.

The basic ground colour and the recommended hardness vary according to the variety. In general, it is advisable to pick the fruit at the time when their colour is changing from green and yellow. At the time of picking, the flesh should be firm, somewhat juicy, with a slight aroma and slight acidity.

3.2 Quality characteristics for storage

Only fruit of quality "extra" and "I", the characteristics of which are defined in AGRI/WP 1/EUR.STAN.6, should be put into store.

Fruit put into cold store should be sound, free from bruises or physiological disorders and free from any visible sign of fungal or bacterial attack. It should also be clean.

3.3 Various treatments

For most varieties, the fruit should be rapidly cooled after harvesting. Certain varieties, for example Elberta and Red Haven, are sensitive to this treatment, however, and show a tendency to a cotton-wool texture. Treatment with iced water, to which sodium hypochlorite has been added, has sometimes been recommended, as has treatment with wax.

3.4 Putting into store

The fruit should be put into the cold store as soon as possible after harvesting.

3.5 Method of storage

The fruit should be handled with care. Packages should contain only a single layer of fruit. Storage densities of the order of 200 to 220 kg per cubic metre of usable space are recommended for a stack of pallets.

4 OPTIMUM CONDITIONS OF STORAGE

4.1 Temperature

Temperatures of −1 to 2 °C, subject to exception, have been recommended. A period of 2 to 5 days at a higher temperature, before the fruit is put into the cold, may avoid the development of a cotton-wool texture in certain varieties which are susceptible to this disorder, for example 2 to 3 days at 24 °C for Elberta and Red Haven varieties.

The table given in annex B gives the recommended temperatures for a number of varieties.

1) The basic ground colour should be distinguished from the anthocyanin red pigmentation, the intensity and extent of which vary according to the variety and to a certain extent with exposure to sunlight.

4.2 Relative humidity

The optimum relative humidity for the storage of peaches is 90 %.

4.3 Air circulation

An air circulation ratio of 20 to 25 (see ISO 2169), or a ventilation of 80 to 100 $m^3/t/h$ is recommended.

4.4 Storage life

According to the variety, keeping for 2 to 6 weeks at 0 °C may be expected.

Storage should not be prolonged beyond limits compatible with the maintenance of good quality.

Samples of fruit should be taken in such a way as to detect the appearance of any wastage.

The table given in annex B shows the expected storage life for a number of varieties.

4.5 Operations at the end of cold storage

In certain cases, complementary ripening may be needed at the end of the period in the cold store. Good results have been obtained with ripening temperatures of 18 to 20 °C. If cold storage has been too prolonged, the fruit is, in many cases, no longer capable of ripening normally.

5 CONTROLLED-ATMOSPHERE STORAGE

Good results have been obtained for certain varieties at 0 °C with atmospheres containing 8 to 10 % of carbon dioxide and 11 to 13 % of oxygen. Certain varieties, however, keep badly if the content of carbon dioxide reaches 10 %. Mixtures containing 2 % of oxygen and 0 to 5 % of carbon dioxide have also been recommended. In this field, every variety has its special requirements. Thus, for the Elberta variety, the following gas mixtures have been used :

2 % carbon dioxide, 2 % oxygen;

2 % carbon dioxide, 5 % oxygen;

5 % carbon dioxide, 2 % oxygen.

ANNEX A

LIMITS OF APPLICATION

This International Standard provides guidance of a very general nature only. Because of the variability of the fruit according to the time and place of cultivation, local circumstances may make it necessary to specify other conditions of harvesting or other physical conditions in the store.

This International Standard does not apply unreservedly, therefore, to all varieties in all climates, and each specialist will himself decide on any modifications to be made.

Moreover, this International Standard does not take into account the role played by horticultural factors, and wastage during storage is not dealt with. The importance of these two subjects has not been forgotten, but the influential factors (i.e. ecological or agrotechnical factors) are not very well known. Moreover, the origin of many of the most frequent physiological disorders of peaches is still uncertain, as are often the appropriate means of combating them. It was therefore considered difficult to prepare recommendations on these two points.

Nevertheless, it was considered useful to give in annex C, for information only, a few recommendations which appear sufficiently well founded in the present state of knowledge.

Subject to all possible restrictions arising from the fact that fruits are living material and may vary considerably, the rigorous application of the recommendations contained in this International Standard should enable much wastage in cold storage to be avoided and in most cases long-term storage to be achieved.

ANNEX B

TABLE – Storage in air

Variety	Recommended temperature °C	Expected storage life weeks	General remarks
Madeleine Pouget	2 to 4	2 to 3	
Mayflower	0 to 2	2 to 3	
Adenot	0 to 2	2 to 3	
Amsden	0 to 2	2 to 3	
Incomparable Guillou	0 to 2	2 to 3	
Ribet	0 to 2	2 to 3	
Précoce de Halle	0	2 to 4	
Dixired	2 to 4	2 to 4	After 4 weeks, tendency to a cotton-wool texture
Fair Haven	0 to 2	2 to 4	
Red Haven	0 to 2	2 to 4	
Southland	0 to 2	2 to 4	
Elberta	−1 to 0	2 to 4	Require 3 days of complementary ripening. Tendency to cotton-wool texture. 24 h in 1 % of acetylene at 24 °C, then 12 h in air at 24 °C, counters cotton-wool texture. A period of 2 to 5 days at 24 °C before putting into cold storage enables the storage life to be extended by 1 week.
J.H. Hale	−1 to 0	4 to 6	
Collins	0 to 2	2 to 3	
Cardinal	0 to 2	2 to 3	
Flacăra	−1 to 0	4 to 6	

ANNEX C

WASTAGE IN STORAGE

C.0 INTRODUCTION

The following recommendations on wastage in storage are, as in the main text, of a very general nature. It therefore rests with specialists to amplify them, if necessary, in a manner appropriate for their national varieties.

In general, a distinction is made between cryptogamic and physiological disorders.

C.1 CRYPTOGAMIC DISORDERS

Disorders originating from micro-organisms, whether they are parasites entering through wounds, or latent parasites, are very numerous.

Hardly any means exist for combating these, other than preventive measures concerned with :

- the systematic removal of sources of contamination in the orchard (cankers, rotten fruit, etc.);
- care in all handling operations;
- the sorting of sound from unsound fruit immediately before putting them into the cold store;
- the preliminary disinfection of the cold store and packages;
- the frequent disinfection of the sorting rooms;
- the use of packages impregnated with antiseptics, if this is not prohibited.

C.2 PHYSIOLOGICAL DISORDERS

The most frequent physiological disorders are internal browning and cotton-wool texture.

C.2.1 Internal browning

Internal browning is usually clearly evident around the stone and often spreads out radially.

Possible causes may be :

- storage at too low a temperature;
- storage for too long a period.

C.2.2 Cotton-wool texture

Cotton-wool texture is usually observed only at temperatures from 2 to 4 °C, and is rarely met at 0 °C. It appears in the cold as well as during complementary ripening.

Methods which have been recommended for overcoming woolliness are :

- storage at 0 °C;
- a preliminary period at higher temperature (see 4.1).

It may also be noted that too long a storage at a temperature which is usually tolerated may hinder the development of aroma and may favour the appearance of a reddish coloration in the flesh, or of the disorders previously described.

Strawberries — Guide to cold storage

1 Scope and field of application

This International Standard describes the optimum conditions for the cold storage of varieties (cultivars) of fresh strawberries (genus *Fragaria*) intended for marketing in the fresh condition or for processing.

The limits of application are given in annex A.

2 Conditions of harvesting and putting into store

2.1 Harvesting

Strawberries should be harvested in the coolest part of the day, the best time for picking being early morning in dry weather. The proper stage of maturity for picking is determined by the area and intensity of the red colour. Most varieties should be harvested when three-quarters of the surface possesses the colour specific to the variety. The fruit should be picked by pinching off the stem of each berry between the thumb and forefinger. A portion of stem, about 1 cm long, should be left on each berry.

Strawberries intended for the market should be picked with their calyxes and stems intact. Strawberries intended for processing may be harvested without calyxes.

No more than one fruit should be gathered in one hand.

During picking, the fruit should be sorted immediately into containers by quality groups, without any transfer to other containers. They should be placed directly in baskets, trays, punnets or other containers to avoid further handling and should be packed in a manner that avoids damage (degradation) of the fruits during handling and storage.

Containers for strawberries intended for consumption in the fresh condition should be robust and should not be completely filled. They should protect the fruits from dust.

The airspace between the upper layer of fruits and the bottom of the superimposed container should be at least 2 cm to allow free circulation of air.

To avoid damaging the fruits, they should be handled with care during picking and storage.

If, during picking, the atmospheric conditions are wet and cold, the fruit is more susceptible to grey mould.

2.2 Qualitative characteristics for storage

Strawberries intended for cold storage should be whole, sound, fresh, clean (but unwashed) and free from rot, insect attack, external humidity and foreign odour or taste.

2.3 Various treatments

Because of their perishability, the strawberries should be precooled for several hours after picking to remove natural heat. Precooling by means of a jet of cold air is preferred.

2.4 Putting into store

Strawberries should be put into the cold store immediately after harvesting and precooling.

2.5 Method of storage

The containers should be handled with care. They may be stacked, provided this is done in such a way as to ensure good circulation of air across the fruit, and so as to avoid crushing the containers underneath.

Units of containers should be placed on pallets or on a slatted floor.

To ensure the strength of the containers and to make the most economic use of the store, the containers should be stacked on post pallets which should then be stacked to the height permitted by the store.

3 Optimum storage conditions

3.1 Temperature

The optimum temperature is from 0 to 2,5 °C. The temperature may rise to 6 °C, but under conditions such that variations are minimized. The permitted variation is ± 1 °C.

At 0 °C, the heat produced by respiration corresponds to 700 to 960 kcal/t/h; at 5 °C, this rises to 900 to 1 900 kcal/t/h.

3.2 Relative humidity

The optimum relative humidity of the air is from [illegible] 90 %

3.3 Air circulation

Intense air circulation is desirable during the period of cooling to accelerate and homogenize the cooling of the bulk.

3.4 Storage life

Strawberries may be stored at the recommended optimum storage temperature for 3 to 8 days, according to the quality of the fruit, its destination, the rate of cooling and the storage conditions.

The maximum periods at 0 °C may be :

a) for strawberries with calyxes and stems :

1) intended for the fresh fruit market : 3 to 6 days,

2) intended for processing : 8 days;

b) for strawberries with neither calyxes nor stems : 3 days.

At the higher temperature, the period of keeping will be accordingly shorter; for example, at 6 °C, the period would be for one day only. After these periods of storage, the fruits begin to lose their freshness, their bright colour, and show some shrivelling; there are also losses due to decay and deterioration in flavour.

Throughout the period of storage, the strawberries should be examined every day to assess their degree of maturity and to detect the development of any diseases (see annex B).

3.5 Operations at the end of storage

When removed from the cold store, strawberries intended for the market should be gradually warmed (to avoid condensation); once the strawberries have been made commercially available, cooling should be discontinued. The fruit should be sent for marketing or processing as soon as possible after removal from the store.

Annex A

Limits of application

This International Standard provides guidance of a very general nature only. Because of the variability of the fruit according to horticultural factors, local circumstances may make it necessary to specify different conditions of harvesting or other physical conditions in the store.

The recommendations in this International Standard do not apply unreservedly, therefore, and it will remain for each specialist to be the judge of any modifications to be made.

Strawberries belong to the class of perishable fruits, which are susceptible to deterioration. They breathe intensely and ripen rapidly. Thus, strawberries are not stored for a long period of time and their storage life is very short. However, they sometimes have to be stored for a few days and, in this case, cold storage is recommended.

Annex B

Disinfection and cryptogamic disorders

B.1 Disinfection

To prevent cryptogamic disorders, the following measures are recommended :

- preliminary disinfection of the cold store and of the packages;
- the use of packages impregnated with authorized antiseptics.

B.2 Cryptogamic disorders

The two most important diseases that develop on strawberries during the period of storage originate from the micro-organisms *Botrytis cinerea* (grey mould) and *Rhizopus sp.* The former is a particular cause of loss of strawberries in the field, but it is also serious during storage. *Rhizopus* causes very soft rot of strawberries, which develops mostly during transit, storage and marketing, when the temperatures are above 10 °C.

Round-headed cabbage — Storage in the open

0 Introduction

Cold storage of round-headed cabbage is practically unknown in a number of countries; on the other hand, storage in enclosed spaces, without artificial cooling, is better known, but most round-headed cabbage is commonly stored in clamps (temporary silos) constructed outdoors. This has resulted in the storage technique being largely dependent on local conditions, but, although the simple methods of storage are very well known, it is also necessary to describe them.

1 Scope and field of application

This International Standard lays down guidelines relating to the technique of storing round-headed cabbage (*Brassica oleracea* var. *capitata* Linnaeus sv. *alba* and *Brassica olerancea* var. *capitata* sv. *rubra*) outdoors, to allow a quality suitable for consumption or industrial use to be maintained.

2 Harvest and storage conditions

2.1 Cultivars

The storage techniques described apply equally to all cultivars of cabbage, the keeping of which is of economic interest. Differences due to the weather, soil conditions and other environmental factors in various regions and growing areas, are considerably greater than differencies in cultivars.

However, cabbages of the late cultivars are generally more suitable for storage; so are cabbages grown in light or semi-compact soil.

2.2 Harvest

Cabbages intended for storage shall be ripe, headed and firm. A late harvest favours cracking during storage.

Cabbages harvested from humid soils are less suitable for storage, and irrigation should, therefore, be stopped at least 15 days before harvesting. They shall be harvested in dry weather, at a temperature below 10 °C. The optimum temperatures range from 0 to 5 °C. To avoid damage caused by freezing, cabbages shall not be harvested, handled or transported if the outdoor temperature is below 0 °C. It is recommended that cabbages harvested in wet weather be allowed to dry before storage.

The stem of the heads shall be cut between 1 and 2 cm below the level of the outer leaves; the cut shall be clean and smooth.

2.3 Quality

Cabbages intended for storage shall be whole, fresh in appearance, undamaged, sound and healthy, clean, and, in particular, free of soil and traces of water. Heads showing signs of attack by parasites or diseases or showing pronounced bruises or deterioration due to freezing shall be rejected.

Before storage, it is convenient to remove dead or damaged outer leaves from the heads.

Heads having a mass between 2 and 2,5 kg are most suitable for storage in the open air.

2.4 Putting into store

Cabbage of convenient maturity and suitable for storage shall be put into store as quickly as possible after harvesting. Prior to putting into store, however, the crop shall be dried in a ventilated place protected against frost. During drying, the outer leaves lose their brittle character and adhere tightly to the head. Dried cabbages are less sensitive to damage and disease. The duration of drying shall be 36 to 48 h when cabbages are not sufficiently dry during selection.

It is recommended that cabbages be stored at low temperatures.

2.5 Method of storage

The clamp (a cabbage pile of a roughly triangular cross-section) shall be situated in a location sheltered from water or atmospheric condensation, orientated, if possible, to take into account the prevailing winds. The depth, height, covering and ventilation of clamps vary according to country; different types of clamps may be combined :

- clamps with or without ventilation channels;
- clamps with or without covering;
- underground or soil surface clamps.

Underground clamps provide better storage conditions, notably more uniform temperatures and humidities. However, these types of clamp can be installed only in light and sandy soils and in dry soils. Soil surface clamps are constructed on

compact and heavy soils and on wet soils; in this case, the ground has to be level and clean.

The clamps may be of different sizes. For small clamps (width 1 to 1,2 m), ventilation channels are not usually provided. Such clamps are covered successively with thin layers of insulating materials above the cabbages and by thicker layers of material towards the outside. This allows the required conditions of ventilation to be obtained when the internal temperature drops. In these small clamps, the amount of heat evolved by the cabbages in respiration is lost through the covering layers of the clamps. Also, in clamps without ventilation, the carbon dioxide content increases due to respiration, which is advantageous for the stored cabbage.

Larger clamps (width 1,5 to 2,0 m) have to be ventilated in order to be quickly cooled and to expel the excessive heat evolved during respiration in the larger clamps after the cabbage is stored in the autumn. The ventilation channels have to be covered or uncovered according to the internal and external temperatures of the clamp.

The depths of underground clamps may be 20 to 60 cm. The ventilation channel, constructed from boards, shall be placed along the longitudinal axis of the clamp with its end protruding for a few centimetres.

Ventilation systems vary according to country. Ventilation of the clamps shall be assured by

— horizontal ventilation channels, of internal dimensions 20 to 30 cm and 40 to 50 cm longer at both ends than the base of the clamp;

— vertical ventilation channels, of internal dimensions 15 to 20 cm, of height 150 to 180 cm, and 40 to 50 cm higher than the clamp. Allowance should be made for channels every 2 m.

The recommended width of clamps is between 100 and 180 cm, and the corresponding height is from 70 to 140 cm (although other recommendations require a minimum width of 160 cm, with a permissible clamp height of up to 200 cm). The length of the clamp may be from 15 to 25 m.

The clamp base shall be covered with a layer of clean straw, 10 to 15 cm thick. For outdoor storage in clamps, provision should be made for 15 kg of straw per 100 kg of cabbage. Planks or open-work (lattice) crates may also be used as the foundation. The cabbages should be placed in rows with the cores pointing upwards. Each layer should contain cabbages of the same size.

The choice of the method of storage of cabbages in clamps depends upon local circumstances and conditions, but should guarantee that :

— in autumn, cabbages are cooled as quickly as possible to a temperature of 0 to + 1,0 °C;

— low and constant temperature and uniform humidity are maintained throughout the clamp for the full duration of storage;

— there is protection against the temperature dropping below 0 °C.

The methods and materials used for covering the clamps vary according to local conditions and depend on the ambient temperature and atmospheric humidity. The most important factor, however, is the rate of atmospheric precipitation. Thus the following may be used :

— a covering of earth (sand) in layers, directly over the cabbages;

— a single cover put directly on the clamp surface only;

— covering of the clamp with straw, cornstalk or other similar material, protected by a plastic film;

— a straw cover combined with an external covering of earth;

— covering with any other material locally available.

It is not necessary to provide a ventilation system if the stored cabbage has been pre-cooled and if there is only a thin covering. For this purpose, the heads of cabbage are stored in two or three layers, in a 300 cm wide clamp, sunk into the ground and covered with a layer of light sandy soil. The covering should allow the cabbage to cool as quickly as possible. When the temperature of the cabbage falls to 0 to + 1 °C, and the outdoor temperature is below freezing point, it is necessary to use a thicker covering, for example an earth layer, 10 to 20 cm thick, then over this, a straw layer 20 to 25 cm thick, and another earth layer, 10 to 15 cm thick. Such covering will be sufficient in the case of temperatures down to −20 °C. At lower temperatures, the thickness of the covering has to be increased.

The different storage methods and the various climatic conditions do not permit specification of the dimensions for clamps. The following data is given for information only.

Dimensions of clamp	Ground area of clamp	Mass in one clamp	Ground area required for 10 t
cm	m^2	t	m^2
150 × 120 × 2 500	37,5	7,4	300
200 × 170 × 2 500	50,0	14,0	175

The mass of 1 m^3 of cabbage is about 350 kg, and, in the case of red cabbage, about 450 kg.

Clamps should be placed with the longitudinal sides at least 5 to 6 m apart without the cover; the ends of the clamps should be at least 3 m apart.

3 Optimum storage conditions

Values for temperature, relative humidity, and ventilation rates for clamps in the open cannot be exactly specified, as these parameters are difficult to control and depend on the predominant weather conditions. For this reason, this International Standard does not specify the conditions of storage but specifies the operations necessary for their determination

3.1 Optimum temperature and its control

During storage, the temperature of the clamp should be checked three times a week during autumn, and at least twice a week in winter.

The optimum storage temperature is from 0 to + 1 °C. It is necessary to ensure that the temperature in the clamp does not fall below freezing point for extended periods.

It is equally dangerous if the temperature in the clamp exceeds 5 to 6 °C, and a temperature greater than 8 °C can provoke deterioration.

The temperature shall be measured by means of a thermometer at places 10 m apart along both sides of the clamp. At each place, the thermometer shall be introduced half way up the clamp side, perpendicularly to the layer of earth, and at a depth such that the end of the thermometer reaches the upper surfaces of the cabbages in the clamp. It shall be left from 15 to 20 min in the clamp before the temperature is measured.

The clamps shall be regularly checked during storage and all cracks and gaps shall be blocked up. If the outside temperature falls to freezing point, and if the clamp is not covered with snow, it is necessary to protect it by additional layers of earth. For this purpose, corn stalks, straw covered by tarpaulin etc., followed by another layer of earth, may be used.

During checking, a collapsed edge, a slumped side, or snow melting more quickly in certain places, is a sign of putrefaction of the cabbages.

Sporadic putrefaction of the outer leaves is not a hazard to the stored cabbages, but in the case of significant areas of putrefaction, the clamp must be demolished.

If the external air temperature remains at about 5 °C for 4 to 5 days, the earth layer shall be removed; above 10 °C, cabbages cannot be kept for more than a short time.

3.2 Relative humidity

The optimum relative humidity is from 85 to 90 % (0,85 to 0,90); it should be higher, rather than lower, than this value.

3.3 Duration of storage

Round-headed cabbage may be stored for a short duration up to December or January, or for a longer period up to March or April.

3.4 Covering of the clamps

The constructed clamp shall be loosely covered with a soft straw layer, 20 to 25 cm thick. This straw layer can be made thicker or covered with earth if the external temperature falls to − 1 to − 2 °C, or when the cabbage has properly cooled off.

Earth can also be used directly to cover the clamp — as straw, in contact with the cabbage, may cause mould to grow on the cabbage — by placing a layer of earth only a few centimetres thick over the cabbages. When the clamp has cooled and prior to the advent of a stronger frost, cover the clamp with straw, or any other insulating material, or with a second layer of earth.

If the external temperature continues to decrease and the temperature in the clamp approaches, or reaches freezing point, apply a further layer of earth to the clamp. This settled earth layer shall be of a thickness of about 10 cm. Frozen earth shall not be used. For this purpose, cover the soil adjacent to the clamp, to a width of 50 to 60 cm, with a layer of straw 5 to 10 cm thick prior to the advent of the first frost. Use the earth from under the straw layer for extra covering.

Covering clamps is also important in places where the autumn temperature does not approach freezing point. In this case, cabbage under the thin covering will cool off during the night and warm up less in the day-time.

3.5 Sorting and termination of storage

If the outside temperature exceeds + 5 °C for a long time, a careful check must be made for damage due to putrefaction. Extensive rot may necessitate the opening of the clamp, thus terminating storage. This is achieved by dismantling the clamp. The cabbages shall be removed from one end (face) of the clamp. They shall be removed by hand as the use of forks may impair the quality. The opened clamp shall be covered again if there is a risk of frost, but such covering shall be exclusively with straw.

The cabbages should be carefully sorted and the outer withered or rotten leaves should be removed; the stem should be cut shorter. Afterwards, the recovered cabbages may be marketed after vigorous grading to ensure a quality in accordance with local standards.

Annex A

List of round-headed cabbage varieties recommended for long periods of outdoor storage

Producting country	Recommended varieties
Hungary	Amager, Danish durable, and some regional varieties
Netherlands	Langedijker bewaarwitte, Langedijker bewaargele, Langedijker bewaarrode
Poland	Langedijker, white and red Kamienna Glowa Zimowa z Mor
Romania	White : Amager, Braunschweig, de Buzău, Licurişça Red : Arges, L 403, Cap de negru
USSR	Amager, Zirnovka, Beloruskaja, Podarok

NOTE – The list of recommended varieties will be completed later when further information is available from other cabbage producing countries.

Annex B

Comments

The following comments refer to the role of the area of production and to unforeseen difficulties of storage.

B.1 Role of the area of production (Ecological and production method influences)

These influences, which manifest themselves in the case of round-headed cabbage put into cold store, are equally valid in the case of cabbage stored in clamps.

The following are especially unfavourable influences :

— premature or late harvest, having possibly run to seed;

— heads not sufficiently compact;

— soils over-treated with nitrogenous fertilizers, or moist and compact soils;

— harvest in the rainy season, wetness of the cabbage;

— lesions caused by frost, excessive loss of leaves, or stems cut too short.

B.2 Unforeseen difficulties in storage

Taking into account the range of diseases which can occur in storage, only a brief review is given.

B.2.1 Moisture or frost

Cabbage stored in a moist or frozen condition may become fusty. This can be prevented by appropriate treatment, for example in the case of fustiness that has not yet spread extensively, by selection, moving and cooling, after which the sound heads can remain in storage. In more serious cases, and after the apparition of mould, the cabbages are no longer worth storing in clamps.

B.2.2 Freezing

The outer leaves of frozen cabbage are brittle, and wither and turn yellow after having been thawed. On cutting, the leaves appear vitreous and brown. After thawing, frozen cabbage must be used immediately as it cannot be further stored.

B.2.3 Grey mould (*Botrytis cinerea*)

This appears usually on moist, fusty, or damaged cabbages. The diseased leaves are covered by a layer of grey mould under which the leaves will brown and decay. The advent of grey mould can be prevented by careful handling during preparation and storage, and by protecting the cabbages from mechanical damage.

B.2.4 Black vein (*Pseudomonas campestris*)

The plant becomes infected with microbes in the area of production. The microbes propagate within the veins of the cabbage leaves, making the veins black. Often the disease is only visible after splitting the head. The diseased cabbage should not be used even for forage.

During selection, check for bacterial infection by boring and store only the cabbages showing no signs of infection.

Round-headed cabbage — Guide to cold storage and refrigerated transport

1 Scope

This International Standard gives guidance on the operations to be carried out before and the conditions to be met during the cold storage and refrigerated transport of round-headed cabbages (*Brassica oleracea* L. var. *capitata* L., and *Brassica oleracea* L. var. *sabauda* L.), for maintaining quality and avoiding deterioration.

This International Standard is applicable to round-headed cabbages intended for human consumption.

2 Conditions of harvesting and storage

2.1 Harvesting

Cabbages should be harvested when ripe (firm "head"), i.e. when the size and form of the head of the cabbage is characteristic of the cultivar in question, and during a period of dry weather.

NOTE 1 Premature harvesting may lead to an excessive tendency of the cabbages to wither and, conversely, delayed harvesting may induce bursting of the cabbages.

The best period for harvesting is early in the morning, in dry weather, in the absence of dew and, in the case of irrigated cultivation, 10 days to 15 days after the last irrigation (in order to avoid excessive turgidity of the tissues, cracks in the heads and rotting leaves).

Cabbages harvested in wet weather should be allowed to dry before being stored and transported.

Cabbages damaged or frozen, even partially, should be rejected.

The butt should be cut off slightly below the point from which the outer leaves originate, the latter remaining firmly attached. The cut should be made cleanly and the butt should have a maximum length of 3 cm, in order to avoid cabbages being damaged by mechanical action during handling.

2.2 Characteristics for storage

Late varieties of cabbage are recommended for storage.

Cabbages intended for storage should be sound, of good quality, not run to seed and, depending on the cultivar, of mass 1,6 kg to 3 kg for white cabbage, and 1 kg to 2 kg for red cabbage.

Cabbages should be free from disease and physiological defects.

The heads should be well covered and free from parasites, bruises and damage or injuries due to frost. They should be clean and free from earth fragments or other foreign materials. Their content of agrochemical product residues should not exceed the limits established by the relevant producing or importing country.

The heads should be free from abnormal surface moisture. They should be covered by at least one layer of outer leaves.

2.3 Place of storage

Cabbages should be stored in refrigerated cells of maximum capacity 500 t; the cells should be previously disinfected, free from insects and vermin, aerated and cooled.

The storage of cabbages in the vicinity of products which emit ethylene should be avoided since this may affect the quality of the cabbage by inducing cracks in the head of the cabbage and yellowing and abscission of the leaves.

The time taken to fill a cell should be no longer than 7 days.

2.4 Method of storage

Cabbages may be stored in bulk or in standardized containers.

Cabbages stored in bulk should be ventilated in the vertical direction, and the depth of cabbages in any stack should not exceed 3 m.

Cabbages stored in standardized containers should be ventilated in the vertical or in the horizontal direction or in top-ventilated cells. The height of stacks should not exceed 6 m, and a minimum free space of 80 cm should be left between the top row of containers and the ceiling of the cell. The cabbages should be arranged in rows with their butts facing upwards.

The storage system should ensure good air circulation; it is therefore necessary to leave a space of 5 cm to 10 cm between stacks, and a space of about 65 cm between stacks and the wall.

3 Optimum storage conditions[1)]

3.1 Air temperature

The average air temperature in the cold store should be maintained between 0 °C and 1 °C.

The temperature at the centre of a stack should also be between 0 °C and 1 °C, although white cabbage is able to tolerate a temperature of −0,8 °C.

NOTE 2 Reducing the temperature to below −0,8 °C may cause decomposition of leaf tissue.

Owing to the respiration of cabbages, the temperature at the centre of a stack will increase rapidly if the stacking pattern is incorrect and the ventilation inadequate, and therefore the product temperature should be monitored within representative stacks.

3.2 Relative humidity

The relative humidity should be maintained between 90 % and 98 %.

3.3 Air circulation

The air circulation during storage and transportation should be such (0,25 m/s to 0,40 m/s) that the temperature and relative humidity specified in 3.1 and 3.2 are maintained constant and uniform.

3.4 Storage life and quality control

The storage life of cabbages depends on the cultivar, the quality and the storage conditions (see annex A). The storage life of most cultivars falls into one of three categories: short term (3 months to 5 months), mid term (4 months to 6 months) and long term (5 months to 7 months).

During the storage period, regular quality control of the product should be carried out.

4 Operations at the end of storage

Before marketing, it is necessary to examine cabbages and to discard yellowed or diseased outer leaves, to retrim the butt if necessary, and to discard split or rotten heads.

5 Refrigerated transport

To maintain their quality during transportation, cabbages should be packed in containers standardized in the country concerned.

The duration of transport may be 2 days to 3 days at a temperature of 0 °C to 15 °C, or 8 days to 10 days at a temperature of 0 °C to 1 °C.

1) See also ISO 2169:1981, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement.*

Annex A
(informative)

Influence of horticultural factors on storage life, and defects arising during storage

A.1 Influence of horticultural factors on storage life

Certain ecological or agrotechnical factors have an adverse effect on the storage life of cabbages. These factors may be summarized as follows:

a) cabbages which are harvested too early or too late (e.g. cabbages which have burst or run to seed);

b) cabbages (particularly spring, summer and autumn varieties) having leaves which are excessively curled and which do not adhere tightly to the head;

c) cabbages from land which has been over-treated with nitrogenous fertilizer;

d) cabbages harvested in wet weather;

e) cabbage heads damaged by lesions caused by frost (see note 3), or which have lost most of their leaves or which have had too much of their tops knocked off.

NOTE 3 Certains cultivars of green cabbage which are resistant to cold are able to withstand temperatures slightly below 0 °C but not freezing.

A.2 Defects arising during storage

In general, a distinction is made between damage of physiological origin and damage of biological origin.

A.2.1 Physiological damage

Physiological damage may be characterized by

a) desiccation of the outer leaves, owing to insufficient relative humidity during storage;

b) a glassy appearance of the leaves when the storage temperature has been too low (freezing); the leaves will turn brown on warming;

c) the appearance of small brown specks, owing to lack of oxygen during storage (lack of oxygen occurs when the cabbage or its container is covered with plastic film);

d) loss of the outer leaves or bursting, due to physiological disorders.

A.2.2 Biological damage

Biological damage may be due to bacterial decomposition such as blackening of the veins, caused by *Pseudomonas campestris*, or fungal deterioration.