PUBLICATION 543
FARMERS' BULLETIN 21

ISSUED OCTOBER, 1936
FIRST PRINTING

DOMINION OF CANADA—DEPARTMENT OF AGRICULTURE

THE PACKING AND TRANSPORTATION OF NOVA SCOTIA APPLES

A co-operative project of the Dominion and Nova Scotia Departments of Agriculture carried on under the supervision of the Nova Scotia Horticultural Committee

ed by authority of the Hon. JAMES G. GARDINER, Minister of Agriculture
Ottawa, Canada

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THE PACKING AND TRANSPORTATION OF NOVA SCOTIA APPLES*

INTRODUCTION

The problems connected with handling Nova Scotia apples are numerous and complex. In the past, useful information has been obtained from experiments dealing with particular phases of the subject but the work reported in this bulletin is the outcome of the first really comprehensive study of the subject as a whole. Of perhaps greater importance is the fact that whenever possible information has been statistically analysed, and differences between treatments have been subjected to rigid mathematical tests. In addition, observations by those technical officers who accompanied the experimental shipments are included in this report and they are of great value.

The necessity of correlating all factors can be illustrated by the shipment of a poorly coopered barrel. At the commencement of its journey overseas the barrel may appear to be quite sound and rigid, but upon arrival in England, although the barrel is still intact, in many cases the fruit will be badly bruised. The real reason for these bruised apples is the gradual loosening of the hoops and staves. The slackness which caused the bruising could be due to rough handling, long holding after packing, high temperatures with shrinkage, etc. Although the grower may complain about the poor returns on such a barrel he is seldom in a position to place his finger on the real trouble.

All growers realize the months of effort entailed to produce an apple of the highest quality and yet the few days after it is picked are just as vital. The growth activities are greatly stimulated when the fruit is removed from the spur, and if this vitality is allowed to waste away, the resistance of the apple to subsequent handling is reduced to a minimum. The links of the entire chain of handling operations are essentially interdependent and any of the links or operations which fail to reach the high standard required in these days of keen competition will definitely weaken that chain.

The success of these investigations was only assured by co-operation of all parties concerned and each voluntarily laid himself open to criticism and correction in the light of such a searching analysis.

The experiments were conducted over a period of two years, 1934 and 1935. During this period weather conditions were very different; in 1934 the temperature fluctuated widely and was relatively high at the time of the Gravenstein shipment, whereas uniform cool conditions prevailed in 1935 and the weather was almost ideal for harvesting operations.

MEAN TEMPERATURES FOR SEPTEMBER AND OCTOBER, 1934-1935, EXPERIMENTAL STATION, KENTVILLE

Year	September			October		
	Maximum	Minimum	Average	Maximum	Minimum	Average
1934.....	73·93	52·50	63·22	54·42	39·61	47·02
1935.....	65·16	46·47	55·81	58·22	35·97	47·10

* A co-operative project of the Dominion and Nova Scotia Departments of Agriculture carried on under the supervision of the Nova Scotia Horticultural Committee.

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In 1934 five shipments were made with the following varieties: Gravenstein, King, Ribston and Cox Orange, Wagener, and Northern Spy. The scope of the investigations covered the following points:—

1. Type of barrel.
2. Methods of shaking and filling barrels.
3. Use of pads, paper liners and oiled paper.
4. Methods of handling at the docks at Halifax.
5. Temperature conditions and effects.
6. Analysis of barrel atmospheres during ocean transit.
7. Size of fruit in sample barrels.
8. Study of tights and slacks.
9. Ground colour.

In 1935 only two shipments were made and a study was made of the methods of shaking and filling barrels; temperature conditions and effects; tights and slacks; ground colour and the effect of turning the heads after storage.

No attempt is made in this report to deal separately with each shipment or each factor in relation to each shipment but rather to discuss the findings in their own logical sequence; that is, from orchard to auction.

HANDLING FROM ORCHARD TO WAREHOUSE

Observations during the time the fruit passed over the grader showed that bruises and barrel rubs were quite frequent, which indicates the necessity of careful picking, care in filling barrels, smooth transportation from the orchard and avoidance of unnecessary jolting in the course of loading, and unloading. In addition, there were some indications that it is preferable to use barrels with staves smooth inside for orchard work in order to reduce barrel rubs. It was found in picking the Northern Spy that the use of picking boxes reduced rubs from 15·6 per cent to 9·6 per cent. These boxes should be made with tongued-and-grooved sides.

Great variation was found in the quality and size of fruit from different localities, which is extremely important from an experimental standpoint and should not be overlooked in practice because uniformity of pack is the sole basis for the buyer's confidence in the grade. Growers should, if possible, carry out a certain amount of preliminary grading in the orchard, grouping the large fruit from lightly laden trees apart from the average run.

Picking during high temperature periods means that the fruit will retain its heat for a longer period. Naturally it is a difficult matter to allow for such a contingency, but the cooler the fruit is kept during picking and packing, the longer it will remain in prime condition. Immediate cooling after picking means that the fruit can be left on the tree to reach full maturity without fear of over-mature arrivals on distant markets. These points are stressed in view of the practice of some growers of allowing the picked fruit to stand in the orchards for several days at a time when temperatures are high. It is also a wise move to place freshly picked fruit in storages which have been previously cooled as much as possible before usage. The temperature effects are of great importance throughout the entire season but where fruit is to be held any length of time prior to shipment, temperature then becomes the dominant factor in subsequent marketability.

TYPES OF BARREL

Four different types of barrel were used, namely: the Ontario hardwood barrel, the Nova Scotia softwood barrel with the split birch, elm, and ash hoops and made to standard specifications.

In the King shipment the following types of barrels were also used: the plywood or Waterloo barrel, the tongued-and-grooved, the ash-hoop and elm-hoop

barrels. In the Spy shipment the three-quarter barrel was used in addition to the four types mentioned above. One hundred and forty-four half-barrels were also used for the shipment of Cox Orange forwarded with the Ribston shipment.

The softwood barrels made up with split birch, ash, or elm hoops were much the same with regard to bruising effects. It was noted that there were more barrel rubs in barrels made of rough softwood staves. After considering all types of hoops used on the softwood barrel it was found that the flat elm hoop when well driven, nailed and the nails clinched, made a rigid package and remained cleaner in handling than barrels with hoops of other types.

Data on all barrel types, however, showed that no one type was superior in all respects. The plywood or Waterloo barrel was found to be unsuitable. This barrel was standard size as to content but made with straight sides of three-ply veneer in one piece. The heads were of the same material, reinforced around the edges with a half-inch square hardwood strip and fastened with special brads. Although the smooth inside surface reduced barrel rubs the straight sides rendered its stowage with ordinary barrels unsatisfactory and the shape of the package made it unsuitable to withstand shocks during handling.

The tongued-and-grooved softwood barrels with the staves smooth inside and out, the hardwood elm-hoop (Ontario) barrel, and the Nova Scotia softwood barrel, both smooth inside, reduced the amount of severe bruising and chafing as compared with the other types.

The three-quarter barrel which was used in the Northern Spy shipment was found to be quite unsatisfactory for the large-sized apples, as they arrived slack, and consequently more barrel rubs and severe bruises were recorded than in other lots.

The half-barrel carried Cox Orange apples excellently but fruit larger than $2\frac{1}{2}$ inches appeared to be unsuited to this package.

In brief, it may be said that the barrel type to be preferred is one made of good stock, well coopered, with the quarter hoops well driven, nailed and the nails properly clinched, and clean inside and out. For the purpose of clinching the use of a metal block against the nail on the inside of the barrel is recommended. Nails should be of sufficient length to allow for adequate clinching.

USE OF PADS, PAPER LINERS AND OILED PAPER

Closely allied to the type of barrel is the consideration of other methods of reducing barrel rubs and end bruises and increasing the attractiveness of the package. Excelsior pads were found to be desirable in reducing bruises in the tail although corrugated paper pads proved to be quite satisfactory in a later shipment (1935). Pulp heads were found to be sufficient in the head of the barrel; pads were unnecessary. Bruising was not affected by paper liners but barrel rubs were reduced.

The main thing to be borne in mind, however, with regard to liners is the great improvement which is obtained in appearance. The same applies with regard to shredded paper in the face in colours which form a bright contrast to that of the fruit. Results further showed that wads of shredded paper prevented bruising to much the same extent as excelsior pads. In so far as scald control is concerned the paper should be scattered through the barrel at the time of picking when the apples and packages are dry. Several barrels of Gravenstein were stained by the paper, and therefore the grower is advised to make sure that he purchases only non-staining paper.

It may be thought that the use of a barrel with a smooth interior will obviate the need for liners. From the point of view of chafing such may be the case but when the necessity for attractiveness in market appeal of high-grade fruit is considered such a move would be false economy.

SHAKING AND FILLING

In this category each individual has his own preconceived notions and what is poor shaking to one is good enough for another. It is therefore necessary in such a fundamental practice as this to find common ground in order to insure uniformity.

The term shaking is used to describe the shaking of the barrel to settle the fruit during the filling operation. The term racking is defined as shaking of the barrel after it is filled, with the use of a follower or shaker to settle the fruit before heading.

In filling the barrels the following methods were used with the Gravenstein, Ribston, and Northern Spy shipments:—

1. Barrels lightly shaken (three times), filled level with the croze, racked seven times.
2. Barrels slightly shaken (three times), filled half way between croze and top of staves and racked seven times.
3. Barrels lightly shaken (three times), filled well rounded above staves and racked seven times.

A duplicate series as to height of fill was put up, but instead of three shakings during the fill six shakings were given, or as each apronful was lowered into the barrel. This series was well racked. The fruit was jarred fourteen times during the process. The barrels were quartered between each series of shakes and during the final racking.

Comparison was also made in these three shipments of the ring tail and jumble tail methods. From the results of these tests it would seem that height of fill and amount of shaking are closely associated. Lightly shaken barrels filled to the top of the staves and well shaken filled level with the croze showed much less bruising than those barrels well shaken and filled to the top of the staves or those lightly shaken and filled level with the croze. High filling inevitably results in over pressing and severe bruising whilst lightly shaken barrels, it has been found, arrive slack with a high percentage of bruised fruit. In addition, barrel rubs were materially reduced in the well-shaken series.

The value of careful ring tailing was shown by a reduction of severe bruising due to the more uniform surface which allowed for even distribution of pressure on the fruit when the header was used.

There were some indications that russeted varieties should be filled slightly higher in the barrel than the smooth-skinned varieties.

Although no direct comparisons are available, the results with the King shipment in 1934 and the Ribston shipment in 1935 point significantly to the fact that suitable mechanical shaking undoubtedly offers the greatest opportunity for the obtainment of a uniformly tight pack. Furthermore, mechanical shaking eliminates the possibility of careless hand shaking and in some cases the complete omission of this necessary practice.

The above findings, while they may be in a sense foregone conclusions, do emphasize the need for some standard method in barrel packing.

MISCELLANEOUS OBSERVATIONS

It was noted during the course of the packing operations that there was too great a tendency to bump the apples while leading on to the grading table. Poorly coopered barrels should be eliminated for overseas shipment or for orchard handling. Loosely and poorly faced barrels invariably arrive on the market slack. Further slacking is often due to packing over-mature fruit, which will shrink or rot, and lastly, fruit from " off trees " which is excessively large should be graded separately.

Under this heading some observations made with regard to nailing and stencilling are pertinent. It was noted that barrels on the overseas market were nailed in a great number of ways. The most satisfactory methods are either placing ten nails equally spaced and driven into the head of the barrel level with the croze or with two headliners and fewer nails.

A great number of stencils observed were so crowded and blurred as to be scarcely recognizable. This can be avoided by using clean, planed and if possible two-piece heads, with brief concise markings.

TEMPERATURE RELATIONS IN THE WAREHOUSE COLD STORAGES AND DURING RAILWAY TRANSIT

Accurate records of temperature were kept throughout the entire experiments, that of the fruit by means of fruit thermometers, and air temperatures by means of recording thermographs placed in the warehouses and railroad cars. A special multiple indicating resistance thermometer apparatus was used for fruit and air temperatures in connection with a test on an iced car between Kentville and Halifax. It was also used for the records obtained in the holds during the ocean crossing.

Precooling of the fruit was carried out at the Kentville Experimental Station cold storage and also at the Halifax Cold Storage and, during one shipment, fruit was held in a local cold storage plant.

During the fall of 1934 the temperature fluctuated within wide limits and during the period over which the Gravenstein shipment was undertaken maximum daily temperatures averaged 73·5°F.; on the other hand, the period for the corresponding shipment in 1935 which went forward on September 24 (three days later than in 1934) averaged 63·6°F.

There were four main storage treatments, which included cooling in the Valley and at Halifax, cold storage on the boat, and common storage throughout. In addition, the practicability of icing cars at Kentville was investigated.

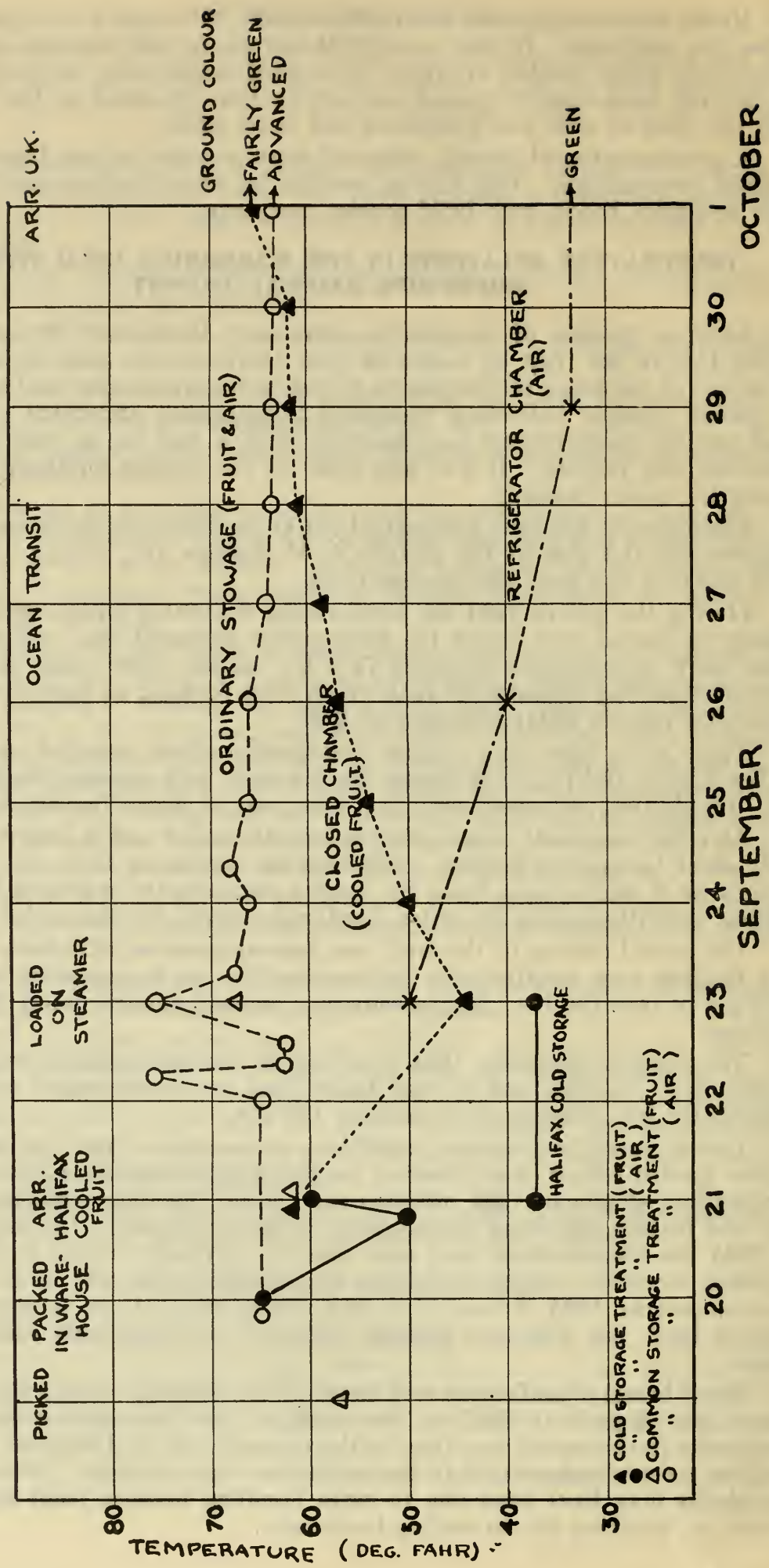
An effort was made to have the cooled lots packed and in cold storage within forty-eight hours after picking. Although the cooling in 1934 was not as satisfactory as it might have been, the results undoubtedly indicated the value of cooling, notwithstanding the extra handling required by the cooled lots.

The actual cooling of the fruit was accomplished in 1935 both at Kentville and Halifax very satisfactorily by lowering the air temperature to 20°F. and with aid of fans the fruit temperature was lowered approximately 20 degrees in 30 hours.

The Ribston shipment, 1934, was held in cool and common storage for six weeks before moving and it was found that rot development was decidedly reduced by low temperature treatment (32°F.).

Under warm temperature conditions over-mature fruit, as evidenced by yellow ground colour, was observed on the English market at the time of the Gravenstein shipment, 1934, whereas the cooled lots were considerably greener and less mature, and were consequently in better demand. On the other hand, in 1935 the temperatures were such that the ordinary stored fruit arrived in excellent condition and the cooled lots were distinctly greener. With the Gravenstein shipments, 1935, it was noted that cooling reduced the amount of severely bruised fruit, but with the Ribston shipment no appreciable differences were found.

Slack barrel classification was shown to be different on the English market from that adopted at Halifax; for example, the Gravensteins had distinctly less slacks in the cooled lots than in the common lots at Liverpool, whereas the Halifax records indicated that the conditions were reversed. Then again, the tap slacks may have been due to extra handling because local tests failed to detect any slacking due to cooling treatments.


TEMPERATURE CONDITIONS
SHIPMENT OF GRAVENSTEIN APPLES, 1934
PICKED
PACKED IN WARE-HOUSE
ARR. HALIFAX COOLED FRUIT
LOADED ON STEAMER
OCEAN TRANSIT
ARR. U.K.
GROUND COLOUR
FAIRLY GREEN
ADVANCED
GREEN
ORDINARY STOWAGE (FRUIT & AIR)
CLOSED CHAMBER (COOLED FRUIT)
REFRIGERATOR CHAMBER (AIR)
HALIFAX COLD STORAGE
▲ COLD STORAGE TREATMENT (FRUIT)
● " " (AIR)
△ COMMON STORAGE TREATMENT (FRUIT)
○ " " (AIR)
TEMPERATURE (DEG. FAHR.)
80
70
60
50
40
30
20
21
22
23
24
25
26
27
28
29
30
1
SEPTEMBER
OCTOBER

In 1934 a car was iced just before loading, no attempt was made to cool the car and no salt was used. Such a method, it was shown, had very little, if any, cooling effect. Inside air temperatures upon arrival actually registered one degree higher than outside temperatures. However, in 1935 the cooled lots were shipped in a car which was previously cooled down with ice and salt to about 41°F. at the time of loading, and the fruit and air remained at this temperature until unloaded at Halifax.

Briefly, then, it would seem that using ice only in a warm car is of little value and that fruit already cooled may be kept cool if the car is properly iced with ice and salt.

METHODS OF HANDLING AT HALIFAX

Two methods of handling the barrels from the railroad car to the ship's side were tested, namely, rolling on the bilge and carrying on trucks. Rolling on the chime was abandoned as being impossible under the circumstances.

In so far as bruising effects were concerned neither of the above methods could be differentiated, one showing slightly more bruising at Halifax and the other slightly more at London. Differences were very marked, however, in regard to the cleanliness of the barrel and on this account trucking is recommended and the shipping companies have generally adopted this method.

Bumping and jolting are the main causes of bruising in dock handling and for this reason the platform sling has largely displaced the rope sling for loading the barrels into the ship's holds.

GENERAL OBSERVATIONS

Most of the bruising may be attributed first of all to bumping; secondly, to poorly coopered barrels which lacked rigidity; and lastly, to loosely packed barrels.

The cars should be cleaned out before being loaded and on no account should stones be used for chocks. Evidence of such poor methods were noted from time to time as demonstrated by dirty barrels and broken staves.

It was noticed that while provision was made to land the platform slings in the holds onto pads, in some instances barrels were rolled off the top tier with nothing to ease bumping of barrel on barrel. Bumping barrels on their ends is a particularly bad practice.

The use of dunnage under the chimes of barrels in the bottom tier and tiering bilge on chime in the ship's hold reduces the possibility of damage and assists in making for better weight distribution.

TEMPERATURES IN THE SHIPS' HOLDS

Three types of stowage were used on board ship: first, ordinary stowage for common stored lots; second, closed insulated space for cooled fruit; and third refrigerated space. The last was usually maintained at about 36°F. and no fruit temperatures were taken under these conditions during the voyage.

Two sets of resistance thermometer cables were installed, one in ordinary stowage and the other in the closed space. By this means air and fruit temperatures were recorded in different parts of the stack three times a day. In addition, air temperatures on the bridge and that of the sea water were obtained from the ship's log. Records were taken of the ventilation facilities and the times during which they were in operation. The ventilation facilities were on the whole good and every effort was made to prevent the fruit from heating in the ordinary stowage space. This was accomplished on some ships by temporary air ducts which ran down to the bottom of the hold. These were connected to canvas windsails which caught the air and produced a downward

draught. In addition, four force draught fans were operated one hour in every four, which delivered over 4,000 cubic feet per minute into the hold. In favourable weather the hatches were removed so that under all conditions there was little chance of hot air accumulation. In the King shipment, for example, the ordinary stored fruit arrived at a temperature of 50°F. although outside temperatures rose to 59°F.

The cooled fruit in the closed insulated space was characterized by an approximately consistent one and one-half degree rise per day, so that temperatures upon arrival approximated those recorded in ordinary stowage. This rise in temperature may have been due to the high temperatures of the chambers when the fruit was placed and the vital heat given off by the fruit itself.

In conjunction with these records daily analysis of the air inside barrels was undertaken in the Gravenstein shipment, the temperature conditions of which were relatively high. The maximum concentration of carbon dioxide recorded was 6 per cent, which is not enough gas to harm the fruit but may have rather a beneficial effect (carbon dioxide in air 0·03 per cent).

METHODS OF HANDLING AT UNITED KINGDOM PORTS

The practice of using rope slings is still in use at certain ports. In view of the possible damage to packages it is felt that this method should be discontinued as at Halifax, in favour of the platform sling, for discharging cargoes of fruit.

After removal from the boat the barrels are sorted out as to marks and moved thereafter on electric trolleys or trucks to shed space allotted to each consignee.

CONCLUSIONS

(1) Well-coopered barrels with staves smooth inside or tight orchard boxes should be used for picking.

(2) Fruit from lightly laden trees carrying abnormally large apples should be separated in the orchard and packed separately from normal-cropping trees.

(3) Fruit picked under warm temperature conditions should be given special care in handling, and warehouses cooled as much as possible before use.

(4) Well-coopered barrels, smooth inside, are the most satisfactory, and only standard barrels should be used for apples above $2\frac{1}{2}$-inch in size.

(5) In packing, paper liners, shredded paper, a pad in the tail and pulp head in the head are desirable.

(6) Barrels shaken six times during filling and then racked seven times, filled level with the top of the croze and ring tailed will produce little slacking or bruising.

(7) Cooling as soon after picking as possible delayed maturity and heavy bruising.

(8) Loading warm fruit into a car just iced before loading is valueless under short-haul conditions, but cool fruit placed in a car properly iced and cooled will maintain a steady temperature until arrival at Halifax.

(9) Fruit at 60°F. can be cooled to below 40°F. within twenty-four hours if a temperature of 20°F. with fans is used in the cooling process. Such facilities are to be found in the Halifax Cold Storage.

(10) By the proper use of adequate ventilation facilities in the holds of ocean steamers fruit may be discharged in a relatively cool condition.

(11) The temperature of cooled fruit will rise at the rate of approximately one and one-half degrees per day if placed in a closed insulated chamber in ship's hold.

(12) The carbon dioxide content of barrels may increase from 0·03 per cent (air) to 6 per cent in ocean transit. This concentration of carbon dioxide is not injurious to the fruit.

(13) The use of rope slings in loading and unloading ships should be discontinued and preference given to platform slings.

(14) The handling of barrels at docks on trolleys is preferable to rolling on the bilge.

ACKNOWLEDGMENTS

The officers responsible for the carrying out of these investigations wish to express their most sincere appreciation for the co-operation of the following organizations, and for their hearty support in the work undertaken. Without the assistance so generously provided these investigations could not have been successfully carried out:—

Port Williams Fruit Company.

North Mountain Fruit Company.

Kentville Fruit Company.

F. M. Chute & Son.

Falmouth Fruit Company.

United Fruit Companies of Nova Scotia, Ltd.

R. & D. Sutton.

Dominion Atlantic Railway.

Halifax Harbour Commission and the Halifax Cold Storage Plant.

Cunard-White Star Limited.

Furness, Withy Limited.

The Canadian Government Fruit Trade Commissioner and staff, London.

J. & H. Goodwin Company, London, for furnishing warehouse accommodation for the examination of samples.

The various fruit brokers in England for facilitating the work there and furnishing reports on the fruit.

The Handling Committee of the Nova Scotia Fruit Growers' Association for support and valuable advice.

Ottawa: Printed by J. O. Patenaude, I.S.O., Printer to the King's Most Excellent Majesty, 1936.