

COVERSHEET

Final Report: 31 December 1993

Project Number: FV/110

Project Title: Bulb Onions: an assessment of changes in skin quality of bulb onions from farm store to point-of-sale.

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Date project commenced: 1 August 1992

Date project completed: 31 December 1993

Keywords - Bulb Onions, Skin quality, Post storage handling, Shelf life.

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RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

* **Project Objective**

To assess changes in skin quality of bulb onions from farm store to retail point-of-sale, and to identify the causes of these changes.

* **Key Results**

Product leaving the farm store had up to 15% skin quality defects. After grading, loose line handling, and cold storage prior to despatch, this had increased to 46% skin quality defect, and after cool-chain distribution, retail holding area and shelf, quality defects had risen to, for example, 59% of the onions trialled.

Temperature and relative humidity were measured throughout the post-storage handling of onions, and indicated consistent control through cool-chain distribution. At the retail store, both in the holding area and on the retail shelf, control of temperature and relative humidity was less good.

* **Opportunity for Application**

Onion growers/packers must look critically at the handling of onions between farm store and the point of despatch. Crucial areas to consider are bulker loading and unloading, and the grading/packing line.

Retailers must look critically at temperature and relative humidity control both in holding areas at retail stores and on the retail shelf, together with product handling at these stages.

SUMMARY

Objective and Scope of the Project

The objective of the study was to monitor changes in bulb onion skin quality from farm store, through the grading and packing line handling, cool-chain distribution, to the point-of-sale at the retail store.

60-80mm diameter free-flow product from commercial crops of Rijnsberger onions were selected, and assessed for skin quality at 3 different removal times from farm store (January, March and May 1993).

Assessments were made at various points between farm store and retail shelf including:- farm store, post-bulker, post-topper, post-grader, post-loose line, post-cold store prior to despatch, distribution depot, holding area of retail store, and retail shelf.

Temperature and relative humidity of both product and ambient conditions were continually measured to indicate environment changes.

Quality and weight loss assessments were reinforced by sub-samples being taken at each point in the chain and assessed for shelf-life characteristics.

Results

Skin Quality Assessments

The results indicated that product leaving the farm store had between 6-15% skin quality defect. Damage consisted mainly of skin cracking and loss.

Onions leaving the bulker, prior to grading, showed an increase in quality defects of a further 5%. This was primarily due to an increase in mechanical damage eg scuffing.

In this study, topping did not damage the onions, or cause additional skin defects.

During grading and packing, skin quality defects increased by a further 26%, giving a total of up to 46% product with quality defects. The increase at this stage was due to mechanical damage and pinpricking.

From cold store, prior to despatch, through cool-chain distribution, to and including the retail holding area, there were no additional skin defects. However, existing defects became more distinct as the product was exposed to fluctuating temperatures and humidities, particularly at the retail store.

On the retail shelf, over a 24 hour period, the percentage of skin defects increased by a further 13%, with an increase in skin cracked and open and skin loss due to fluctuating temperature and humidity. Mechanical damage increased due to simulated consumer handling.

Temperature and Relative Humidity

Product temperature through to the end of cool-chain distribution was maintained between 4-8°C. In the retail holding area prior to the shop display, product temperature over a 12 hour period rose to 10°C. On the retail shelf over a 24 hour period, product temperature rose to 15°C.

Ambient and product relative humidity (RH) through to the end of cool-chain distribution fluctuated between 75 and 90% RH over a 24 hour period. Once the product was received at the retail store, greater fluctuations over a 12 hour period were recorded eg RH dropped from 80 to 60% on one occasion; but rose from 60 to 80% on another.

Once on the retail shelf, ambient humidity consistently fell overnight from 60 to 35% RH, with a rise the following morning over a 12 hour period up to 50% RH.

Shelf Life Assessments

Improved shelf life was apparent with product taken direct from the farm store compared with product taken from other assessment points, all of which gave similar shelf-life results.

Weight loss figures tended to relate to stored age of product. Over the period of shelf life, weight loss in January ranged from 2.25 to 4.19%, whereas in May it ranged from 3.46 to 8.15%.

Action Points for Growers

- * Attention to crop management in the field and store to maximise skin quality and to minimise skin cracking and skin loss, through varietal choice, timely harvest, and good store management. Mechanical damage should also be kept to a minimum at harvesting and store loading.
- * Bulkers used for moving product from farm stores to a centralised packing/grading facility need to be looked at critically both at loading and unloading. Drops at either stage must be kept to a minimum, and protruding bolts and sharp edges must be avoided within the bulker.
- * Grading and packing lines must be inspected regularly. All drops must be minimised, together with avoidance of soil clods on the line, and actual build-up of soil on the line. Regular cleaning to avoid soil build-up is necessary.

Action Points for Retailers

- * During cool-chain distribution with "free flow" product consider the use of polythene wrappers within trays to maintain product temperature and humidity.
- * Within the holding area of the retail store, better control of temperature and relative humidity is necessary. Suggestion that product is placed in controlled temperature storage at 4-8° C with controlled humidity at 75 - 80% ie an extension of cool-chain distribution.
- * On the retail shelf, better environment control might be achieved, with lower temperature, and higher, more consistent humidity. A system of humidification may be necessary.

Anticipated Practical and Financial Benefits

The British Onion Producers Association identified in a survey that 89% of consumers stated that, when choosing onions, the condition of the skin was regarded as important. In order to maintain and increase market share, U K producers need to improve skin quality in the face of competition from imports. This study contributes to that objective.

When growers implement the suggestions within this report, skin quality defects should be minimised by better handling. Experience to date indicates a possible reduction in damage of up to 10% in the packing operation with more attention paid to bulker loading/unloading and regular inspection of grading/loose line to minimise drops and the build-up of soil.

The difference between B and C grade in the 60-80 mm size band is approximately £40 per tonne. If 10% of product moves into B grade from C, based on 100 tonnes of C grade, this indicates an additional return of £400.

Retailers need to look at methods of improving temperature and humidity control both in the holding area at the retail store and at the point-of-sale.

EXPERIMENTAL SECTION

Introduction

The value of the UK bulb onion market at the farm gate is estimated to be £30 million with over 30% of the crop supplied to supermarkets. In a survey, commissioned by the British Onions Producers Association (B.O.P.A), 89% of consumers stated that when choosing onions, the condition of the skin was regarded as important.

Leading grower representatives of the onion industry have expressed concern at the change in quality that can occur in bulb onions between the farm store and their being displayed at retail outlets.

The objective of this study is to monitor bulb onion quality from farm store, prior to warming up, through grading, post-packing storage/holding, and distribution to the point of sale.

Materials and Methods

Three commercial crops (2 module raised, 1 direct drilled) of Rijnsberger onions were selected, and product was monitored from the farm store, through a single commercial grading, packing and distribution network, to the retail point of sale, at each of 3 removal dates from farm store (January, March and May 1993).

"Free-flow" onions of 60-80mm diameter were used in the study, rather than "pre-packed" product, since this is the preferred means of retailing onions at present.

The packing system used within this study involved bulk-stored crop being unloaded from farm stores into bulkers. These were unloaded at the packing station, onto a line with topper, grading line, packing/loose line with positive selection, into retailer trays, and then into a cold store prior to despatch. The timescale involved here was normally 24 hours.

Product was then moved by cool-chain transport to a distribution depot, and onto a retail store, and point-of-sale. The timescale involved was normally a further 24 hours.

Onions were assessed on the retail shelf for a further 24 hour period.

Quality assessments were made at the following points:-

A. In farm store

Central Grading and Packing Facility

B. Post-bulker, pre-topper

C. Post-topper, pre-grading line

D. Post-grading line, pre-loose line

E. Post-loose line, pre-cold store

F. Post-cold store, prior to despatch

Retailer Distribution

G. Arrival at distribution depot

H. Arrival at retail store

Central Grading and Packing Facility

J. Holding area at retail store (x3)

K. Retail Shelf (x3)*

* Product was kept in trays, on the retail shelf, and the same trays were assessed on each of three occasions.

At each assessment point, approximately 260 bulbs (the equivalent of 3 retailer trays) were randomly selected and each bulb was scored on a 0-20 scale for skin quality defect as shown in Appendix I. Defects included skin cracking, skin loss, pinpricking and mechanical damage.

In addition, the first assessment in the farm store scored each bulb for the number of skins, internal disorders, and for pressure markings.

Squirrel data loggers measuring temperature and relative humidity, were used to monitor environmental conditions at all stages from farm store to retail shelf. Both ambient conditions and those within the stacked pallet of retailer trays were recorded.

At each assessment point, a sub-sample of 6 bulbs x 3 replicates were taken and placed in shelf-life facilities at HRI Kirton. Conditions within shelf-life were consistent at 21°C, 50% relative humidity and 200 lux, for 18 hours in every 24 hours. During the shelf-life period the onions were individually scored for damage using the system shown in Appendix 2, and weighed daily to assess the accumulated percentage weight loss.

Results: Run 1 (18 January 1993)

The onion crop monitored was module-raised, grown on silt in Lincolnshire, and stored in ambient storage.

The mean number of skins per bulb at the farm store based on an assessment of 164 onions, was 1.88, with 1.22% showing an internal scale breakdown. Pressure bruising was apparent on 64.5% of the bulbs.

Skin Quality Assessments

The quality scores at each assessment point are shown in Table 1.

The skin quality assessment in the farm store indicate 15.31% of the onions with defects, primarily due to skin cracked and open, with small percentages of skin cracked and closed, and mechanical damage (slight and severe).

On leaving the bulker, 20% of the onions showed defects, with a similar breakdown to the farm store assessment but an increase in the category skin loss less than 50%.

After grading, the percentage of onions with defects increased to 53.88%, mainly due to 27.35% pin pricking and associated skin cracking and loss, and 12.66% mechanical damage and associated skin cracking and loss.

From the end of grading line assessment through the loose line, cold store, depot, holding area, and retail shelf there appeared to be no significant change in the percentage of onions with defects. The figures do indicate however that the pin pricking symptom increased in severity, with an increase in associated skin cracking and loss.

Temperature (°C) and Relative Humidity (%)

Full details of temperature and relative humidity (RH) measurements are available, but summary plots are shown in Graphs I and II.

The temperature graph indicates that the onions were held at 12°C ambient in the bulker, 9°C when placed in the cold store post grading and packing, 6-7°C on leaving the cold store prior to despatch, 6-8°C during cold-chain distribution. At the retail store, the product was placed in a non-temperature controlled holding area, prior to placement on the retail shelf. In the holding area, the temperature of the product rose. Ambient temperatures rose from 7°C to 13°C, product temperature rose from 7°C to 11°C. On the retail shelf, there was a steady temperature rise from 11°C to 15°C.

The relative humidity graph indicates the onions at 70% RH in the bulker, a reduction to 45% across the topper, grading and loose line; but back to 60-70% in the cold store prior to despatch. During cool-chain distribution, relative humidity fluctuated between 75-90%, with similar relative humidities measured in the holding area prior to the retail shelf.

On the retail shelf, product was held at 85-90% RH overnight until early morning when a sudden drop in relative humidity from 85% to 50% was recorded. During the morning, the product increased from 50% to 65-70%.

Shelf Life Assessments

Quality scores and accumulated percentage weight loss summaries are shown in Table 2.

The results in Table 2 indicate decreasing shelf life of product from Assessment point A (Farm Store) through to Assessment point C (Post-grading line). Accumulated percentage weight loss also increases over this period, with figures recorded up to 4.19%.

After Assessment point C, shelf-life quality and accumulated percentage weight loss appear not to change.

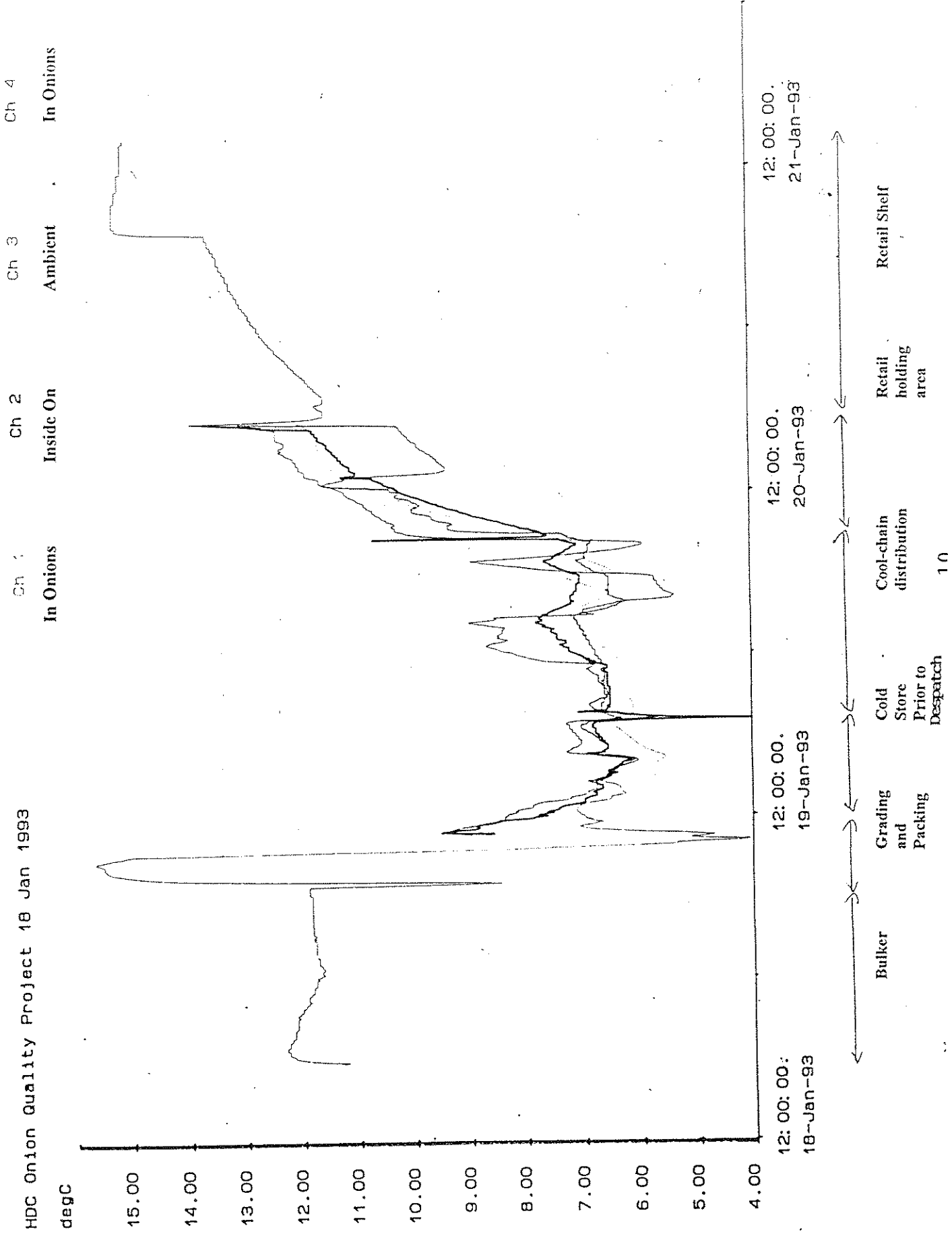
TABLE 1. SKIN QUALITY ASSESSMENT (18th - 21st JAN 1993)

ASSESSMENT POINT	A	B	C	D	E	F	G	H	I	J	K	L	M
	STORE	BULKER	GRADED	LOOSE	COLD S.	DEPOT	HOLD	HOLD	HOLD	SHOP	SHOP	SHOP	SHOP
% CLASS I (No problems)-----	84.7	79.9	46.1	48.7	56.1	47.9	49.3	42.6	53.1	54.1	42.5	48.8	40.3
% WITH DEFECTS-----	15.3	20.1	53.9	51.3	43.9	52.1	50.7	57.4	46.9	45.9	57.5	51.3	59.7

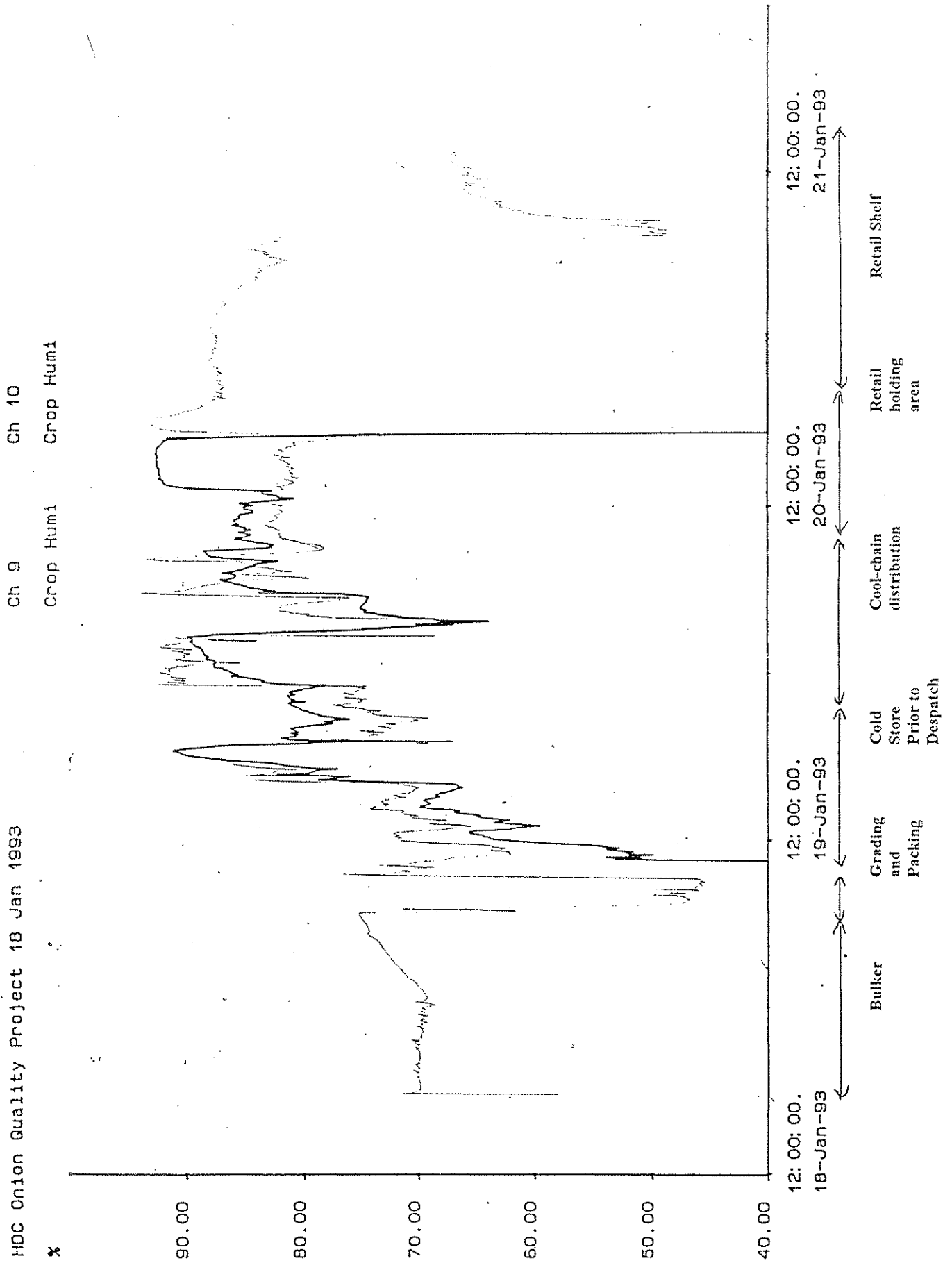
SKIN CRACKED & CLOSED -----	1.6	1.1	.8	.0	.0	.4	.0	.9	.0	1.2	.0	.0	.0
SKIN CRACKED & OPEN -----	11.1	10.0	9.0	5.8	4.3	3.0	4.5	2.6	6.2	15.3	11.3	13.8	17.9
LESS THAN 50% SKIN LOST-----	.7	5.7	4.1	1.8	.0	.8	.5	1.3	1.3	3.5	.0	5.0	3.0
MORE THAN 50% SKIN LOST -----	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PIN PRICKED -----	.0	.0	13.9	24.1	14.3	17.8	21.3	25.1	15.5	9.4	17.5	11.3	11.9
PIN PRICKED,SKIN CRACKED & CLOSED-----	.0	.7	.4	1.3	.4	.8	1.8	1.3	.4	.0	.0	.0	.0
PIN PRICKED,SKIN CRACKED & OPEN-----	.0	.4	6.1	4.5	11.7	14.4	9.0	8.1	9.7	3.5	11.3	8.8	3.0
PIN PRICKED,LESS THAN 50% SKIN LOST-----	.0	.0	6.9	4.5	4.3	2.1	4.5	6.8	4.4	8.2	8.8	8.8	16.4
PIN PRICKED & MORE THAN 50% SKIN LOST-----	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
MECHANICAL DAMAGE (SLIGHT) -----	1.3	.7	2.9	1.8	4.3	2.1	2.7	2.6	2.7	.0	5.0	.0	.0
MECH.DAMAGE (SLIGHT),SKIN CRACKED & CLOSED--	.0	.0	.0	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SLIGHT),SKIN CRACKED & OPEN----	.0	.7	3.7	2.2	1.3	7.2	4.5	6.8	3.1	1.2	2.5	2.5	.0
MECH.DAMAGE (SLIGHT),LESS THAN 50% SKIN LOST	.0	.0	2.4	3.1	1.7	1.3	.5	.9	3.1	3.5	1.3	.0	4.5
MECH.DAMAGE (SLIGHT),MORE THAN 50% SKIN LOST	.0	.0	.8	.0	.0	.4	.0	.0	.0	.0	.0	.0	.0
MECHANICAL DAMAGE (SEVERE) -----	.7	.0	.8	.9	.0	.4	.9	.4	.0	.0	.0	.0	1.5
MECH.DAMAGE (SEVERE),SKIN CRACKED & CLOSED--	.0	.0	.0	.0	.4	.0	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SEVERE),SKIN CRACKED & OPEN----	.0	.0	.8	.0	.4	.8	.0	.4	.0	.0	.0	.0	.0
MECH.DAMAGE (SEVERE),LESS THAN 50% SKIN LOST	.0	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SEVERE),MORE THAN 50% SKIN LOST	.0	.4	1.2	.9	.4	.4	.5	.4	.4	.0	.0	1.3	1.5

Ref Graph2.hdc

Graph I. Summary Plot of Temperature (°C) from Bulker to Retail Shelf



Graph II. Summary Plot of Relative Humidity (%) from Bulker to Retail Shelf



Results: Run 2 (29 March 1993)

The onion crop monitored was direct-drilled; grown in Kent on a silty-loam soil, and stored in refrigerated storage.

The mean number of skins per bulb at the farm store, based on an assessment of 157 onions, was 2.28, with 0.63% showing an internal scale breakdown. No pressure bruising was apparent in the sample.

Skin Quality Assessments

The quality scores at each assessment point are shown in Table 3.

In the farm store 7.44% of the onions had skin defects, primarily due to skin cracked and open, with small percentages of skin cracked and closed, skin loss less than 50%, and mechanical damage.

On leaving the bulker, 13.2% of onions showed defects, with a similar breakdown to the farm store assessment but an increase in the mechanical damage (slight).

After topping, there was no change in the percentage of bulbs with skin defects.

After grading, the percentage of onions with defects increased to 19.23%, consisting of 4% skin cracked and open, 3% hairline cracks, 10% mechanical damage (slight), and associated skin defects.

From the end of the grading line assessment, through the loose line, cold store and depot, there was no significant change in the percentage of onions with defects but the severity of mechanical damage increased over the grading and packing line with an increase in associated skin cracking and loss.

The first assessment in the holding area at the retail store, indicated an increase in percentage of onions with defects to 27.31%, consisting mainly of 10% with skin cracked and open, and 14.23% mechanical damage (slight and severe) with associated defects.

There was a further increase with the first assessment on the retail shelf 24 hours later. The percentage of onions with defects was recorded as 35.25%, consisting mainly of skin cracked and open at 13.41%, and 19.17% mechanical damage (slight and severe) and associated defects.

The final assessment on the retail shelf, indicated 45.2% onions showing skin quality defects, with increases in skin loss less than 50% at 8.4%, and mechanical damage (slight and severe) and associated defects at 24%.

Temperature (°C) and Relative Humidity (%)

Full details of temperature and relative humidity measurement are available, but summary plots are shown in Graphs III and IV.

Onions were held at 10°C ambient in the bulker, rose to 14°C across the grading and loose line, followed by a drop to 6°C in the cold store. During the cold store period, product temperature reduced from 10°C to 8°C. During cool-chain distribution, product and ambient temperature was maintained close to 8°C.

At the retail store, product was placed in a non-temperature controlled holding area, prior to placement on the retail shelf. In the holding area, ambient temperature rose from 8°C to 10°C, with product temperature following a similar trend. On the retail shelf both ambient and product temperatures rose gradually from 10°C to 14°C over a 24 hour period.

The relative humidity graph indicates the onions at 70% RH in the bulker. There was a divergence between ambient and onion relative humidity in the period overnight, which is explained by ambient temperature changes.

In the cold store prior to despatch, ambient RH fluctuated around 75%, with product RH at 60%. During cool chain distribution, ambient and product RH fluctuated within the range 75-90%.

During the holding period, prior to the retail shelf, ambient RH rose from 50% to 80%. Product RH stayed constant at 80-85%.

Product was placed onto the retail shelf in late afternoon and overnight ambient RH fell from 80% to 30% RH, with product RH falling from 85% to 45%. The following morning RH climbed in ambient from 30% to 53%, product RH from 45% to 60%.

Shelf Life Assessments

Quality scores and accumulated percentage weight loss summaries are shown in Table 4.

The results in Table 4 indicate similar shelf life characteristics from all assessment points, with the exception of assessment point B (post-bulker) which had improved shelf life.

Accumulated percentage weight loss appear to increase over the period from the farm store to the retail shelf, with figures recorded up to 6.9%.

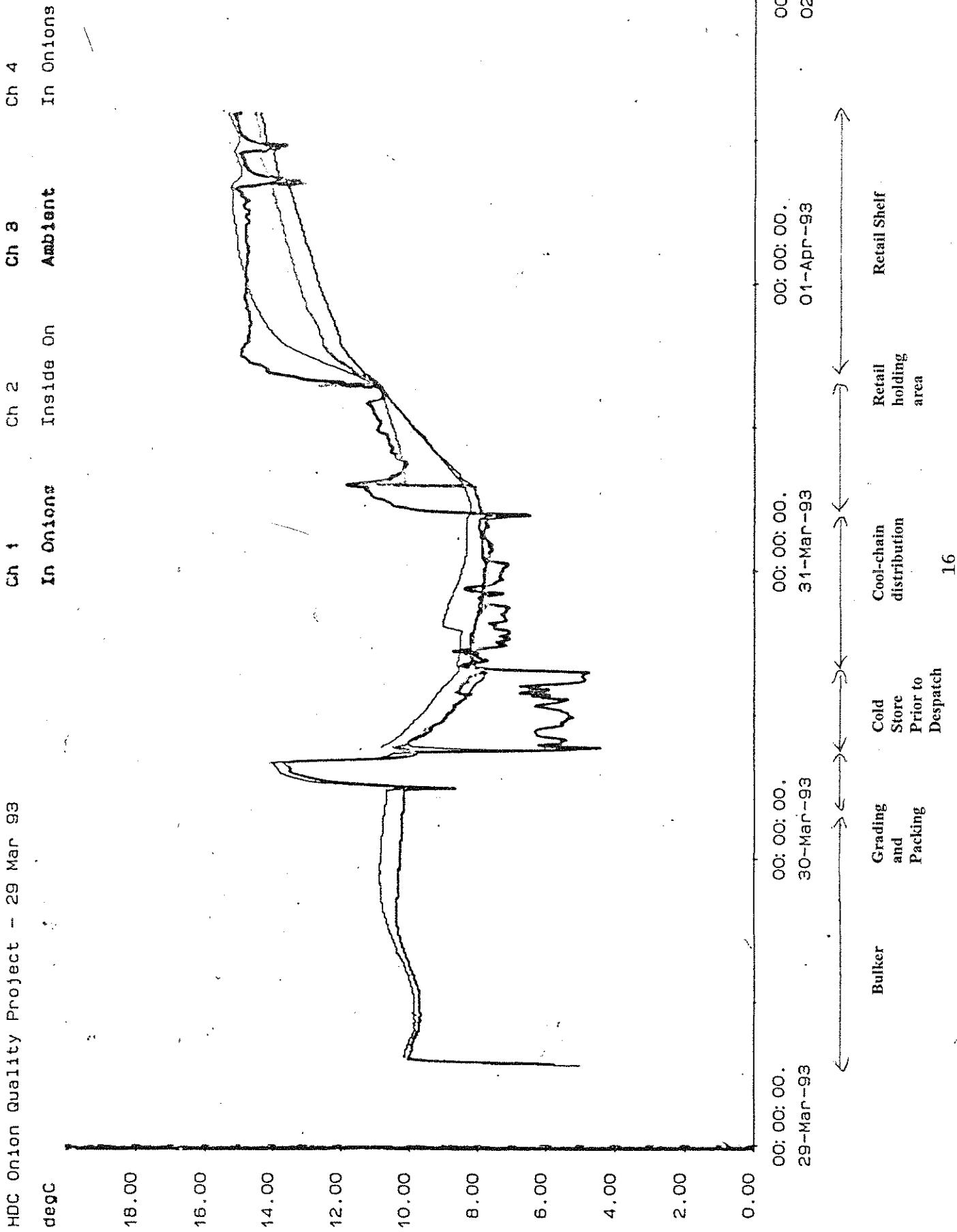
TABLE 3. SKIN QUALITY ASSESSMENT (29th MAR - 1st APR 1993)

ASSESSMENT POINT	A STORE	B BULKER	C TOPPED	D GRADED	E LOOSE	F COLD	G DEPOT	H HOLD	J HOLD	K HOLD	L SHOP	M SHOP	N SHOP
% CLASS I (No problems)-----	92.6	85.8	87.1	80.8	80.4	76.0	83.0	72.7	70.0	77.5	64.8	59.4	54.8
% WITH DEFECTS-----	7.4	13.2	12.9	19.2	19.6	24.0	17.0	27.3	30.0	22.5	35.2	40.6	45.2

SKIN CRACKED & CLOSED -----	.4	1.6	1.1	3.1	.8	2.7	.6	.0	.4	.8	.8	.0	.0
SKIN CRACKED & OPEN -----	5.0	4.8	1.5	4.2	4.6	5.7	5.1	10.0	9.0	7.0	13.4	14.2	12.6
LESS THAN 50% SKIN LOST-----	.4	1.2	3.7	1.2	3.1	1.5	2.3	.8	.4	1.9	1.9	2.3	8.4
MORE THAN 50% SKIN LOST -----	.0	.0	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PIN PRICKED -----	.0	.0	.7	.0	.0	1.5	.0	.4	.4	.4	.0	.0	.0
PIN PRICKED,SKIN CRACKED & CLOSED-----	.0	.0	.0	.0	.4	.0	.0	.0	.0	.0	.0	.0	.0
PIN PRICKED,SKIN CRACKED & OPEN-----	.0	.0	.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
PIN PRICKED,LESS THAN 50% SKIN LOST-----	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PIN PRICKED & MORE THAN 50% SKIN LOST-----	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
MECHANICAL DAMAGE (SLIGHT) -----	.8	4.0	2.6	6.5	7.7	7.6	8.0	4.2	4.9	3.5	5.7	3.8	4.2
MECH.DAMAGE (SLIGHT),SKIN CRACKED & CLOSED----	.0	.0	.0	.0	.4	.0	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SLIGHT),SKIN CRACKED & OPEN-----	.0	.4	.4	1.9	2.3	4.2	1.7	8.8	12.4	5.8	9.6	11.5	7.7
MECH.DAMAGE (SLIGHT),LESS THAN 50% SKIN LOST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SLIGHT),MORE THAN 50% SKIN LOST	.0	.0	.4	.8	.0	.4	1.1	.4	1.5	4.7	3.1	8.8	12.3
MECHANICAL DAMAGE (SEVERE) -----	.8	.8	.4	.8	.0	.0	.0	.8	.0	.4	.8	.0	.0
MECH.DAMAGE (SEVERE),SKIN CRACKED & CLOSED----	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SEVERE),SKIN CRACKED & OPEN-----	.0	.4	.0	.0	.4	.4	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SEVERE),LESS THAN 50% SKIN LOST	.0	.0	.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SEVERE),MORE THAN 50% SKIN LOST--	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

Ref graph3.hdc

Graph III. Summary Plot of Temperature (°C) from Bulker to Retail Shelf



Graph IV. Summary Plot of Relative Humidity (%) from Bulker to Retail Shelf

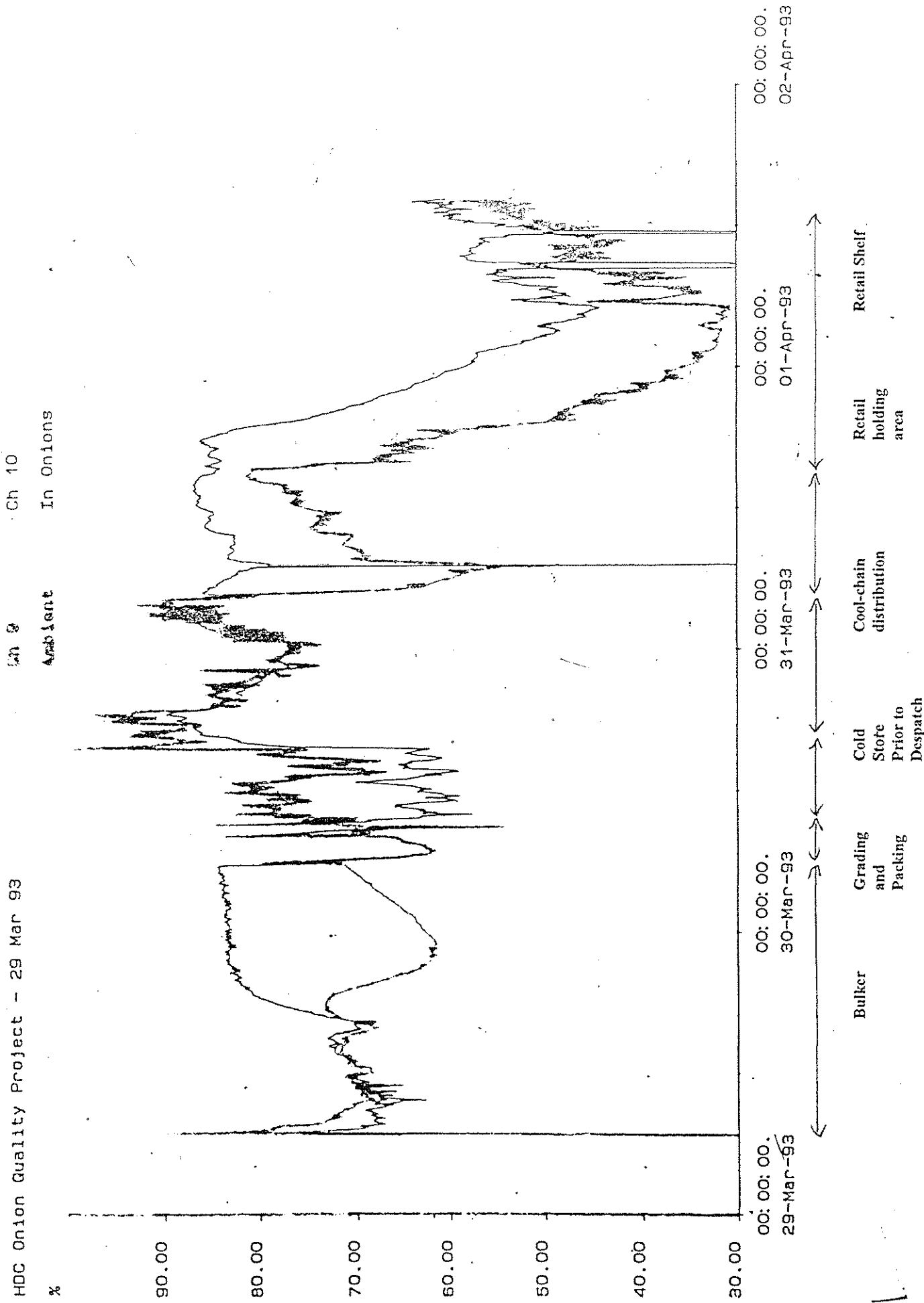


Table 4. Shelf Life Summaries of Quality and Accumulated Weight Loss (%)

SHELF LIFE OF ONIONS - ADAS - WEEK BEGINNING 29.03.93

TRT	REP	DATE															ACC. % WT. LOSS										
		30.03.93	31.03.93	1.04.93	2.04.93	3.04.93	5.04.93	7.04.93	9.04.93	11.04.93	13.04.93	15.04.93	17.04.93	19.04.93	21.04.93	23.04.93		25.04.93	27.04.93	29.04.93	3.05.93	5.05.93	7.05.93				
B	1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.2	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.8	4.421		
	2	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.8	3.729		
	3	2.0	2.0	2.0	2.5	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3.0	4.812	
	MEAN	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.9	4.321	
C	1	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3.5	5.386	
	2	1.8	1.8	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.8	3.739	
	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3.2	5.501	
	MEAN	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	3.2	4.875
D	1	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.7	4.278	
	2	2.5	2.5	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	3.5	4.946
	3	1.8	1.8	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	3.2	4.499
	MEAN	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	3.1
E	1	1.8	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	3.3	5.039
	2	1.8	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.7	5.231
	3	1.7	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	3.8	4.904
	MEAN	1.8	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	3.5
F	1	1.8	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	3.2	4.729
	2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	3.0	5.155
	3	1.5	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	3.0	3.874
	MEAN	1.8	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	3.1
G	1	-	-	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.5	5.615
	2	-	-	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	3.5	5.932
	3	-	-	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	3.8	5.489
	MEAN	-	-	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	3.5
H	1	-	-	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	3.0	5.845
	2	-	-	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	3.2	4.476
	3	-	-	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	3.3	6.594
	MEAN	-	-	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	3.2
J	1	-	-	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	3.0	4.540
	2	-	-	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	3.2	9.402
	3	-	-	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.7	6.802
	MEAN	-	-	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	3.3
K	1	-	-	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	3.0	5.220
	2	-	-	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	3.2	4.827
	3	-	-	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	3.5	5.764
	MEAN	-	-	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	3.2
N	1	-	-	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.8	8.795
	2	-	-	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	3.5	4.800
	3	-	-	3.2	3.0	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.8	5.402
	MEAN	-	-	3.0	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.7

Results: Run 3 (11 May 1993)

The onion crop monitored was module-raised in Lincolnshire; grown on silt, and stored in refrigerated storage.

The mean number of skins per bulb at the farm store based on an assessment of 149 onions, was 2.18. No internal disorders were apparent but 59.9% of the bulbs showed pressure bruising.

Skin Quality Assessments

The quality scores at each assessment point are shown in Table 5.

The skin quality assessment in the farm store indicates 5.99% of the onions with defects, due to 2.30% with skin cracked and open, 1.84% with skin loss less than 50%, and 1.84% with mechanical damage (slight).

On leaving the bulker, 11.64% had defects, with an increase in skin cracked and open to 8.19%. Skin loss less than 50% and mechanical damage (slight) did not change.

There was no change in the percentage of bulbs with defects, after topping.

After grading, the percentage of onions with defects increased to 25.23%, consisting of 8.26% with pin pricking and associated problems, and 9.63% with mechanical damage (slight and severe) and associated problems.

After the loose line, the percentage of onions with defects increased to 36.65%. Pin pricking and associated problems rose to 19.0%, with mechanical damage (slight and severe) contributing 13.57%.

On leaving the cold store at despatch, the percentage of onions with defects had risen to 46.41%, with increases in pin pricking and associated problems to 25.84%, and mechanical damage (slight and severe) to 16.76%.

From despatch, through the cool-chain distribution and the holding area at the retail store, there was little change in the percentage of the onions with defects. However, the severity of the symptom increased. For example, the percentage of onions with pin pricking alone decreased, but the percentage of onions with pin pricking and an open skin crack increased.

The second assessment on the retail shelf (N) gave a marked increase in the percentage of onions with defects. This was assessed as 59.81%, due to an increase in skin cracked and open to 11%, and pin pricking and associated problems to 36.36%.

Again, in this last category, the emphasis was moving from mechanical damage (slight) to mechanical damage (slight) plus associated skin crack and skin loss.

Temperature (°C) and Relative Humidity (%)

Full details of temperature and relative humidity are available but summary plots are shown in graphs V and VI.

Onions were held at 12°C ambient in the bulker, rose to 18°C during the grading and loose line operations, and a drop to 4°C ambient in the cold store prior to despatch. During the period in cold store, product temperature reduced from 10°C to 5°C.

During cool-chain distribution, product and ambient temperature were maintained at 6-8°C.

At the retail store, product is placed in a ambient holding area, prior to placement on the retail shelf. In the holding area, ambient temperature rose from 7°C to 12°C at initial placement and continued to rise to 14°C. Product temperature over this period rose from 7°C to 10°C.

On the retail shelf over a 24 hour period, ambient temperature fluctuated between 14°C and 17°C, with product temperature gradually rising from 10°C to 15°C.

The relative humidity graph indicates the onions at 85% RH in the bulker. During cold store prior to despatch, and cool-chain distribution relative humidity fluctuated between 75 and 90%.

During the holding period, prior to the retail shelf ambient RH fell from 80% to 60%, the product RH from 90% to 75% over a 12 hour period.

As before, product was placed on the retail shelf in late afternoon, and overnight ambient RH fell from 60% to 35%, with product RH falling from 75% to 50%. The following morning ambient RH rose up to 50%, with product RH rising to 70%.

Shelf Life Assessments

Quality scores and accumulated percentage weight loss summaries are shown in Table 6.

The results in Table 6 indicate similar shelf life characteristics and accumulated percentage weight loss from all assessment points. The exception was assessment point A (farm store), which had improved shelf life, and a lower accumulated percentage weight loss.

Accumulated percentage weights loss appeared similar from all assessment points with figures recorded up to 8.15%.

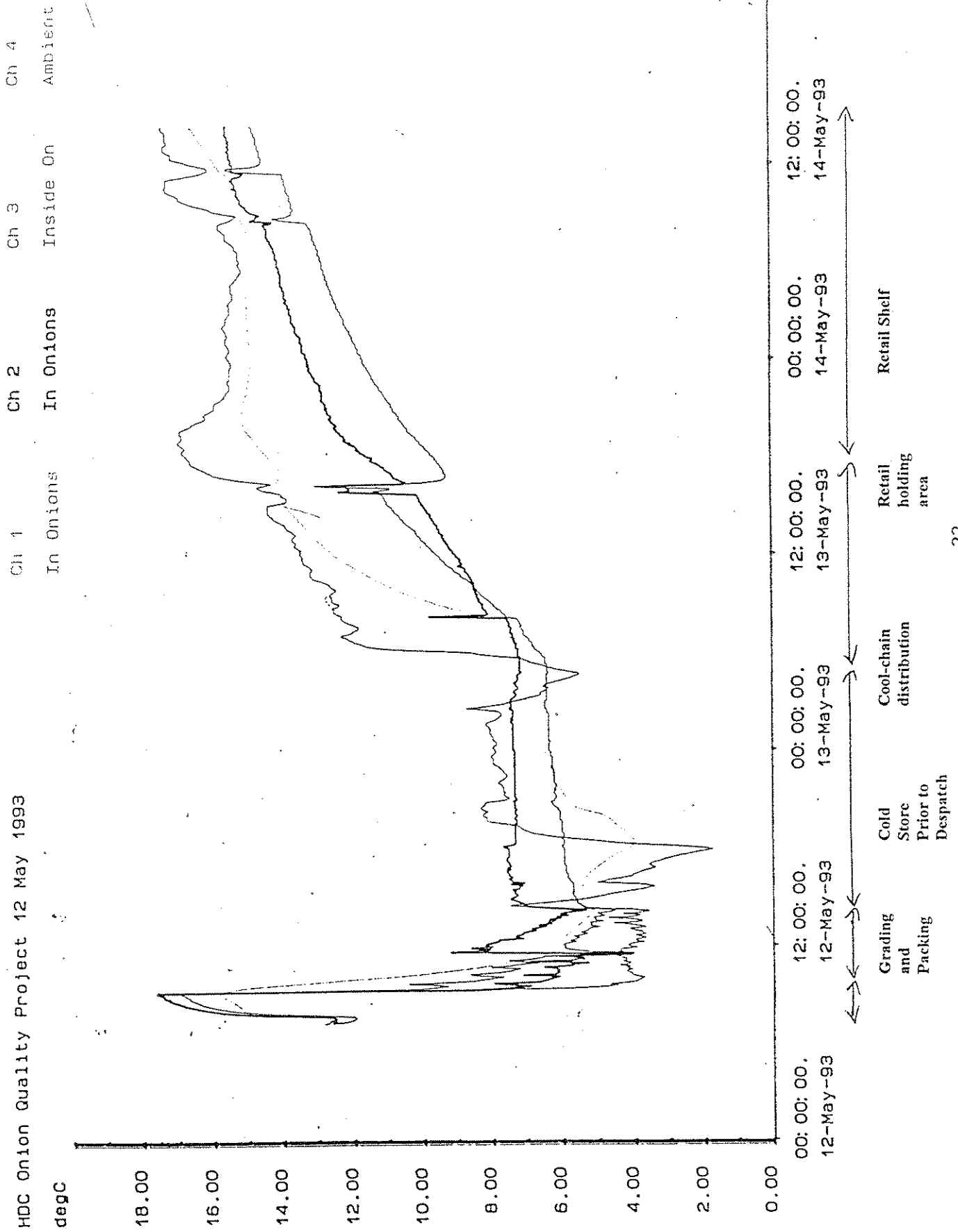
TABLE 5. SKIN QUALITY ASSESSMENT (11th - 15th MAY 1993)

ASSESSMENT POINT	A STORE	B BULKER TOPPED	C	D GRADED	E LOOSE	G COLD	H CORBY	J HOLD	K HOLD	L HOLD	M SHOP	N SHOP	O SHOP
% CLASS I (No problems)-----	94.0	88.4	88.0	74.8	63.3	53.6	47.4	50.2	57.4	60.0	58.9	40.2	47.4
% WITH DEFECTS-----	6.0	11.6	12.0	25.2	36.7	46.4	52.6	49.8	42.6	40.0	41.1	59.8	52.6

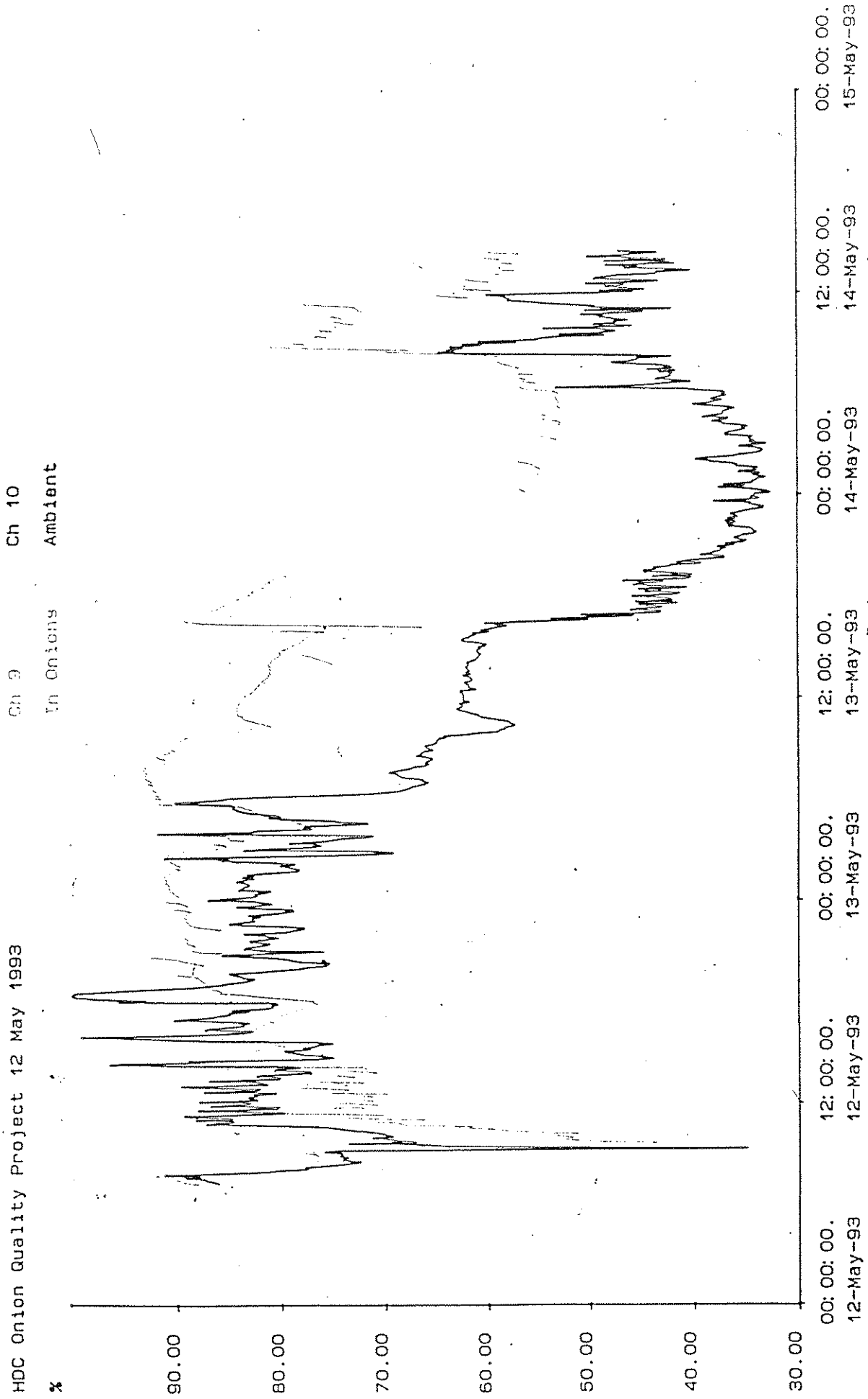
SKIN CRACKED & CLOSED -----	.0	.0	.0	.0	.9	.0	.0	.5	.0	.0	.0	.0	.5
SKIN CRACKED & OPEN -----	2.3	8.2	6.3	5.5	3.2	3.3	7.9	4.7	7.4	5.2	10.0	11.5	11.0
LESS THAN 50% SKIN LOST-----	1.8	.4	3.1	1.8	.0	.5	.0	.9	.5	1.4	.0	1.4	1.4
MORE THAN 50% SKIN LOST -----	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PIN PRICKED -----	.0	.0	.0	7.3	17.6	17.2	20.5	16.0	16.7	16.2	9.1	12.9	10.5
PIN PRICKED,SKIN CRACKED & CLOSED-----	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PIN PRICKED,SKIN CRACKED & OPEN-----	.0	.0	.0	.0	.9	.5	.0	.0	.0	.0	.0	.0	.0
PIN PRICKED,LESS THAN 50% SKIN LOST-----	.0	.0	.0	.5	.5	7.7	8.8	12.2	9.3	7.1	12.4	14.4	10.5
PIN PRICKED & MORE THAN 50% SKIN LOST-----	.0	.0	.0	.5	.0	.5	.5	.9	1.9	3.8	2.9	9.1	9.1
MECHANICAL DAMAGE (SLIGHT) -----	1.8	.9	2.1	6.0	9.0	7.7	7.0	7.0	4.6	3.8	3.3	3.8	3.3
MECH.DAMAGE (SLIGHT),SKIN CRACKED & CLOSED--	.0	.0	.0	.5	.5	1.0	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SLIGHT),SKIN CRACKED & OPEN----	.0	.4	.5	.9	2.3	6.2	5.6	3.8	2.3	1.4	3.3	3.8	3.3
MECH.DAMAGE (SLIGHT),LESS THAN 50% SKIN LOST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SLIGHT),MORE THAN 50% SKIN LOST	.0	.0	.0	.0	.5	.0	1.4	.5	.0	1.0	.0	2.9	2.9
MECHANICAL DAMAGE (SEVERE) -----	.0	.9	.0	2.3	1.4	.5	.0	1.9	.0	.0	.0	.0	.0
MECH.DAMAGE (SEVERE),SKIN CRACKED & CLOSED--	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
MECH.DAMAGE (SEVERE),SKIN CRACKED & OPEN----	.0	.4	.0	.0	.0	1.4	.9	.9	.0	.0	.0	.0	.0
MECH.DAMAGE (SEVERE),LESS THAN 50% SKIN LOST	.0	.4	.0	.0	.0	.0	.0	.5	.0	.0	.0	.0	.0
MECH.DAMAGE (SEVERE),MORE THAN 50% SKIN LOST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

Ref graph4.hdc

Graph V. Summary Plot of Temperature (°C) from Grader to Retail Shelf



Graph VI. Summary Plot of Relative Humidity (%) from Grader to Retail Shelf



CONCLUSIONS

The results indicate similar trends with all 3 product runs, and the conclusions are outlined below.

Skin Quality Assessments

1. Skin quality in the farm store, prior to handling and grading etc, was recorded as up to 15% defects, consisting of skin cracking and open, and skin loss less than 50%. No pin pricking or mechanical damage was apparent at this stage.
2. Onions leaving the bulker prior to grading showed an increase in skin defects of up to 5%. This was due primarily to an increase in mechanical damage (slight).

Bulkers need to be looked at critically, both at loading and discharge. Drops at either stage must be minimal. Avoid protruding bolts or sharp edges within the bulker.

3. Post topper sampling indicated no additional skin defects. The topping operation in this study appeared not to create any mechanical damage or loss of skin quality.
4. As onions crossed the grading and loose line, skin quality defects increased up to 31%. This was due to mechanical damage (slight) and pin pricking.

Mechanical damage on the grading/loose lines is generally caused by product drop, and protruding bolts and sharp edges.

Pin pricking is caused by soil clods on the grading and loose line, or by the build up of soil on the actual line itself. When soil and onion bulbs come into contact in a moving line, this pin pricking symptom is created.

5. From cold store prior to despatch, through cool-chain distribution to and including the retail holding area, there were no additional skin defects.

However, existing defects became more severe eg pin pricking alone started to become pin pricking plus skin cracked open. The damage caused at an earlier stage became more severe due to fluctuation in temperature and humidity

6. The percentage of defects on the retail shelf increased over a 24 hour period, by a further 13% with additional skin cracked and open, skin loss and mechanical damage. This is due to continued fluctuating temperature and humidity, and product handling.

Temperature and Humidity

1. Product temperature through to the end of cool-chain distribution was held between 4-8°C, but at the retail holding area prior to the retail shelf, product temperature over a 12 hour period rose to 10°C. On the retail shelf, over a 24 hour period, product temperature rose to 15°C.

2. The control of ambient and product humidity through to the end of cool-chain distribution, fluctuated between 75 and 90%.

Once the product was received at the retail store greater fluctuations in relative humidity were measured. There were examples of ambient RH dropping from 80% to 50%, but also rising from 60% to 80%.

Once on the retail shelf ambient humidity fell overnight from 60% to 35%, with a rise the following morning up to 50% RH.

Greater environmental control is needed in both the retail holding area and at the point-of-sale. Cool-chain distribution should be extended into these 2 areas, with temperatures maintained at 4-8°C., and humidity close to 75%.

Shelf Life Assessments

1. The results indicate improved shelf life of the product taken direct from the farm store, but samples taken subsequently at the various assessment points, had similar shelf-life characteristics ie increasing exposure to grading, packing, distribution and retail handling did not affect shelf life.
2. Weight loss figures appeared to relate to the month when the product was removed from farm store and the age of product, rather than with differences between assessment points.

In January, the accumulated weight loss was up to 4.19%.

In March, the accumulated weight loss was up to 6.9%.

In May, the accumulated weight loss was up to 8.15%.

SKIN QUALITY ASSESSMENT

- 0 No problems
- 1 Skin cracked and closed
- 2 Skin cracked and open
- 3 Less than 50% skin lost
- 4 More than 50% skin lost
- 5 Pin pricked
- 6 Pin pricked, skin cracked and closed
- 7 Pin pricked, skin cracked and open
- 8 Pin pricked, less than 50% skin lost
- 9 Pin pricked and more than 50% skin lost
- 10 Mechanical damage (slight)
- 11 Mechanical damage (slight), skin cracked and closed
- 12 Mechanical damage (slight), skin cracked and open
- 13 Mechanical damage (slight), less than 50% skin lost
- 14 Mechanical damage (slight), more than 50% skin lost
- 15 Mechanical damage (severe)
- 16 Mechanical damage (severe), skin cracked and closed
- 17 Mechanical damage (severe), skin cracked and open
- 18 Mechanical damage (severe), less than 50% skin lost
- 19 Mechanical damage (severe), more than 50% skin lost

FV/110 Bulb Onions: An assessment of changes in skin quality of bulb onions from farm store to point-of-sale shelf-life scoring system

1. Clean/unblemished, no flesh bare.
Can go up a grade as skins peel off, but only from 1 to 2.
2. Skin blemished/slight cracking of skin to show flesh, not another skin.
3. Skin loss < 50% (or cracks becoming wider showing flesh) Obvious softness.
4. 50% skin loss or more, mechanical damage or disease.

When all onions in the tray are class 4, take the final weight before discarding.