EFFECT OF LOWERING THE MOISTURE CONTENT OF CHEDDAR CHEESE ON QUALITY AND YIELD

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SUMMARY

Cheese was manufactured experimentally on eight consecutive days in each month of a year at a selected factory. A manufacturing technique designed to produce cheese of a lowered moisture content was employed on alternate days in each period, while a normal technique was employed on the other days.

A difference of 1·73 per cent. in the average moisture content in the fat-free-substance of the two types of cheese was attained. The low-moisture cheese attained an average total grade points score 0·67 pt. higher than that attained by the normal cheese, and it also scored significantly higher average points for flavour, body and colour.

The results obtained failed to clearly indicate the lower level of the percentage of moisture in the fat-free-substance of the cheese below which no further improvement in grade could be gained. Some observations are made in regard to the possible relationship between this finding and the cheese-grading system.

Fluctuations in the level of moisture content in the fat-free-substance of the cheese and in the differences between the two types of cheese in regard to the moisture content, and a weakened relationship between grade points scored and moisture content when considered over the whole period, suggested that the optimum level of moisture content in the fat-free-substance insofar as grade is concerned might be a fluctuating rather than a fixed one.

The lowering of the moisture content of the cheese caused a loss of yield equal to 1.72 per cent. of production. The possible monetary loss involved is considered in relation to a varying price level for cheese and the extent to which differential payments according to cheese grade might recompense for the loss.

I. INTRODUCTION

Most practical cheesemakers agree on the necessity to reduce the moisture content of cheddar cheesecurd when the milk used is of poor quality, in order to increase the chances of producing cheese of acceptable quality. Authors of text-books on cheesemaking commonly infer that an association between the moisture content of cheese and its quality does exist. Thus Sammis (1942, p. 75) stated "... it is to be expected that high moisture cheese from unclean or over ripe milk will develop unclean or acid flavours sooner and to a greater extent than if the cheese has been made drier". Van Slyke and Price (1952, pp. 38-9) stated: "Moisture content has a decided influence on many properties of cheese such as acidity, flavour, body, texture and speed of ripening. These properties differ widely within each variety of cheese and for different types of cheese. Properties induced by low moisture are preferred by some consumers while buyers in other markets

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want cheese with high moisture. It is obvious that no single moisture standard can indicate a quality ideal for every market". Wilster (1955, p. 212) stated: "The water in the fat-free portion of cheese will range from 52 to 58 per cent. in cheese from different factories. In freshly made cheese the ideal percentage is approximately 55 to 56 per cent and in one month old cheese it is from 53 to 54 per cent. Further research under accurately controlled conditions is necessary in order to show the desired percentage. For cheese which is to be cured for about a year a low percentage of moisture in the fat-free portion of cheese is undoubtedly desirable."

Experimental work designed to investigate the relationship, if any, between the moisture content of cheese and its grade has been very limited. Sammis and Germaine (1929) examined the composition and quality of a number of experimental cheeses and showed among other things that there was a lowering of quality score of the cheese corresponding with an increase in the proportion of moisture to casein.

In a report to the Australian Society of Dairy Technology, MacDonald *et al.* (1957) stated that the results from some Australian experimental cheese manufacturing showed an improvement in score for total grade score, flavour, body and colour, but not texture, as the percentage of moisture in the fat-free-substance of the cheese decreased.

The work reported here was undertaken with a view to assessing the extent to which a lowering in the percentage of moisture in the fat-free-substance of cheddar cheese could improve the quality and also to examine some of the economic aspects of such a practice.

II. METHODS

(i) *General.*—A factory with a daily milk intake ranging from 500 to 1,500 gal. during the year was selected. Experimental cheese manufacture was conducted for eight consecutive manufacturing days in each month of a complete year. On these days the whole of the factory's milk intake was manufactured into cheese, using techniques designed to produce a lowered moisture content on certain days and a normal moisture content on the alternate days, but at the same time endeavouring to attain as high a grade score as possible on all days. By utilizing the whole of the factory's intake of milk in this way, it was hoped to attain reasonable uniformity in the composition and cheesemaking characteristics of the milk being used for the manufacture of the two types of cheese.

The yields of cheese obtained by the different methods were recorded and the loss of weight (shrinkage) of the two types of cheese was assessed for the 10 days during which they were stored at the factory. The cheese was graded and analysed at 2-3 weeks of age.

(ii) *Manufacture of Cheese.*—In general, the methods employed for the manufacturing of cheese were those described by Rice and Morris (1954).

However, preliminary investigational work was carried out to determine a satisfactory technique for producing cheese with a lowered moisture content. It was found that the addition of calcium chloride to the milk at the rate of 3 oz per 100 gal produced a firm clot which allowed extra cutting of the coagulum. The smaller particles thus produced could be expected to lose moisture more rapidly, at least in the early stages of manufacture (Whitehead and Harkness 1954). (The possibility of the addition of calcium chloride to the milk having effects other than promoting rapid coagulation with rennet necessitated the use of this substance on the alternate, i.e. "normal", days as well.) A slightly higher cooking temperature of 101°F was employed and the whey was run off at a slightly higher acidity. Dry-stirring of the curd was carried out when the whey was drained off and small curd blocks were cut for cheddaring.

A lower salting rate was employed. It was the intention to reduce the moisture content of the curd before the salting stage was reached so that only sufficient salt to give a normal concentration of salt in the moisture of the cheese would be required. By keeping the concentration of salt in the moisture at the same level for both types of cheese, the possibility of differences in cheese quality being caused by differences in salt content was eliminated.

The main features of the two cheese manufacturing procedures employed are set out hereunder:—

Treatment	Low-moisture Cheese	Normal Cheese
Calcium chloride	3 oz per 100 gal milk	3 oz. per 100 gal milk
Starter	Same percentage both types of cheese	Same percentage both types of cheese
Cutting	Extra cut given with vertical knife	Normal cutting
Cooking	Cooked to 101°F in 35-40 min	Cooked to 98°F in 35-40 min
Running	Run at a slightly higher than normal acidity	Run at a normal acidity
Drying	Given from 1-4 dry stirs	Not given any dry stirs
Cheddaring	Cut small and turned every 10 min	Cut large and turned every 15 min
Milling	Milled at 1½ hr from drying	Milled at 1½ hr from drying
Salting	2½% salt at 2¼ hr from drying	3-3¼% salt at 2¼ hr from drying

In order to obviate any effect of the starter cultures used, the alternation of the two methods of cheese manufacturing was reversed after the first four days of the 8-day periods. Since the factory was using a 4-day rotation of starters, this allowed each day's starters to be used in the manufacture of both types of cheese.

(iii) *Assessing Cheese Yield and Cheese Shrinkage.*—The weight of milk used in the manufacture of cheese each day was recorded. The cheeses produced were weighed when removed from the presses and again at 10 days of age just before they were transported from the factory. From the figures thus obtained it was possible to calculate the weight of green cheese produced for each 100 lb milk used and also the amount of weight lost by the cheese during the storage period.

A composite sample of the milks used for each type of cheese during the 8-day periods was analysed to determine the butterfat and the casein contents. From the yield of green cheese per 100 lb milk and the butterfat test of the milk, it was possible to calculate the yield of cheese per lb butterfat used in cheese manufacturing.

The casein content of the milk employed in the manufacture of the two types of cheese was recorded in order to take account of the effect on the yield of cheese which differences in the composition of the two lots of milk might have. However, no significant differences in either fat or casein content occurred between the two composite samples of milk during any of the 8-day periods of the experiment and therefore it was possible to make a direct comparison of the cheese yields obtained.

(iv) *Grading, Sampling and Analysing the Cheese.*—The 80 lb cheeses produced were submitted to the State Dairy Produce Inspector for official grading and allotment of points as normally conducted in Queensland and the Commonwealth of Australia. Under this system, the maximum points allotted are 50 for flavour, 30 for body and texture and 20 for condition, which includes colour. In application, this system does not result in a very wide variation in the points scored by different cheeses for body and texture, and of course does not provide any distinction between these two attributes in the points allotted. However, it is usual for the actual points allotted to be supplemented by a brief written description of any defects. It was considered necessary to translate these written descriptions into a scale of points which would adequately reflect any differences between the qualities of various cheeses, and a special key to effect this translation was adopted for each of the three attributes, body, texture and colour. The keys used are shown hereunder:—

Comments on Body	Points Allotted
Firm, good, meaty	5
Fairly firm, fairly good, shade weak, inclined weak, very slightly weak, firm inclined mealy	4
Slightly weak, firm but slightly mealy, firm but slightly corky	3
Weak, pasty, corky, mealy	2
Very weak, very pasty, very corky, very mealy	1

Comments on Texture	Points Allotted
Close	5
Very slightly open	4
Slightly open	3
Open	2
Very open	1

Comments on Colour	Points Allotted
Good, bright	5
Fairly good, fairly bright, slightly wavy, slightly uneven, very slightly dull	4
Slightly dull, slightly bleached	3
Dull, bleached	2
Very dull, very bleached	1

At the same time as the cheeses were graded, which was at 2-3 weeks of age, samples were taken for analysis. The person grading the cheese was unaware of the composition or intended nature of the cheese, i.e. whether it was normal or low-moisture, and was thus free from any preconceived judgments in relation to it. In order to eliminate the possible effect of sampling at slightly different ages, about 1 in. of the rind end of the cheese plugs was rejected from the sample in each case. It was considered that this practice would adequately safeguard the samples against the effect of variations in the degree of dehydration of the outside layers of the cheese (Scott 1954).

The moisture content was obtained by drying samples to constant weight in a vacuum oven (25-27 in. vacuum) maintained at the temperature of boiling water. Butterfat content was determined by the Babcock test.

III. RESULTS

(a) General

A total of 174 vats of cheese was manufactured in the course of the experiment, but in the consideration of the results all vats of cheese which showed any abnormality in manufacture not related to the particular method of manufacture, such as starter slowness, or were in any other way in doubt as regards normality, were excluded. When this abnormality affected one vat of a pair, both were excluded. In some cases it was not possible to obtain analyses or grades of the vats of cheese manufactured and a number of vats were thus excluded from consideration in comparisons of composition with grade scores. The fate of the batches of cheese used in compiling the various tables of results is shown in Table 7.

(b) Quality of Cheese

A comparison of the average moisture content and average grade points scored by the two classes of cheese produced during the experiment is shown in Tables 1 and 2.

TABLE 1

COMPARISON OF MOISTURE CONTENTS OF NORMAL AND LOW-MOISTURE CHEESE

Type of Cheese	No. of Vats	Average Moisture (%)	Average Moisture in Fat-free-substance (%)
Low-moisture	60	34·84	52·26
Normal	60	36·17	53·99

TABLE 2

COMPARISON OF GRADE POINTS SCORED BY NORMAL AND LOW-MOISTURE CHEESE

Type of Cheese	No. of Vats	Average Normal Grade Points Scored		Average Special Grade Points Scored		
		Total	Flavour	Body	Texture	Colour
Low-moisture	75	91·02	41·49	4·28	3·41	4·35
Normal	75	90·35	40·95	3·87	3·28	4·05

TABLE 3

SPREAD OF DIFFERENCES IN POINTS SCORE FOR NORMAL AND LOW-MOISTURE CHEESE
(Low-moisture score minus Normal score)

—	Points Difference																	Total No. of Pairs	Average Points Difference
	−3½	−3	−2½	−2	−1½	−1	−½	0	½	1	1½	2	2½	3	3½	4	4½	5	
Total grade—No. of Pairs ..	1	0	2	3	4	7	2	8	9	15	8	6	2	4	0	2	1	1	75	0·66 ± 0·19*
Flavour—No. of Pairs	..	..	1	1	3	7	8	9	13	14	8	6	1	3	0	1	..	..	75	0·53 ± 0·14*
Body—No. of Pairs	..	..	..	1	..	14	..	21	..	32	..	6	..	1	..	..	..	..	75	0·41 ± 0·11*
Texture—No. of Pairs	..	1	..	5	..	8	..	39	..	13	..	9	..	0	..	..	..	..	75	0·13 ± 0·12
Colour—No. of Pairs	..	..	..	1	..	12	..	31	..	25	..	6	..	..	..	..	..	..	75	0·31 ± 0·10*

* Significant at 1% level.

These tables show that a difference of 1·73 per cent. in the average moisture content in the fat-free-substance of the two types of cheese was attained. The maximum possible error in a determination of the percentage moisture in the fat-free-substance of cheese has been stated by Whitehead (1948) to be ± 1·15 per cent. under the methods of sampling and analysis employed by him. The maximum error in determining the percentage of moisture in the fat-free-substance of cheeses analysed in this work could not be expected to be any greater than this and therefore would be considerably less than the average difference in percentage of moisture in the fat-free-substance attained.

There was a difference in grade points scored in favour of the low-moisture cheese in the case of total grade, flavour, body, texture and colour. The difference was greatest for total grade and least for texture.

The spread of differences in the various grade points scored is shown in Table 3. This method of presentation shows the relative frequency with which the various differences resulted. In the case of total grade, the low-moisture cheese scored better than the normal cheese in 48 pairings, was equal in 8 pairings and was worse in 19 pairings. The low-moisture cheese scored better for flavour in 46 pairings, was equal in 9 pairings and was worse in 20 pairings. The respective figures in relation to body score are 39, 21 and 15; for texture score they are 22, 39 and 14; and for colour score they are 31, 31 and 13.

In Table 4, the vats of both types of cheese produced during the experiment are considered independently of their intended nature, i.e. whether normal or low-moisture, and a comparison is made of the average moisture content of the fat-free-substance of the vats of cheese scoring within certain divisions of the points scale for the various properties considered. In Table 5, a comparison is made on a similar basis but in this case the points scores of the batches of cheese are averaged for certain divisions of the range of moisture content in the fat-free-substance.

(c) Yield of Cheese

The average yields of cheese obtained are shown in Table 6 together with the average losses of weight (shrinkage) during the 10 days the cheese was held at the factory prior to disposal. A lowering of the yield of cheese occurred in the case of the low-moisture vats, but this was slightly compensated for by the reduced loss of weight incurred with this type of cheese during the time it was held at the factory. The gross lowering of yield of cheese found was 0·19 lb per 100 lb milk, or 0·06 lb cheese per lb butterfat, while the figures for the net loss were 0·17 lb and 0·05 lb respectively.

The calculated loss of yield incurred by reducing the moisture content of cheese from 36·17 to 34·84 per cent., when the initial yield is 9·96 lb per 100 lb milk, is 0·20 lb per 100 lb milk. The actual loss found in these trials

TABLE 4

PERCENTAGES OF MOISTURE IN THE FAT-FREE-SUBSTANCE OF VATS OF CHEESE WITHIN DIVISIONS OF POINTS SCORED FOR VARIOUS PROPERTIES

(a) Total Grade

Divisions of Points	Over 92·5	92·0–92·5	91·0–91·5	90·0–90·5	89·0–89·5	88·0–88·5	Below 88·0
No. of vats	4	17	46	42	9	3	2
Average moisture	52·3	53·0	53·1	53·3	53·8	54·3	54·5
Range of moisture	49·5–54·9	50·3–56·9	49·9–57·1	49·6–57·7	52·5–55·8	53·6–55·2	53·9–55·1

(b) Flavour

Divisions of Points	Over 42·5	42·5	42·0	41·5	41·0	40·5	40·0	39·0	Below 39·0
No. of vats	4	6	21	36	34	9	8	2	3
Average moisture ..	52·3	52·7	53·1	53·2	52·9	54·0	53·9	54·4	54·3
Range of moisture ..	49·5–54·9	50·3–56·9	50·0–56·5	49·9–57·7	49·6–55·9	52·8–56·0	52·5–55·8	53·6–55·2	53·9–55·1

(c) Body

Divisions of Points	5	4	3	2	1
No. of vats	33	68	22	..	..
Average moisture	52·7	53·4	53·4	..	..
Range of moisture ..	49·5–56·9	49·6–57·7	50·7–55·8	..	..

(d) Texture

Divisions of Points	5	4	3	2	1
No. of vats	14	21	81	7	..
Average moisture	53·6	52·4	53·2	54·3	..
Range of moisture ..	50·5–56·9	49·5–56·0	49·9–57·7	52·8–55·3	..

(e) Colour

Divisions of Points	5	4	3	2	1
No. of vats	36	77	10	..	..
Average moisture	52·5	53·5	53·8	..	..
Range of moisture ..	49·5–56·9	49·9–57·7	52·0–55·1	..	..

CORRELATION COEFFICIENTS

Total grade score	·1225**
Flavour score	·1039**
Body score	·0592
Texture score	·0318
Colour score	·0853

** Significant at 5% level.

TABLE 5

POINTS SCORED FOR VARIOUS PROPERTIES OF VATS OF CHEESE WITHIN DIVISIONS OF PERCENTAGE OF MOISTURE IN THE FAT-FREE-SUBSTANCE

	Divisions of Moisture Percentage						
	Over 55·0	54·0–54·9	53·0–53·9	52·0–52·9	51·0–51·9	50·0–50·9	Below 50·0
Total Grade—							
No. of vats	17	27	27	23	15	11	3
Average points score	90·4	90·6	90·5	90·8	91·0	91·4	91·5
Range of score	87·0–92·5	88·0–93·0	87·0–92·0	89·0–93·0	90·0–93·0	90·0–92·5	90·5–93·0
Flavour—							
No. of vats	17	27	27	23	15	11	3
Average points score	41·0	41·1	41·1	41·4	41·5	41·7	41·8
Range of score	38·5–42·5	38·5–43·0	38·5–42·5	40·0–43·0	41·0–43·0	41·0–42·5	41·0–43·0
Body—							
No. of vats	17	27	27	23	15	11	3
Average points score	4·0	4·0	4·1	4·0	4·3	4·4	4·3
Range of score	3·0–5·0	3·0–5·0	3·0–5·0	3·0–5·0	3·0–5·0	3·0–5·0	4·0–5·0
Texture—							
No. of vats	17	27	27	23	15	11	3
Average points score	3·4	3·3	3·3	3·3	3·3	3·7	3·7
Range of score	2·0–5·0	2·0–5·0	2·0–5·0	2·0–5·0	3·0–5·0	3·0–5·0	3·0–4·0
Colour—							
No. of vats	17	27	27	23	15	11	3
Average points score	4·1	4·1	4·2	4·1	4·3	4·7	4·7
Range of score	3·0–5·0	3·0–5·0	3·0–5·0	3·0–5·0	4·0–5·0	4·0–5·0	4·0–5·0

is not greater than this, and it therefore seems a safe assumption that the manufacturing methods employed in reducing the moisture content did not cause any increased loss of cheese-yielding constituents other than moisture.

TABLE 6

COMPARISON OF CHEESE YIELDS AND SHRINKAGES

Type of Cheese	Average Green Cheese Yield		Average Shrinkage (%)	Calculated Average Yield of 10-day-old Cheese	
	Per 100 lb Milk (lb)	Per lb Butterfat (lb)		Per 100 lb Milk (lb)	Per lb Butterfat (lb)
Normal	9·96	2·74	0·99	9·86	2·71
Low-moisture ..	9·77	2·68	0·82	9·69	2·66

TABLE 7

DISSECTION OF REJECTIONS FROM TABLES OF RESULTS

Reasons for Rejection	Number of Vats Rejected					
	Table 1		Tables 2 and 3		Tables 4 and 5	
	Normal	Low-moisture	Normal	Low-moisture	Normal	Low-moisture
Abnormality—						
In normal						
In low-moisture ..	4	4	4	4		2
In both						
Grade not obtained—						
For normal						
For low-moisture ..						
For both			8	8	8	8
Analysis not obtained—						
For normal	1	1			1	
For low-moisture ..						
For both	22	22			16	16

IV. DISCUSSION

(a) Quality of Cheese

The improvement shown in the grading quality of cheese resulting from a lowering of its moisture content is apparently composed of an improvement in all the main attributes with the exception of texture, where the difference is so small as to be not significant. While the improvement gained in the average grade is not great (0·67 grade points), it should be noted that this was achieved when the average moisture content of the normal cheese was only 36·17 per cent. and when this cheese was already achieving a fair average grade of 90·35 pt. Had the normal cheese been of a higher moisture content, the differences attained between the two types of manufacture could have been greater.

The extent to which the difference in grade would be reflected in a difference in the quality of the matured cheese was not assessed owing to difficulties associated with the storing and maturing of large quantities of cheese and also

because it was felt that the task of the cheese grader is partly to endeavour to predict the mature quality of the cheese and the grade he assigns it should therefore reflect this. While the actual quality of the cheese when matured is extremely important in the long-term interests of the industry as a whole, the more immediate concern, especially to the individual factory, is the grade initially assigned to the cheese.

It seems logical to expect that there is a limit in the reduction of the moisture content of cheddar cheese below which the grade not only fails to be improved but is actually lowered. For example, it is recognized that an excessively dry cheese has a hard and corky body which detracts from its quality and incurs a loss of grade points. However, an examination of the results obtained in this work, as set out in Tables 6 and 7, does not allow a decision to be made in regard to just what content of moisture in the fat-free-substance of cheddar cheese can be regarded as the lower limit beyond which any further reduction does not improve the quality. In these results it is observed that some improvement in score, except in the case of body, is still evident at the lowest average level of moisture content encountered. Since there is a tendency for very dry cheese to be almost completely lacking in any flavour, the question arises as to whether these results indicate an excessive negativity in the cheese grading system where flavour judgments are concerned, especially in view of the dominant role which flavour judgment plays in determining the grade of the cheese.

It is possible that if the cheese lost points because of a lack of any flavour, just as it loses points for the presence of abnormal flavours, the results could have been more clearly indicative of the minimum level of moisture in the fat-free-substance that is desirable.

The relationship between moisture content and grade is not so apparent from Tables 6 and 7; this could be expected from the results in Tables 4 and 5, where paired vats are compared. Since the experiment was carried on over a long period, it could be argued that a seasonal influence might have interfered with the results included in these tables. It is possible that the most suitable moisture content in the fat-free-substance at one time of the year is not the most suitable at another time. Such a shift in the optimum moisture content during the year would reduce the apparent relationship between moisture content and grade by spreading the best grades over a wider range of moisture content.

The average moisture content of the cheese resulting from the two methods of manufacture fluctuated throughout the experiment, but the better average grade for the low-moisture cheese indicates that its fluctuating level of moisture content was closer to the also fluctuating optimum level. The range in the monthly average moisture content in the fat-free-substance of the low-moisture cheeses was 49·9 to 54·3 per cent., while the corresponding range for the normal cheese was 52·4 to 56·2 per cent.

It is of interest to note that, although there was no marked change at any time in the methods used to gain a reduction in the moisture content of the cheese, the difference between the monthly average moisture content in the fat-free-substance for the two types of cheese varied from 0·7 to 2·7 per cent. It is a matter of conjecture as to why a set method of manufacture should be much more effective in reducing the moisture content of the fat-free-substance of the cheese at some times than it is at others. The fat and casein contents of the milk used in cheesemaking during this experiment did not appear to have any consistent influence on the extent of moisture reduction achieved by the low-moisture technique of manufacture.

(b) Yield of Cheese

The yield of cheese obtainable from a certain quantity of milk is an important economic factor in the cheese industry and one which can be measured. The better grading quality of the low-moisture cheese produced during this experiment must be weighed against the loss of cheese yield which occurred. The net reduction of 0·17 lb in the yield of cheese per 100 lb milk represents a loss of 1·72 per cent. of production. The monetary value of this varies according to the price obtainable for cheese, and is set out hereunder for various price levels.

Price of Cheese (per cwt)	Value of Loss of 1·72 per cent. Yield
s.	*s. d.*
150	2 7
170	2 11
190	3 3
210	3 7
230	3 11
250	4 4
270	4 8
290	5 0
310	5 4

It can be seen that the cost by way of lost cheese yield as a result of the low-moisture method of manufacture varies from 2s. 7d. to 5s. 4d. per cwt cheese according to the price level. With a system of differential payments for cheese according to its grade, there could be some monetary compensation by way of a higher price for the better grade of cheese. The price differentials at present imposed by the Australian Dairy Produce Board are as follows:—

Cheese Grade (pt.)	Difference from Basic Price (per cwt)
	s. d.
94 and over	+ 1 2
93	–
92	– 1 2
91	– 2 4
90	– 4 8
88-89	– 9 4
86-87	–17 6
83-85	–50 2

From this it can be seen that the particular grading results achieved in this experiment, viz. an increase in average grade from 90·35 to 91·02 pt., would bring about an increased monetary return of 2s. 4d. per cwt cheese. Therefore the cost of the lost yield would be recouped only if the price for cheese was as low as 135s. per cwt.

If the corresponding increase in grade was brought about from a lower normal level than that experienced in this experiment, the recoupment from the increased differential would be greater. Thus an increase in average grade from 89·35 to 90·02 pt. would recoup the cost of the lost yield up to a price level of 270s. per cwt.

The influence which quality itself has on the economics of the industry as a whole is difficult, if not impossible, to measure. While the maintenance of a high standard of quality and the establishing of a good reputation for the produce in world markets must be expected to have some ultimate effect on the economic security of the industry, the assessment of the value to be placed on such intangibles is quite outside the nature and scope of this work.

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