MEASURING POTATO PROCESSING COSTS DUE TO HARVEST DAMAGE & DEFECTS

by
Mark McKinney & Wayne L. Thiessen

Introduction

At this conference meeting in 1973, a gentleman by the name of Haakon Thomsen said, "If you are growing better than normal potatoes and the price you received did not include an incentive for this better quality, you are paying some other grower's bills."

This comment was a part of his discussion about "incentive contracting" whereby the payment for potatoes would be reflective of the product value.

In my studies, I found no easy solution, however, to a method of determining product value. Certainly before change in value during storage, or a reasonable basis for establishing values for "incentive contracting," a relevant grading system is required.

Most potato storage research has evaluated storage efficiency by measuring weight loss (shrink) as the major variable. Total storage costs were then presumed to be covered by adding the directly determinable costs. Those costs include labor and equipment for receiving and withdrawal, warehouse rent, warehouse operating costs and interest on investment.

If the ultimate use of the potatoes is for fresh pack, then shrink may be a valid measure of variable storage loss. This is true because the U. S. D. A. grade for potatoes usually changes very little during storage.

Increasingly greater and greater numbers of people on processing line trim tables throughout each processing season was mute but substantial testimony, nevertheless, to processing value losses.

Some reduction in finished product quality may also occur. This loss is storage related, and is a storage cost--a cost often directly related, however, to harvest time damage.

In our efforts to ascertain the extent of those losses in processing value, it was necessary to measure the processing value both prior to and after storage.

First, numerous analyses were made on the U. S. D. A. grading system and on various alterations of that system to determine relevance to the actual processing value of potatoes. All analyses, whether in comparison with factory achievments, trim labor time and yield studies, or processed sample economies, indicated a very low correlation between 'value as determined by grade' and 'value as determined by performance.'

In short, there seemed to be no grade system established whereby true and relevant processing value could be determined. This paper relates to how we developed and are now using a grade system that we find is capable of measuring processing value.

Objectives

The objectives of this study were to:

(a) develop a system for evaluating potatoes to determine their relative value in producing frozen french fries and related products, and
(b) utilize the system to evaluate potato lots prior to and after storage to more accurately ascertain storage losses.

It was also our desire to develop a system that would more accurately ascertain value as a basis for purchase or sale.

Methods and Materials

Numerous small samples of Russet Burbank potatoes were taken from storage. Samples were selected to represent as much variation in quality (i.e., size, shape, rot, bruise and mechanical injury) as available in our storages at that time.

Peeled potato and trimmed potato yields for each lot were measured, as was the time required for trimming. Individual lot values were determined, based on yield of clean usable potato material and cost of trim labor required.

Trimming was done to remove defects to the extent necessary for processing into acceptable finished product.

Various grading techniques involving numerous categories of measurements such as tuber size, french fry length, defect levels, trimming requirements, and fry color were employed.

Out of many things measured because we thought they were important quality factors, the statistical evaluation (all statistical functions, including guidance on procurement of data, as well as analysis of data procured, were performed by J. Scott Robertson, Research Analyst, Ore-Ida Foods, Inc., Boise, Idaho) indicated little difference in value between many of the categories. Consequently, according to the statistical indications, data was procured on the basis of two size categories and three defect levels.

The two size categories were peeled tubers weighing less than 5 oz. and those weighing 5 oz. or more. The three defect categories were: (a) potatoes requiring no trimming were classed as #1 grade potatoes, (b) potatoes requiring trimming prior to further processing were classed as #2 grade, (c) potatoes to be discarded as waste because trimming labor would be excessive were classed as grade #3 potatoes.

Statistical analysis was applied to the data to obtain a formula expressing the value of each category. Additional analysis determined the credibility level of the formula in relation to the actual values determined from the time and yield measurements.

Internal quality of the potatoes was evaluated, after peeling, by strip cutting into french fries. Discounts in value were applied to lots having excessive quantities of low gravity strips as determined by brine separation, high sugars as determined by fry color score, or other observable internal defects.

Applicability of the grade system was tested by grading more than 100 million pounds of potatoes prior to processing and comparing those grades to actual processing achievements.

Performance of the graded potatoes was evaluated daily by using factory recovery figures, production of finished product per unit of processing labor time, plus a small cost factor for the processing and waste handling equipment.

Results & Discussion

A poor correlation developed between the contract price or lot value as determined by USDA grade factors and the actual value of various lots as determined from material loss and labor costs incurred during preparation for processing. There was also a poor correlation between contract price and factory performance. Contract price included a base price plus incentive factors for bruise-free potatoes, US #1 potatoes and US #1 and #2 over 10 oz. in weight.

Statistical analysis of the data procured on thirty-nine lots of potatoes, utilizing the experimental peeled grades as described and also evaluated for time and yield, allowed development of a formula of relative value for each size and grade category. When compared to the actual processing value as determined by actual trim labor costs and yields of material ready for processing, this formula did show a reasonably high correlation as shown in Table 1.

Statistical evaluation of the data indicated that the cost of trimming labor, when both direct and indirect labor costs were considered, was greater for potatoes under 5 oz. that required trimming (#2 grade potatoes) than the resulting yield in clean potato material was worth. Grade 3 potatoes, being cull potatoes, are of negative value for the following reasons: (a) since the material is not usable, it has no direct value, (b) labor is required to sort out the material for discard, (c) mechanical and pollution control equipment capacity must be available to handle the material, and (d) the severity of the #2 grade category is probably directly correlated with the amount of #3 potatoes in the lot. Therefore, the index of value for #3 potatoes attributed a substantial negative index to them.

An index of relative processing value related to trim labor and yield of trimmed material was established and shown in Table 1. By knowing how much dirt was removed in washing and how much loss was sustained in the peeler for each lot, the index was calculated on the weight of both washed and field-run potatoes.

For measuring storage losses, the index of value on field-run potatoes going into storage compared to the index when removed from storage should be used as the basis for determining changes in value. However, if some of the dirt cannot be accounted for in the withdrawal volumes, then an index based on washed weight might be more meaningful.

The data shown in Table 2 is from a commercial factory operation. Many operational factors, including daily factory production efficiencies, are quite variable. A perfect index of the value of the raw potatoes would not show an identical daily cost index per unit of finished production due to such variations in factory performance. Several days are noted where calculated relative costs per unit of production show irregularities. While this could be interpreted as an indication of improper grading, it is more probably caused by factors that affected the efficiency of the factory production for that day.

Overall, it is readily apparent that the general drop in index as the processing season progressed was approximately equivalent to the increase in processing costs attributable to raw product quality. This is interpreted as reasonable proof that the grading system did measure the relative processing value of various potato lots. It would also indicate that any changes in grade noted while potatoes were held in storage was a reasonable assessment of the change in processing value and, therefore, a fair assessment of the storage costs attributable to reduction in value while in storage.

Table 3 indicates that processing value changes in storage may exceed 20% of the direct processing value that existed in the potatoes at the time of receiving. Such economic losses are in addition to shrink which is often used as a measure of storage loss.

The principal value of these measurements in relation to stored potatoes is that more accurate measurements can now be made on the value of reducing such factors as bruise, bruise proliferation in storage, and quality changes caused by sub-standard warehousing. Documentation of those losses ismandatory in order: 1) to determine the economic feasibility of instituting practices or equipment use that will reduce them, and 2) determine whether any expense or investment cost incurred and designed to reduce such losses does in fact reduce losses sufficiently to show a reasonable monetary return on the investment involved.

Conclusions

Based on data gathered on small potato lots, a grading system was developed which evaluated size and defect level (external and internal). This system has been effectively applied to large lots of commercially stored and processed potatoes. As the grade index drops, processing labor increases and yield decreases so that relative index of cost to produce finished product remains similar throughout the processing season.

The system provides a basis of evaluation upon which to measure raw product value, processing potential, and factory efficiency.

The system seems to offer a means whereby the effect of various experimental storage treatments may be accurately evaluated and storage losses as related to processing value determined.

Table 1. Size by grade and cost index/cwt of peeled potatoes for 39 lots evaluated by trim time and yield measurements.

Lot No.	Cost Index*	% Grade #1 Under 5 oz.	% Grade #1 5 oz. Minimum	% Grade #2 Under 5 oz.	% Grade #2 5 oz. Minimum	% Grade #3 Under 5 oz.	% Grade #3 5 oz. Minimum	
1	68.77	17.8	41.1	7.4	29.6	1.5	2.5	
2	108.30	11.3	35.8	9.9	39.2	1.9	1.9	
3	87.25	15.2	39.0	9.8	33.0	.5	2.4	
4	103.30	15.3	30.3	9.3	41.3	1.3	2.5	
5	102.07	15.1	32.2	11.2	36.7	1.6	3.2	
6	102.47	15.5	27.5	16.3	38.7	1.5	.5	
7	94.41	24.1	23.6	9.1	39.4	1.6	2.1	
8	68.73	25.9	40.2	6.5	24.5	1.7	1.2	
9	67.58	21.3	37.3	5.6	34.4	1.3	.1	
10	62.58	29.3	40.3	5.8	23.1	.9	1.1	
11	85.87	21.0	34.7	7.0	32.8	2.4	2.2	
12	110.09	17.3	32.8	9.2	37.5	2.2	1.0	
13	98.84	18.5	29.8	7.0	42.5	2.0	.2	
14	110.91	16.9	29.6	8.1	42.1	1.9	1.4	
15	112.59	18.6	29.0	10.7	35.4	1.9	4.5	
16	122.98	16.4	27.5	11.0	42.1	.9	2.1	
17	113.37	17.0	34.0	9.0	34.3	3.0	2.7	
18	106.11	21.2	35.2	10.8	27.7	2.9	2.2	
19	93.13	20.1	36.8	9.0	31.2	2.9	.0	
20	204.96	10.6	5.9	29.6	42.1	8.8	2.9	
21	168.74	11.9	16.4	23.5	40.5	7.6	.2	
22	142.70	17.1	28.6	15.6	30.8	4.1	3.9	
23	127.07	18.7	27.6	12.1	36.0	3.9	1.7	
24	144.15	20.0	17.6	17.9	37.2	4.1	3.2	
25	102.71	29.0	26.2	12.4	27.6	2.8	2.0	
26	96.69	27.9	35.2	6.8	25.8	2.2	2.2	
27	117.41	28.1	27.7	11.5	26.8	3.1	2.7	
28	86.21	25.3	35.4	9.8	26.3	1.1	2.1	
29	97.05	26.0	34.7	15.3	21.2	2.5	.3	
30	94.45	25.3	35.8	12.1	22.4	2.0	2.5	
31	109.38	29.1	30.5	14.0	19.5	3.2	3.7	
32	100.54	26.7	31.9	13.7	23.0	2.5	2.2	
33	116.80	29.7	28.7	14.4	24.4	1.9	1.0	
34	90.22	26.6	35.7	10.6	23.1	2.4	1.5	
35	93.92	20.5	34.5	9.7	30.8	2.4	2.1	
36	147.06	21.4	23.2	13.8	37.9	1.4	2.3	
37	108.38	22.6	32.2	10.7	31.5	2.6	.4	
38	113.28	27.0	28.1	11.8	29.4	3.6	.0	
39	116.23	23.1	11.4	13.9	47.4	3.2	1.0	
Average	107.62	21.1	30.4	11.6	32.5	2.5	1.8	
St.Dev.	27.06	5.4	7.6	4.7	7.2	1.6	1.1	
High	204.96	29.7	41.1	29.6	47.4	8.8	4.5	
Low	62.58	10.6	5.9	5.6	19.5	.5	-	
Index of value per pound for ready to use potato material		2.60	3.60	2.60	3.60	3.25		
Cost Index at Trim Tables		none	none	3.35	1.01	4.39		R = .92
Remaining Index or Formula of Value		2.60	3.60	(.75)	2.59	(1.14)		

*Cost Index: The cost index for each lot was determined by allowing 8 index points per minute of trim labor time required plus 3.25 index points per pound material lost in the trimming operation. The recorded index was then adjusted to a per hundredweight of peeled potatoes. Under the conditions of the study, all trim material, whether from large or small potatoes, was accumulated together and subtracted from the remaining index at an average value.

Table 2. Index values and processing labor costs for potato lots as delivered to the factory following storage.

Date	Index of Value Per Cwt. for All Potatoes Delivered to the Plant for Processing - Cwt. Basis		Relative Cost of Potatoes to Produce 1,000 lbs. Finished Product If Cost is Based on Index at 67¢ Per 100 Index Points		Processing Labor Cost Factor Per 1,000 Lbs. Finished Product		Total Processing Labor Plus Material Indexed Values Per 1,000 Lbs. Finished Product	
10-10	235		30.04		3.53		33.57	
11	238		31.14		3.66		34.80	
12	237	Av. 235	30.19	30.14	3.55	3.59	33.74	33.73
13	230		29.19		3.63		32.82	
23	218		27.98		4.32		32.30	
24	217		29.02		5.03		34.05	
25	197	Av. 211	26.45	27.69	4.67	4.25	31.12	31.94
26	208		27.44		3.63		31.07	
27	214		27.57		3.61		31.18	
30	212		28.24		3.96		32.20	
31	215		28.13		3.88		32.01	
11-01	218	Av. 210	28.36	28.02	4.20	4.24	32.56	32.29
2	209		28.01		4.34		32.35	
3	197		27.38		4.83		32.31	
6	178		26.10		6.81		32.91	
7	195		26.45		6.43		32.88	
8	199	Av. 198	27.78	26.72	5.85	6.16	33.63	32.87
9	207		27.41		6.06		33.47	
10	199		25.84		5.63		31.47	
12-11	230		30.33		8.18		38.51	
12	237		31.57		8.09		39.66	
13	217	Av. 217	27.85	28.32	7.83	7.87	35.68	36.19
14	199		26.51		7.63		34.14	
15	203		25.33		7.62		32.95	
27	184		24.66		7.25		31.91	
28	196	Av. 196	26.69	26.08	7.06	7.03	33.75	33.11
29	198		26.90		6.78		33.68	
1-08	210		27.11		7.78		34.89	
9	200		26.02		7.35		33.37	
10	204	Av. 201	26.44	26.13	7.04	7.28	33.48	33.40
11	186		24.10		6.84		30.94	
12	204		26.96		7.37		34.33	
4-9	192		23.91		8.59		32.50	
10	196	Av. 197	24.32	24.29	9.07	8.60	33.39	32.89
11	197		24.26		8.47		32.73	
12	201		24.66		8.26		32.92	

Table 3. Grade or index comparisons on potato lots evaluated prior to and after storage in seven different warehouse units. (Average lot size = approximately 8,000,000 lbs.)

Storage	Withdrawal Date	Average Grade Index Going Into Storage	Average Grade Index Out of Storage	Change in Grade During Storage
1	November	236	211	- 10.5%
2	Late Nov.	237	211	- 11%
3	Late Jan.	231	201	- 13%
4	February	247	203	- 18%
5	March	248	198	- 20%
6	March	237	187	- 21%
7	March	230	195	- 15%