Economic Feasibility of Screening Farmer Stock Peanuts Prior to Marketing

M.C. Lamb[a*] and P.D. Blankenship[b]

ABSTRACT

Screening farmer stock peanuts prior to marketing provides a method to increase the per-ton value of peanuts. The mechanical separation of larger, higher value pods (overs) from smaller, lower value pods—which includes foreign material (FM) and loose shelled kernels (LSK) (thrus)—results in significant changes in farmer stock grade. Based on data from 394 runner lots in the Southeast, the percentage of sound mature kernels and sound splits (SMKSS), LSK, FM, and other kernels (OK) was changed by +0.61, -4.31, -2.32, and -0.3 between overs and unscreened lots, respectively. The average value of farmer stock peanuts was $29.15/Mg higher in the screened lots (overs) compared to the unscreened lots. Although the average per-ton value of screened peanuts is increased, economic feasibility of screening is dependent upon several factors. Two specific marketing scenarios for farmers are analyzed including production of quota poundage only and production in excess of quota poundage where additional peanuts are used to replace peanuts removed during the screening process. Thus, opportunity cost must be included. Typical investment in high capacity (minimum 18 Mg/hr) screening equipment is approximately $150,000. Amortized at 10% rate of interest over a 6-yr period with depreciation allowances and labor and energy cost included, a minimum of 4536 Mg/yr must be screened to effectively "spread" fixed cost, thus indicating that only exceptionally large farmers, groups of farmers, or buying points have sufficient volume for screening. Further, the quality of peanuts prior to screening also impacts economic feasibility. These factors will be incorporated to estimate probability decision thresholds to determine if individual lots can be profitably screened prior to marketing.

Key Words: Peanut quality, peanut marketing.

Mechanical screening of farmer stock (FS) peanuts (*Arachis hypogaea* L.) prior to farmer marketing provides a method to improve the quality and value of peanuts (1). Screening divides FS lots into two sublots—overs and thrus. Overs are larger, higher value pods which generally make up 85 to 95% of an unscreened FS lot. Thrus comprise the remainder of the lot composition and include smaller, lower value pods, loose shelled kernels (LSK), and foreign material (FM). Several studies have addressed the impact of screening on peanut quality and value (4,5). The Peanut Quality Enhancement Project (PQEP) examined screening at eight buying points in the U.S. and concluded that peanut quality and value were increased

[a]Res. Fellow, Dept. of Agri. Economics and Rural Sociology, Auburn Univ., Auburn Univ., AL 36849 and USDA,ARS, National Peanut Research Lab., 1011 Forrester Drive, S.E., Dawson, GA 31742.
[b]Agric. Eng., USDA,ARS, National Peanut Research Lab., 1011 Forrester Drive, S.E., Dawson, GA 31742.
[*]Corresponding author.

by screening (1). Removal of LSK, small immature pods, and damaged kernels is an aflatoxin management strategy which would improve peanut quality prior to and in storage and during subsequent processing (3). Significant improvements in peanut quality were found in a study addressing the design and operational settings of screening devices when proper flow rates and maintenance were followed (2).

Screening was demonstrated to consistently improve peanut quality. However, these studies did not provide an in-depth analysis of the economic feasibility of screening FS peanuts prior to marketing. Several factors must be considered by a farmer when deciding whether screening is a profitable alternative to marketing unscreened peanuts. On average, if screening is economically feasible, then certain grade ranges exist at which FS peanuts should probably not be screened. The objective of this study was to address the economic feasibility of screening FS peanuts under the current peanut policy and to provide information to assist the peanut industry on investment decisions. An additional objective was to estimate probability decision thresholds based on unscreened FS grade factors to provide farmers information of the expected returns of screening individual lots compared to marketing lots unscreened.

Materials and Methods

Investment in high capacity (minimum 18 Mg/hr) screening equipment requires significant capital outlay. Depending on the type of screening device, amount of land preparation, installation cost, and other related costs, investment in screening equipment can range from \$125,000 to \$175,000. Total investment cost of \$150,000 is used in the analysis. Due to the number of years remaining on the current peanut program, capital outlay was amortized over 6 yr at 10% interest. A 15-yr straight line depreciation is included on fixed assets and salvage value is assumed to be zero. Operation cost of screening was estimated based on the labor valued at minimum wage, and electricity usage gathered from previous studies was adjusted to current dollars (1).

The grade and screening data used in this analysis were gathered in the PQEP conducted in 1988 (1). Runner-type peanut lots from the Southeast were analyzed (n = 394) from buying points cooperating in PQEP. Grade data for the unscreened lots, overs, and thrus were obtained following standard Federal-State Inspection Service grading procedures (10). All lots were Segregation 1. Individual lot weights were recorded for the unscreened lots and after screening for overs and thrus lots.

Two marketing scenarios were addressed because Southeast farms market both quota and non-quota peanuts. In each scenario, peanuts in the thrus were graded and marketed as oil stock based on total meat content. Calculations of weights and peanut value are presented on a net weight basis to properly reflect the current marketing system. Value deductions for excess FM, damage (DAM), and moisture content (MC) were included using standard grading and value determination procedures.

Scenario 1 assumed that a farmer produced only enough peanuts to fill quota before screening. Peanut material diverted to thrus during screening was not replaced. Quota poundage not marketed was fall transferred at \$0.22/kg. Scenario 2 assumed that a farmer produced in excess of quota and that material diverted to thrus during screening was replaced with additional peanuts which could have been sold as contract additionals valued at \$386/Mg. Thus, opportunity costs of foregone additional marketings are incorporated into Scenario 2. The following equation was specified to examine the returns to screening for each marketing scenario:

$$R = \frac{\sum}{n} \{[(2000-R_M+R_P)*P_S]+[(R_M*T_M)*P_O]\} - (R_P*P_{UR}) - C - (2000*P_U) + (R_M*P_F) \quad \text{[Eq. 1]}$$

where:

R is the estimated return to screening (\$/Mg),

n is the number of observations (lots) in the data set (n = 394 in this study),

R_M is the amount of peanut material removed during screening (pods and kernels),

R_p is amount of screened peanut material required for replacement of Rm,

$R_p = 0$ in Scenario 1,

$R_p = R_M$ in Scenario 2,

P_S is the price of screened quota FS peanuts grade basis,

T_M is the percent of total meats in the thrus,

P_O is the price of oil stock,

P_{UR} is the price of unscreened contract additional FS peanuts grade basis in Scenario 2,

C is the cost/Mg of screening and handling,

P_U is the price of unscreened quota FS peanuts grade basis, and

P_F is the price received for fall transfer of quota poundage not marketed ($P_F = 0$ in Scenario 2).

Estimation of decision thresholds to assist farmers in deciding to screen individual FS lots must be based on unscreened FS grade factors. Basing the thresholds on unscreened grade factors allows sufficient time for screening and re-grading or to make decisions regarding lots of similar quality prior to grading (i.e., lots from same field) to avoid possible regrading expense. An objective of this analysis is to provide the estimated probability that screening would be economically feasible for the two marketing scenarios previously discussed based on unscreened grade factors. A dichotomous random variable model was defined as $Yi = 1$ if $R \geq 0$ and $Yi = 0$ if $R < 0$ from Eq. 1. Three models commonly used to analyze dichotomous models include the linear probability model (LPM), the logit model, and the probit model (6,7,8). The LPM is often eliminated as an analysis tool due to associated statistical problems and the fact that probabilities are not restricted to range between 0 and 1 in this model. The logit and probit models usually yield similar results and the logit specification is chosen in this analysis (7,8). The logit model is specified as:

$$LOG_e\left(\frac{P}{1-P}\right) = \alpha + \beta'X \quad \text{[Eq. 2]}$$

where:

P = probability that $Y = 1$,

a is the intercept term,

β is the vector of slope coefficients, and

X is the matrix of independent variables.

The predicted probabilities for the feasibility of screening can be computed from:

$$p = \frac{e(\alpha+\beta'X)}{1+e(\alpha+\beta'X)} \quad \text{[Eq. 3]}$$

where:
p is the computed probability, and
e is the base of the natural logarithm.

The economic feasibility of screening FS peanuts prior to marketing was hypothesized to depend upon unscreened grade factors. All unscreened grade factors were evaluated in the model including FM, OK, DAM, SMKSS, LSK, and MC.

Results and Discussion

Due to the significant capital outlays required for the screening investment, the cost/Mg of screening FS peanuts is primarily dependent on the tonnage screened. Building and screening device costs account for 76% of total installation cost of screening systems (1). Thus, the ability to 'spread' fixed cost with adequate volume is prerequisite to feasiblely investing in screening. Variable cost, which is primarily comprised of labor and energy, is estimated to be \$5.79/Mg and does not vary with screening volume. Variable and total screening costs are illustrated in Fig. 1 for increasing tonnages of peanuts screened. As shown in Fig. 1, the amount of peanuts screened impacts total cost by reducing per-unit fixed cost. This implies that only exceptionally large peanut producers, groups of producers, or buying points should consider investment in screening equipment in order to obtain screening cost in the \$11/Mg or less range, thus the analysis assumed 4536 Mg of farmer stock peanuts are screened.

Mean farmer stock grade factors in the unscreened, overs, and thrus lots are presented in Table 1. Significant increases ($P \leq 0.05$) were not found between SMKSS in the unscreened and overs lots while SMKSS in the thrus were significantly different when compared to the unscreened and overs lots. Although not presented in Table 1, significant differences in SMKSS between the unscreened and overs lots were found at the $P \leq 0.10$ level. LSK were significantly decreased ($P \leq 0.05$) in the overs compared to the unscreened lots from screening. Reduction of LSK in the overs demonstrates the effectiveness of screening in separating LSK, thus minimizing one of the risk components of aflatoxin (4). OK in the

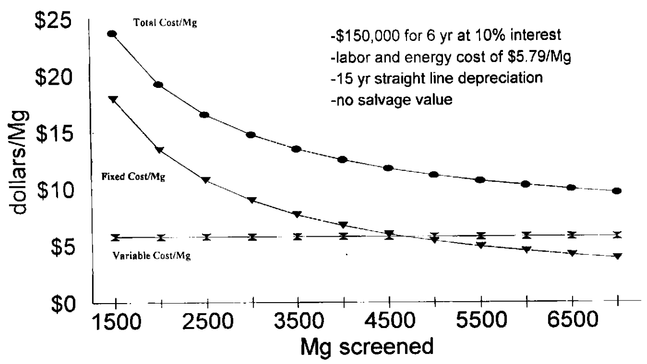

Fig. 1. Variable, fixed, and total cost/Mg for screening farmer stock peanuts.

Table 1. Mean farmer stock grade factors in unscreened, overs, and thrus lots, n = 394.

Variable	Unscreened[a]	Overs	Thrus
	%	%	%
SMKSS	72.39 a	72.99 a	50.69 b
LSK	5.12 a	0.82 b	37.85 c
OK	4.89 a	5.11 a	22.71 b
DAM	0.35 a	0.36 a	0.41 a
HULLS	22.31 a	21.44 b	26.17 c
FM	4.22 a	1.89 b	24.95 c
MC	8.56 a	8.55 a	8.55 a

[a]Means followed by the same letter within rows are not significantly different at $P \leq 0.05$ as determined by Duncan's new multiple range test..

thrus were significantly different ($P \leq 0.05$) from the OK in the unscreened and overs lots. No significant differences ($P \leq 0.05$) were found in DAM. HULLS and FM were each significantly different ($P \leq 0.05$) among the unscreened, overs, and thrus lots.

The average return to screening was estimated from Eq. 1 for the marketing scenarios previously defined. In Scenario 1, no replacement of removed peanut material occurred and the average return to screening quota farmer stock peanuts was \$17.48/Mg less than unscreened lots. Thus, at the average grade factors used in this analysis, screening farmer stock peanuts with no peanuts to replace peanut material removed during the screening process is not economically feasible. Unscreened grade factors did exist in Scenario 1 whereby it was feasible to screen FS lots. However, positive returns to screening in Scenario 1 occurred in only 24% of the observations.

The results of the logit regression specified in Eq. 2 for Scenario 1 are contained in Table 2. The model was limited to the log of SMKSS and log of LSK as independent variables because of lack of significance of other independent variables. As expected, SMKSS was negatively related to screening feasibility while LSK was positively related. Both variables and the constant term were significant. The parameter estimate for SMKSS (-16.39) suggests that, for a 1% increase in SMKSS, the log of the odds of screening being feasible decreases by approximately 16%. Conversely, a 1%

Table 2. Maximum likelihood parameter estimates and descriptive statistics from the logit model for Scenario 1.[a]

Variable	Parameter estimate	Pr >Chi-square
Constant	65.92 (14.06)	0.0001
Log (SMKSS)	-16.39 (3.34)	0.0001
Log (LSK)	1.87 (0.34)	0.0001

[a]Homer and Lemeshow goodness-of-fit statistic = 5.22. Based on a 50:50 classification: Correctly specified = 76.6%, sensitivity = 7.5%, specificity = 98.0%, false positives = 46.2%, and false negatives = 22.6%. Standard errors are in parenthesis.

increase in LSK increases the log of the probability of screening feasibility by approximately 1.9%. The Homer and Lemeshow goodness-of-fit statistic was 5.22 (8 d.f.) in this scenario which was not significant, indicating that the model did not provide a good fit to the data (9). An alternate method to examine the goodness-of-fit of the logit model was provided by in-sample evaluation of the estimated model. Based on a 50:50 classification probability cutoff, over 76% of the sample data were correctly classified (Table 2). Sensitivity, which is the ratio of correctly classified events (Y = 1) over the total numbers of events, was very low and indicates the low number of event occurrences in this scenario. Conversely, specificity, which measures the ratio of correctly classified nonevents (Y = 0) over the total number of nonevents, was 98% and indicates that the model did a very good job of indicating when screening should not occur. False positives, the ratio of non-events incorrectly classified as events over the sum of all observations classified as events, were 46%. False negatives, the ratio of events incorrectly classified as nonevents over the sum of all observations classified as nonevents, were only 23%. Thus, this model was more likely to recommend screening when screening should not occur than to recommend not screening when screening would be a feasible alternative.

The predicted probabilities of screening feasibility for Scenario 1 are contained in Table 3 for unscreened SMKSS and LSK values from Eq. 3. The predicted probabilities are graphically illustrated in Fig. 2. From Table 3 and Fig. 2, the probability of screening feasibility exceeds 0.50 for only a limited combination of SMKSS and LSK—indicating that when no replacement of removed peanut material occurs, screening is feasible only for lower quality peanuts based on unscreened SMKSS and LSK combinations. For SMKSS > 77%, screening is not feasible regardless of LSK, and for LSK < 2%, screening is not feasible regardless of SMKSS.

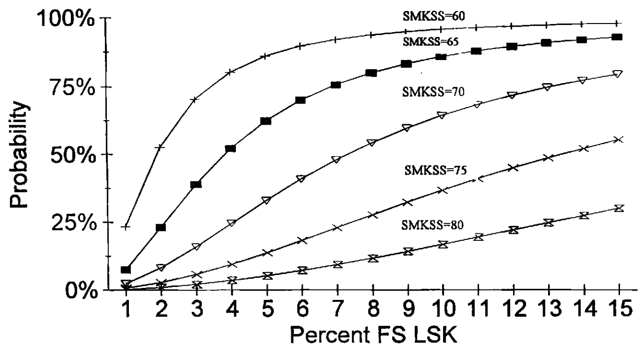

Fig. 2. Probability of screening feasibility when screening quota farmer stock peanuts and no replacement of removed peanut material occurs.

In Scenario 2, removed peanut material was replaced by peanuts valued as contract additionals based on unscreened grade factors. The average return to screening quota farmer stock peanuts in this scenario was $3.63/Mg. Positive returns to screening in Scenario 2 occurred in 61% of the observations.

The results of the logit regression specified in Eq. 2 for Scenario 2 are presented in Table 4. Again, the signs on the two independent variables were consistent with a priori expectations and both variables and the constant term were significant. The parameter estimate for SMKSS (-10.38) suggests that, for a 1% increase in SMKSS, the log of the odds of screening being feasible decreases by approximately 10%. Conversely, a 1% increase in LSK increases the log of the probability of screening feasibility by approximately 1.16%. The Homer and Lemeshow goodness-of-fit statistic was 14.40 (8 d.f.), indicating that the model also provided a good fit to the data in this scenario (9). In the model for Scenario 2, more than 64% of the sample data were correctly classified (Table 4). Sensitivity was low in this scenario at 87%, again indicating the much larger

Table 3. Predicted probabilities of screening FS lots being feasible based on unscreened FS grade factors for marketing Scenario 1.

LSK	SMKSS (%)																			
(%)	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
1	0.23	0.19	0.15	0.12	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
2	0.53	0.46	0.39	0.33	0.28	0.23	0.19	0.15	0.12	0.10	0.08	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01
3	0.70	0.64	0.58	0.52	0.45	0.39	0.33	0.28	0.23	0.19	0.16	0.13	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02
4	0.80	0.76	0.70	0.65	0.58	0.52	0.46	0.40	0.34	0.29	0.24	0.20	0.17	0.14	0.12	0.09	0.08	0.06	0.05	0.04	0.04
5	0.86	0.82	0.78	0.73	0.68	0.62	0.56	0.50	0.44	0.38	0.33	0.28	0.24	0.20	0.17	0.14	0.11	0.09	0.08	0.06	0.05
6	0.90	0.87	0.84	0.80	0.75	0.70	0.64	0.59	0.53	0.47	0.41	0.35	0.30	0.26	0.22	0.18	0.15	0.13	0.11	0.09	0.07
7	0.92	0.90	0.87	0.84	0.80	0.76	0.71	0.65	0.60	0.54	0.48	0.42	0.37	0.32	0.27	0.23	0.19	0.16	0.14	0.11	0.09
8	0.94	0.92	0.90	0.87	0.84	0.80	0.76	0.71	0.66	0.60	0.54	0.48	0.43	0.37	0.32	0.28	0.24	0.20	0.17	0.14	0.12
9	0.95	0.93	0.92	0.89	0.87	0.83	0.79	0.75	0.70	0.65	0.60	0.54	0.48	0.43	0.37	0.32	0.28	0.24	0.20	0.17	0.14
10	0.96	0.94	0.93	0.91	0.89	0.86	0.83	0.79	0.74	0.69	0.64	0.59	0.53	0.47	0.42	0.37	0.32	0.27	0.23	0.20	0.17
11	0.96	0.95	0.94	0.92	0.90	0.88	0.85	0.82	0.78	0.73	0.68	0.63	0.58	0.52	0.46	0.41	0.36	0.31	0.27	0.23	0.19
12	0.97	0.96	0.95	0.93	0.92	0.90	0.87	0.84	0.80	0.76	0.72	0.67	0.61	0.56	0.50	0.45	0.40	0.35	0.30	0.26	0.22
13	0.97	0.97	0.96	0.94	0.93	0.91	0.89	0.86	0.83	0.79	0.75	0.70	0.65	0.60	0.54	0.49	0.43	0.38	0.33	0.29	0.25
14	0.98	0.97	0.96	0.95	0.94	0.92	0.90	0.87	0.84	0.81	0.77	0.73	0.68	0.63	0.58	0.52	0.47	0.41	0.36	0.32	0.27
15	0.98	0.97	0.97	0.96	0.94	0.93	0.91	0.89	0.86	0.83	0.79	0.75	0.71	0.66	0.61	0.55	0.50	0.45	0.39	0.35	0.30

Table 4. Maximum likelihood parameter estimates and descriptive statistics from the logit model for Scenario 2.[a]

Variable	Parameter estimate	Pr>Chi-square
Constant	43.11 (12.51)	0.0006
Log (SMKSS)	-10.38 (2.94)	0.0004
Log (LSK)	1.16 (0.24)	0.0001

[a]Homer and Lemeshow goodness-of-fit statistic = 14.40. Based on a 50:50 classification: Correctly specified = 64.7%, sensitivity = 87.0%, specificity = 30.8%, false positives = 34.3%, and false negatives = 39.2%. Standard errors are in parenthesis.

number of event occurrences in this scenario. Specificity was 30.8% which reflects the decreased number of nonevents. False positives were 34.3% while false negatives were 39.2%.

The predicted probabilities of screening feasibility for Scenario 2 are contained in Table 5 for unscreened SMKSS and LSK values from Eq. 3 and are graphically illustrated in Fig. 3. From Table 5 and Fig. 3, the probability of screening feasibility exceeds 0.50 for a large number of combinations of SMKSS and LSK. This indicates that, when contract additionals are used to replace peanut material that was removed, then screening is feasible for an increased number of SMKSS and LSK combinations. On average, it is feasible to screen these peanuts. The predicted probabilities in Table 5 and Fig. 3 indicate that, in this marketing scenario, only peanuts of above average grade combinations should not be screened.

Summary and Conclusions

Screening FS peanuts has gained interest as a method

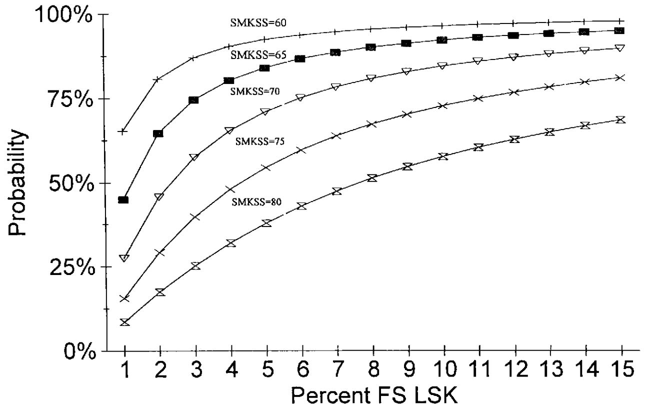

Fig. 3. Probability of screening feasibility when screening quota farmer stock peanuts and removed peanut material is replaced with contract additional peanuts.

to improve peanut quality and increase value. Feasibility of screening FS peanuts is dependent on several factors. The cost/Mg of screening is important. Due to the significant capital requirements to install a screening device, approximately 4536 Mg of peanuts must be screened each year to result in screening cost of $11/Mg. While significant improvements in FS grade factors were found in overs lots compared to unscreened lots, the estimated economic feasibility of screening FS lots is dependent on the quality of unscreened lots and the marketing situation of the producer. At the average grade factors in this study, it is not feasible to screen quota FS peanuts if peanut material removed is not replaced or replaced by quota peanuts. However, on average, it is feasible to screen peanuts if the removed

Table 5. Predicted probabilities of screening FS lots being feasible based on unscreened FS grade factors for marketing Scenario 2.

LSK	SMKSS (%)																				
(%)	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
1	0.65	0.61	0.57	0.53	0.49	0.45	0.41	0.37	0.34	0.31	0.28	0.25	0.22	0.20	0.18	0.16	0.14	0.12	0.11	0.10	0.09
2	0.81	0.78	0.75	0.72	0.68	0.65	0.61	0.57	0.53	0.50	0.46	0.42	0.39	0.35	0.32	0.29	0.27	0.24	0.22	0.19	0.17
3	0.87	0.85	0.83	0.80	0.77	0.74	0.71	0.68	0.65	0.61	0.58	0.54	0.50	0.47	0.43	0.40	0.37	0.33	0.31	0.28	0.25
4	0.90	0.89	0.87	0.85	0.83	0.80	0.78	0.75	0.72	0.69	0.65	0.62	0.59	0.55	0.51	0.48	0.45	0.41	0.38	0.35	0.32
5	0.92	0.91	0.90	0.88	0.86	0.84	0.82	0.79	0.77	0.74	0.71	0.68	0.65	0.61	0.58	0.54	0.51	0.48	0.44	0.41	0.38
6	0.94	0.93	0.91	0.90	0.88	0.87	0.85	0.83	0.80	0.78	0.75	0.72	0.69	0.66	0.63	0.60	0.56	0.53	0.50	0.46	0.43
7	0.95	0.94	0.93	0.92	0.90	0.89	0.87	0.85	0.83	0.81	0.78	0.76	0.73	0.70	0.67	0.64	0.61	0.57	0.54	0.51	0.47
8	0.95	0.95	0.94	0.93	0.91	0.90	0.89	0.87	0.85	0.83	0.81	0.78	0.76	0.73	0.70	0.67	0.64	0.61	0.58	0.55	0.51
9	0.96	0.95	0.94	0.94	0.92	0.91	0.90	0.88	0.87	0.85	0.83	0.81	0.78	0.76	0.73	0.70	0.67	0.64	0.61	0.58	0.55
10	0.96	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.88	0.86	0.85	0.82	0.80	0.78	0.75	0.73	0.70	0.67	0.64	0.61	0.58
11	0.97	0.96	0.96	0.95	0.94	0.93	0.92	0.91	0.89	0.88	0.86	0.84	0.82	0.80	0.77	0.75	0.72	0.69	0.66	0.63	0.60
12	0.97	0.97	0.96	0.95	0.94	0.94	0.93	0.91	0.90	0.89	0.87	0.85	0.83	0.81	0.79	0.77	0.74	0.71	0.69	0.66	0.63
13	0.97	0.97	0.96	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.88	0.86	0.85	0.83	0.81	0.78	0.76	0.73	0.71	0.68	0.65
14	0.98	0.97	0.97	0.96	0.95	0.95	0.94	0.93	0.92	0.90	0.89	0.87	0.86	0.84	0.82	0.80	0.77	0.75	0.72	0.70	0.67
15	0.98	0.97	0.97	0.96	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.88	0.87	0.85	0.83	0.81	0.79	0.76	0.74	0.71	0.69

peanut material is replaced by lower value peanuts (quota replaced by contract additionals or contract additionals replaced by loan additionals). Depending on unscreened SMKSS and LSK values, the predicted probability of screening being feasible existed in both marketing scenarios. Thus, feasible decisions regarding screening depend upon screening cost, the producers marketing situation, and the quality of unscreened peanuts.

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