CONSUMER PREFERENCES FOR GROUNDNUT QUALITY

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ABSTRACT

On any market day, groundnut prices vary from one lot to another. These price differences are due to variations in the quality mix, reflecting preferences of groundnut users for certain qualities over others. In order to identify and quantify these quality characteristics, 163 groundnut samples were collected from Adoni Market in Andhra Pradesh and analyzed for seven distinct quality characteristics. With multiple regression analysis it was found that 60 to 65% of the variation in prices across lots can be explained by a set of six relevant quality characteristics.

Plant breeders working on the selection of high yielding varieties need to also select for preferred quality characteristics, in order to assure good consumer acceptance of the improved variety. What are preferred quality characteristics? In this paper we derive information on the preference for groundnut qualities from their market prices.

There are substantial price variations across different lots of groundnut pods transacted in any assembling market on any market day. These variations are due to differences in the quality mix i.e., the combination of relevant quality characters, from one lot to another. Some of these quality factors have a positive and others a negative influence on price. If these quality characteristics are identified and their contribution to price estimated quantitatively, the qualities with high or low customer preference are known.

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This information can be used by breeders to assess new varieties of groundnut for customer preferences in terms of market value. This paper is a first attempt to identify and quantify the relevant quality characteristics of groundnuts, and to prepare a groundnut quality index based on these identified characteristics. Such a quality index can be used to predict the customer preferences of newly bred groundnut varieties. The methodology applied here for the first time on groundnuts was developed earlier for sorghum Ot (von Oppen 1976). Experience with the development of a sorghum quality index (von Oppen 1978a, 1978b, von Oppen and Jambunathan 1978, Bapna and von Oppen 1980, von Oppen and Rao 1982, Rao and von Oppen 1983) indicates that further studies of this kind are required to confirm our present results.

METHODOLOGY

In this study we formulated and tested the following hypothesis.

> "Variability in groundnut prices is a function of customer preferences for various quality characteristics".

QUALITY CHARACTERISTICS

Since most groundnuts are finally consumed in the form of oil, their demand is for oil extraction purposes. Groundnuts are also used for confectionery purposes in marginal quantities. Groundnut buyers always prefer characteristics reflecting better oil quality, and quantity. They judge these criteria based on apparent quality characteristics.

Given our experience with groundnut markets, and after discussions with traders and breeders of groundnuts, the following quality characteristics have been identified.

1. Shelling percentage;

2. Hundred seed weight;

3. Moisture content;

4. Percentage of shrivelled seeds;

5. Percentage of damaged seeds;

6. Extent of pod scarification/damage;

7. Oil content;

The first three characteristics are related to the quantity of oil out-turn and the next three are related to the quality of oil. These aspects are discussed below in detail.

1. Shelling percentage: Higher shelling percentage (percentage of seed weight in pod weight) implies more kernels and less waste. The higher the shelling percentage, the higher is the out-turn of final products i.e., oil and cake. Therefore, we hypothesize that prices increase with an increase in shelling percentage. An experienced buyer can estimate the shelling percentage by taking a handful of pods, throwing them up and judging their impact when they fall back into the palm; and by opening a few pods and examining the extent of seed development.

2. Hundred seed weight: Seed size and weight vary from cultivar to cultivar. Within the same cultivar, seed size and weight depends upon the extent of seed maturity. It is a general feeling among traders that the oil content is higher in fully developed seeds compared to underdeveloped seeds. It is hypothesized that the buyers prefer lots with higher seed weight over those with lower seed weight. Hence we expect prices to increase with an increase in hundred seed weight. The buyer estimates the seed weight by examining the seeds.

3. Moisture content: The higher the moisture content, the higher is the loss of weight after processing, a content of < 5% being aceptable. Lots with higher moisture contents require drying before processing which involves cost. If groundnuts of high moisture content are stored without drying, complications such as seed damage by fungi and mites arise. Therefore, we hypothesize that high moisture contents are associated with low prices. Buyers estimate the moisture content by taking handful of pods and holding it in the palm.

4. Percentage of shrivelled seeds: In trade circles it is believed that the shrivelled seeds, compared with developed seeds, contain less oil and possibly more aflatoxin. Therefore, the higher the percentage of shrivelled seeds, the lower the quality of oil and hence the lower the price. Buyers estimate the percentage of shrivelled seeds by opening a few pods and examining the seeds.

5. Percentage of damaged seeds: The presence of damaged seed makes the oil rancid and unacceptable to the consumers. The color and smell changes and the aflatoxin content increases. Therefore, the

higher the percentage of damaged seeds, the lower is the customer preference, hence the lower the price. Buyers can easily estimate the percentage of damaged seeds by inspecting the lot and distinguishing damaged seeds from good seeds on the basis of the seed color.

6. Pod scarification/damage: Scarification occurs at the later stage of pod maturity as a result of Termite damage. The groundnut shell becomes weak as the outer layer of the shell is damaged by the insect, kernels are further damaged during the post-harvesting period. Thus, scarification leads to higher seed damage. It is hypothesized that the higher the scarification level, the lower is the price. Scarification is easily assessed by visual examination.

7. Oil content: It is understood that the average oil recovery rate in expeller industry is around 42% (in kernel). Oil content mostly depends on the cultivar, and the quality within the cultivar. Quality characteristics such as shelling percentage and seed weight have a linear relationship with oil content. All other quality characteristics remaining the same, oil content may vary from cultivar to cultivar. It is hypothesized that the higher the oil content, the higher is the price. An experienced buyer is able to identify the cultivar very easily by inspecting the pods. They also know from experience which cultivar has a higher or lower oil content. The reason for introducing oil content as an independent variable is to capture the variation in oil content across cultivars and its impact on price.

SAMPLE COLLECTION

In the first round 166 groundnut pod samples were collected from the Adoni market in Andhra Pradesh on two market days during May 1984. In this primary assembling market, producers sell groundnut pods through commission agents in the market yard. Sellers bring the produce to commission agents situated in the market yard. The commission agent arranges the produce in separate heaps or lots for inspection by buyers who are mostly oil millers. The price is decided through a tender system[1]. It was decided to sample about fifty per cent of the total number of lots arranged for sale. Therefore, each alternative lot or heap arranged for sale was considered as a sample unit. From each sample unit around 200 gms of produce was collected in polythene bags.

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1. In tender system buyers come and inspect the produce and quote their price in a tender slip for each and every lot offered for sale during a specified period in the morning. After the time is up, the tender slips are opened by the Market Committee officials and the highest bidder gets the lot.

MEASUREMENT OF RELEVANT QUALITY CHARACTERISTICS

To generate the required information for quality characteristics identified earlier, the following measurements were taken:

1. Hundred grams of pods were shelled and the weights of husks and kernel were taken to derive shelling percentage.

2. Kernels were sorted out into shrivelled, damaged and whole kernels, and their weights were taken to derive their percentage shares in total seed weight.

3. Whole seed weight was measured and the numbers counted to derive hundred seed weight.

4. Number of scarified and broken pods were counted to derive the percentage share of scarified and broken pods in total pods.

5. Kernels were analyzed for oil and moisture content. Oil content was analyzed by Nuclear Magnetic Resonance Spectrometer method.

Except for the analysis of oil and moisture content, all the other tests were conducted without any sophisticated equipment.

During this first attempt a few difficulties were encountered which can be rectified in future studies. There was an unnecessary time lag of a couple of months between sample collection and analysis. This time lag posed the following problems:

1. Samples probably lost some of their moisture content, hence there was not much variability among samples in moisture levels at the time of laboratory analysis.

2. Higher levels of pod scarification, moisture and breakage of shell lead to seed damage during storage. So, our data on seed damage includes the portion of seed damaged during the period of storage in our lab, which may or may not be representative of the levels prevailing at the time of sample collection.

STATISTICAL MODEL AND VARIABLE SPECIFICATION

Our hypothesis is

$$P_{it} = f(Q_{rit}) \text{ .... } (1)$$

which implies that the price of i th sample on t th day is the function of r qualities contained in that sample. The methodology developed by von Oppen (1976) for sorghum has been adopted to test this hypothesis. Our samples were collected on different days, and levels of prices and qualities vary generally from day to day. Therefore, they have to be standardized for comparability over days by determining a reference value. The daily average of prices and average of each of the quality characteristics is considered as reference value. In the model developed by von Oppen (1976), reference values for price and quality characteristics are specified as below:

The reference price ($\bar{P}_t$) in logarithmic form for t th day with sample size n_t is computed as

$$\log \bar{P}_t = \frac{1}{n_t} \sum_{i=1}^{n_t} \log P_{it} \quad \text{.... } (2)$$

Similarly, the reference value for r th quality character for t th day ($\bar{Q}_{rt}$) in linear form is

$$\bar{Q}_{rt} = \frac{1}{n_t} \sum_{i=1}^{n_t} Q_{rit} \quad \text{.... } (3)$$

Reference value for s th quality character for t th day ($\bar{Q}_{st}$) in logarithmic form is

$$\log \bar{Q}_{st} = \frac{1}{n_t} \sum_{i=1}^{n_t} \log Q_{sit} \quad \text{.... } (4)$$

The difference between the actual observation and the reference value creates a set of new variables which are used for the analysis. Thus, the new variables are:

$$\tilde{P}_{it} = \log P_{it} - \log \bar{P}_t \quad \text{(for price)} \quad \text{........ } (5)$$

$$\tilde{Q}_{sit} = \log Q_{sit} - \log \bar{Q}_{st} \quad \text{(for quality in logarithmic form) .... } (6)$$

$$\tilde{Q}_{rit} = Q_{rit} - \bar{Q}_{rt} \quad \text{(for quality in linear form) .. } (7)$$

Now equation (1) can be specified as under

$$\tilde{P}_{it} = f(\tilde{Q}_{rit}, \tilde{Q}_{sit}) \quad \text{........ } (8)$$

The term $\tilde{Q}_{rit}$ refers to variables like damaged seed weight, shrivelled seed weight, and percentage of scarified pods which are measured in per cent to total seeds/pods and for practical reasons these are included in linear form. Taking deviations from the mean as observations, implies that the regression equation passes through the origin. The variables included in the estimation of the model are presented below; their means and variability are shown in Table 1.

Dependent variable

$\tilde{P}_{it}$ = Difference between the logarithms of the price (in Rs.) per quintal of the individual sample lot and reference price.

Independent Variables

$\tilde{HS}_{it}$ = Difference between the logarithms of the hundred seed weight of the individual sample and reference hundred seed weight.

$(\tilde{HS}_{it})^2$ = Squared logarithms form of the above variable.

$\tilde{SH}_{it}$ = Difference between the logarithms of the shelling percentage of the individual sample and reference shelling percentage.

$(\tilde{SH}_{it})^2$ = Squared logarithms form of the above variable.

$\tilde{O}_{it}$ = Difference between the logarithms of the oil contents in the individual sample and reference oil percentage.

$(\tilde{O}_{it})^2$ = Squared logarithms form of the above variable.

$\tilde{M}_{it}$ = Difference between the logarithms of the moisture levels in the individual sample and reference moisture level.

$(\tilde{M}_{it})^2$ = Squared logarithms form of the above variable.

$\tilde{SC}_{it}$ = Difference between the percentage of scarification in the individual sample and reference scarification level.

$\tilde{BK}_{it}$ = Difference between the percentage of broken pods in the individual sample and reference level of broken pods.

$\tilde{SS}_{it}$ = Difference between the percentage of shrivelled seeds in the individual

Table 1. Means and variability of untransformed variables in Adoni Market.

Variables	Combined			
	Mean	CV[a] (%)	Minimum	Maximum
Price (Rs./100 kg)	446.0	9.4	236.9	487.3
Hundred seed weight (gms)	29.6	14.8	17.8	38.6
Shelling rate (%)	69.6	7.1	44.4	83.0
Oil content (% in seed)	45.08	4.9	36.7	50.5
Moisture content (% in seed)	6.2	8.3	3.9	9.7
Percentage of shrivelled seed (in total seed weight)	5.2	78.0	0.8	20.2
Percentage of damaged seed (in total seed weight)	2.5	206.2	0.0	29.4
Percentage of whole seed (in total seed weight)	92.4	7.5	59.0	99.3
Percentage of scarified pods (in total no. of pods)	1.4	317.8	0.0	32.8
Percentage of pods bored (in total no. of pods)	0.4	254.6	0.0	7.5
Percentage of pods broken (in total no. of pods)	4.3	113.5	0.0	24.4

a. CV - Coefficient of variation.

sample and reference level of shrivelled seeds.

$\tilde{D}S_{it}$ = Difference between the percentage of damaged seed in the individual sample and reference level of damaged seed.

RESULTS AND DISCUSSION

The correlation matrix of the above variables is presented in Table II. As expected, shelling percentage, hundred seed weight and oil percentage show a positive correlation, while damaged seed weight, shrivelled seed weight, number of scarified pods, broken pods and moisture content show a negative correlation with price. However, simple correlation coefficients can only explain the direction of association and do not measure the exact magnitude of the association. Secondly, our hypothesis is that price is a function of all quality characteristics taken into consideration simultaneously. A multiple regression analysis is an appropriate tool to analyze the problem, and the ordinary least squares method is used to estimate the regression equation. At the initial run, all the variables were included in the analysis one by one. Despite linear relationship between the independent variables[2], all the variables included were contributing to price variation. However, variables like broken pods and moisture content were excluded since they were insignificant.

The results are presented in Table III, Equation 1. All the variables have the expected signs i.e., expected relationship with market price, and are significant at 5% probability level, except for oil content which is significant at 20% probability level. These estimates reveal that groundnut consumers have a strong preference for groundnuts having larger percentage of whole seeds, i.e., mature and undamaged seeds. As the percentage of shrivelled seed or damaged seed to whole seed increases, groundnut prices decline

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2. Although there is linear relationship between the explanatory variables, r values are not very high indicating the absence of multicollinearity among the explanatory variables. It is argued by Klein (Klein, L.R. 1965 Introduction to Econometrics, Prentice-Hall International, London, pp. 64 & 101) that collinearity is harmful if

$r^2_{x_i x_j} \geq R^2_{y \cdot x_1, x_2, \ldots, x_k}$ where $r^2_{x_i x_j}$ is the simple correlation

between any two explanatory variables (X_i and X_j) and R^2 is the overall (multiple) correlation of the relationship. This study also fulfills this requirement.

Table II. Correlation matrix of groundnut price and relevant quality characteristics (Transformed variables).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. Oil content	1.00								
2. Hundred seed weight	0.07	1.00							
3. Shrivelled seed weight	-0.20	-0.34**	1.00						
4. Damaged seed weight	-0.04	0.05	0.11	1.00					
5. Pods scarified	-0.15	0.05	0.06	0.69**	1.00				
6. Pods broken	-0.20**	0.06	-0.09	0.56**	0.36**	1.00			
7. Price	0.19*	0.32**	-0.42**	-0.61**	-0.48**	-0.33**	1.00		
8. Shelling rate	0.08	0.51**	-0.57**	-0.35**	-0.10	-0.10	0.59**	1.00	
9. Moisture content	-0.42**	-0.12	0.16	0.29**	0.06	0.12	-0.27**	-0.18*	1.00

** Significant at 1% probability.

* Significant at 5% probability.

Table III. Market price as a function of quality characteristics of groundnut in Adoni market in 1983 - Multiple regression results.

Variables	Equation 1		Equation 2	
	Regression coefficient	T-value	Regression coefficient	T-value
Log Hundred Seed Weight	0.111	2.58	-2.795	-2.52
Log Hundred Seed Weight Squared	-	-	0.439	2.64
Log Shelling Rate in %	0.396	3.58	11.446	3.52
Log Shelling Rate in % squared	-	-	-1.323	-3.4
Log Oil Content in %	0.190	1.66	-22.569	-2.4
Log Oil Content in % squared	-	-	3.005	2.43
Shrivelled Seed Weight (% in total seed weight)	-0.368	-2.22	-0.369	-2.36
Damaged Seed Weight (% in total seed weight)	-0.818	-4.85	-0.758	-4.63
Scarified pods (in % to total pods)	-0.424	-2.37	-0.45	-2.58
$\bar{R}^2$	0.59		0.66	
Number of observations	163		163	

significantly. The magnitude of the decline is presented graphically in Figure I. It shows that, keeping other quality characteristics constant, if the percentage of damaged seed increases from a reference average of 2.5% to 15%, the price index drops from 1 to 0.91, and if it further increases to 25%, the price index declines to 0.84. Similarly, if the percentage of shrivelled seed to whole seed increases from a reference average of 5% to 15%, price index declines from 1 to about 0.97, and it declines further upto 0.93 if the percentage of shrivelled seed goes upto 25%. The negative influence of damaged seed on price is about twice that of shrivelled seed.

The percentage of scarified pods to total pods also significantly influences groundnut price. The magnitude of its influence on price is similar to that of shrivelled seed.

Hundred seed weight, shelling percentage, and oil content show the expected positive influence on price. These are graphically presented in Figures II, III, and IV. From Figure II, we find that, <u>ceteris paribus</u>, if shelling percentage is decreased from an average of 70% to 60%, index price declines to 0.94, and if it is increased to 80% index price increases to 1.06.

Figure III shows that with an increase in oil percentage from a reference average of 45% to 52%, the price index increases from 1 to 1.03.

Figure IV indicates that with a decline in hundred seed weight from a reference average of 30 to 25 grams, the price index decreases from 1 to 0.98.

It was felt that some variables such as hundred seed weight, shelling percentage and oil content, price may increase at a decreasing rate with an optimum level, i.e., a linear relationship may not give the best fit. Consequently, these variables are also included in quadratic form and the results are presented in Table III, Equation 2.

In this regression all the variables including the squared terms are significant at 1% probability level and R^2 shows that 66% of the variation in prices is explained by the explanatory variables (compared to 59% in Equation 1, Table III). The coefficients of the linear variables such as shrivelled seed weight, damaged seed weight, etc., are the same as in Equation 1. Among the variables entered in squared form, only shelling percentage has the expected signs, i.e., the linear term is positive and the squared term is negative, and both are significant. This relationship is graphically presented in Figure II along with the

Figure I. Price as a function of changes in shrivelled seed and damaged seed (Based on regression estimate).

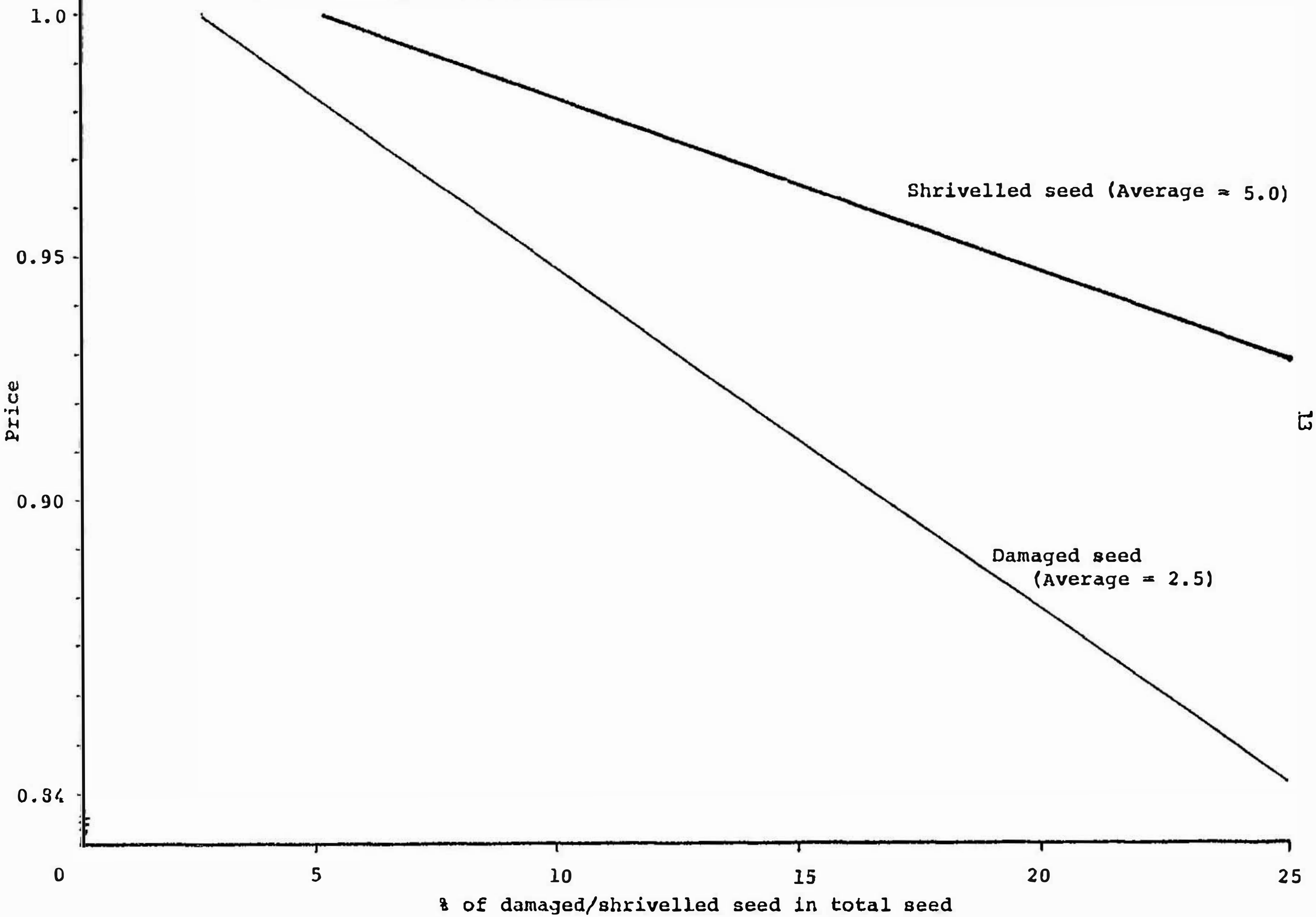


Figure II. Price as a function of shelling percentage (Based on regression estimate).

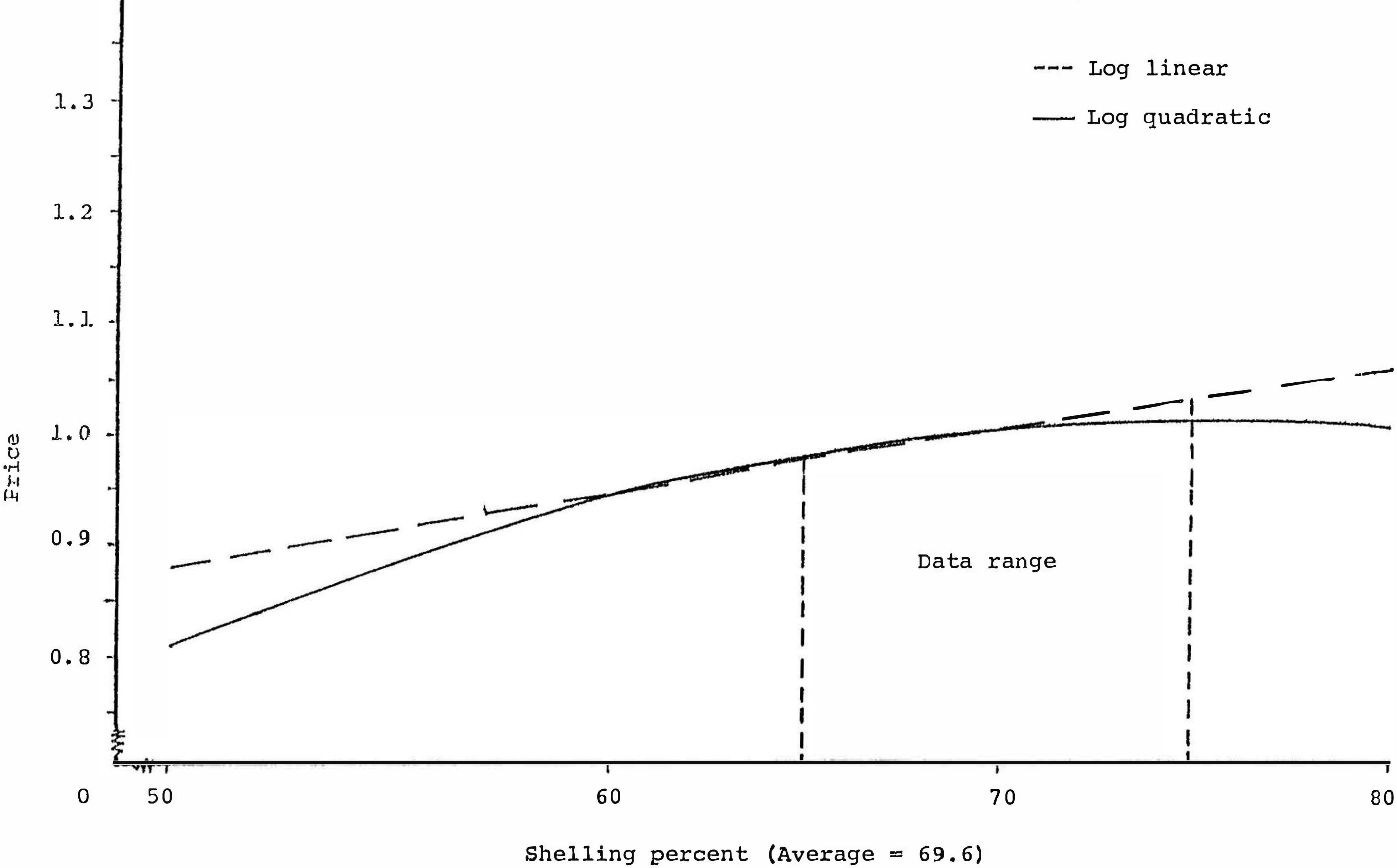


Figure III. Price as a function of oil content (based on regression estimate).

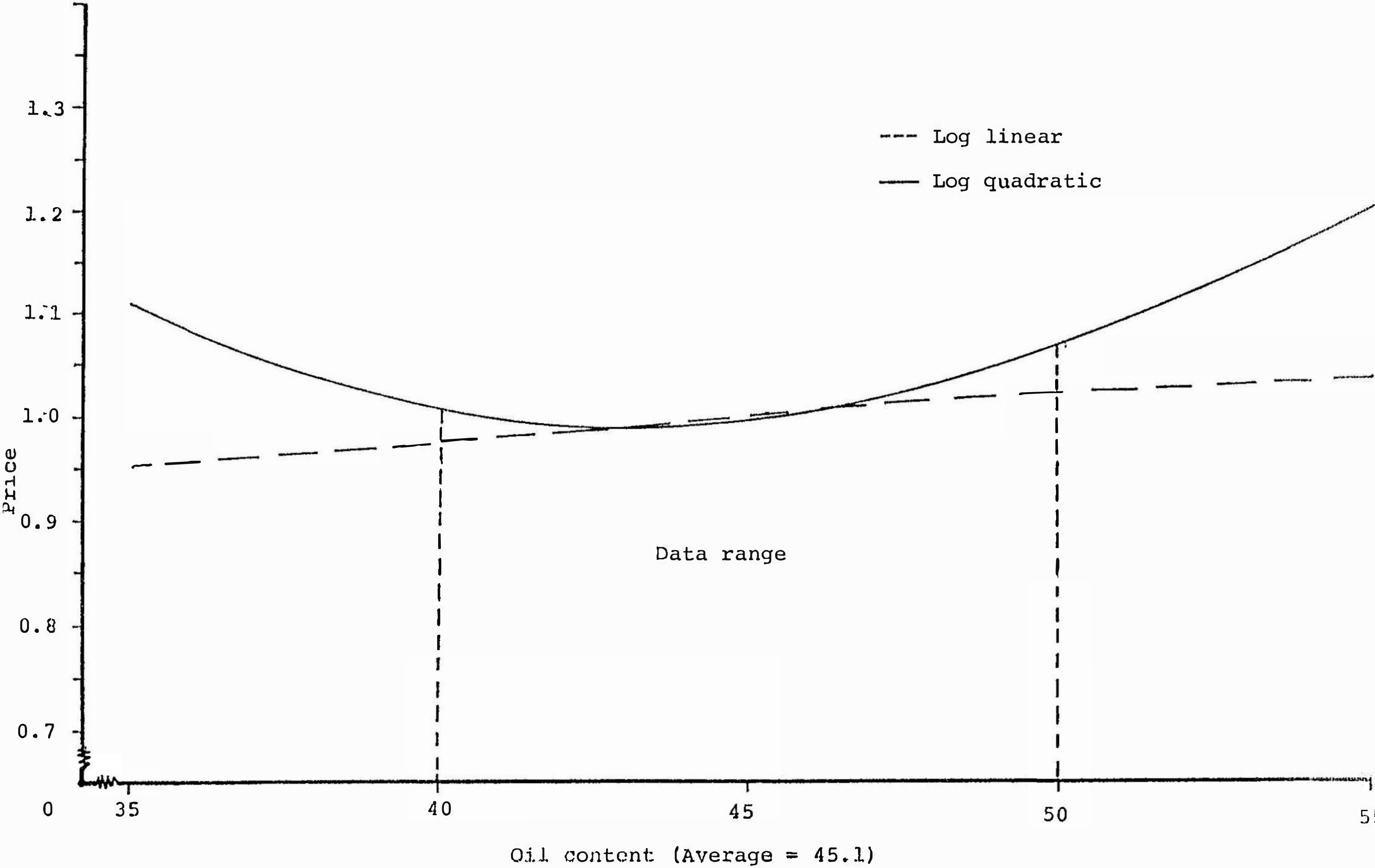
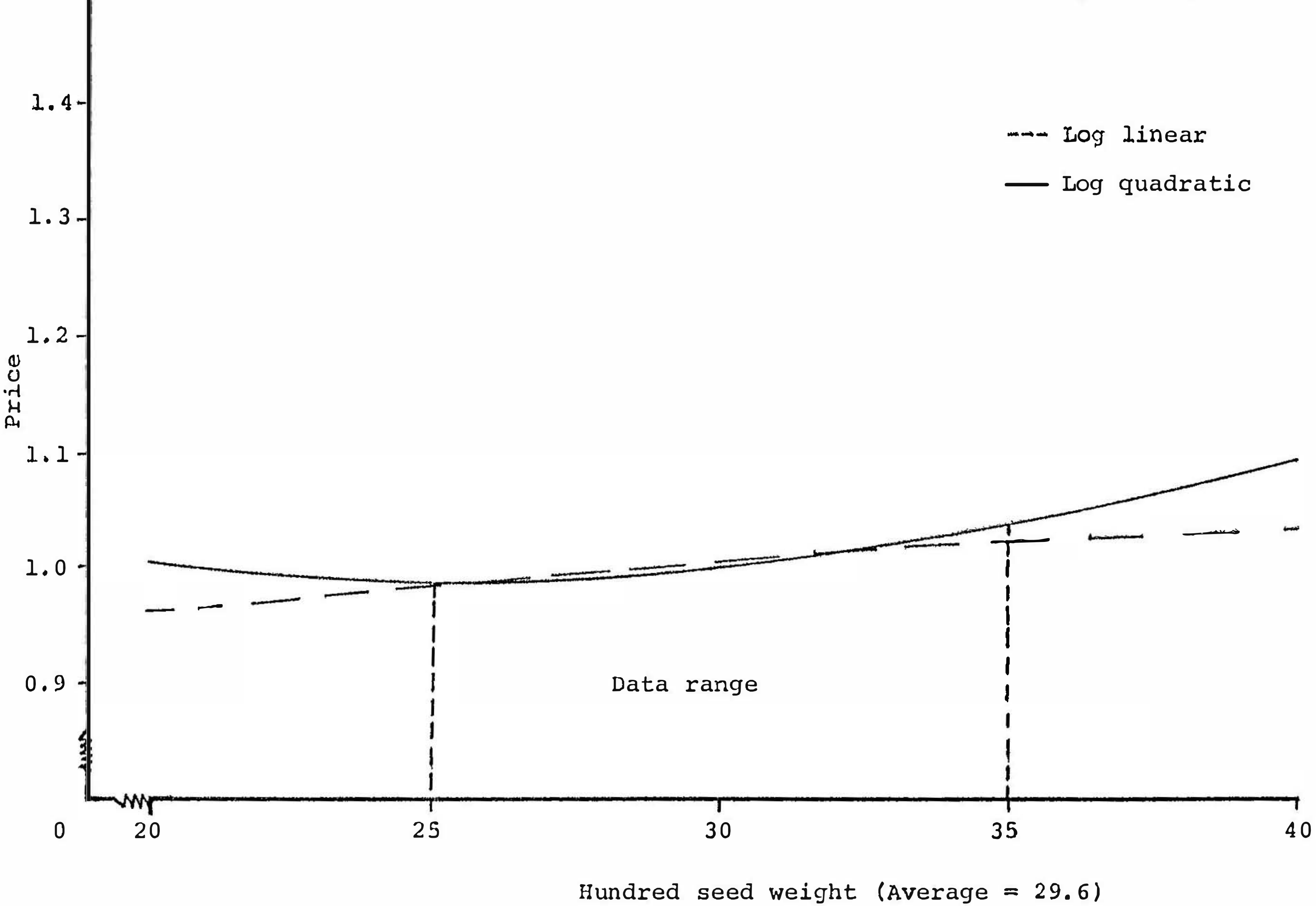


Figure IV. Price as a function of hundred seed weight (Based on regression estimate).



curve derived from the linear equation discussed earlier. The optimal shelling rate is 75.6% at which the price is 1.04. After this point, shelling rate does not appear to have much influence on price. On the contrary, price tends to fall slightly if we move much further from the optimum towards the right. However, considering that our data ranges from 65% to 75%, the log-linear and the log-squared estimates gave consistent results.

For hundred seed weight and oil content, the signs are not as expected. The linear term is negative and the squared term positive, indicating that prices fall initially, reach a minimum, and start rising. They are graphically presented in Figures III and IV. The decline in price with an increase in oil content upto 44% is difficult to explain, particularly when the mean oil content in our sample is 45%. Probably, at low levels, i.e., below 40%, oil content is not considered in price determination; but as oil content increases, prices increase at an increasing rate.

The graph for hundred seed weight shown in Figure IV behaves similar to the one for oil content. However, in this case the range where most of our data fall, represents the rising part of the curve, thus indicating prices to increase with hundred seed weight at an increasing rate.

CONCLUSION

The study is a first attempt to explain market price of groundnuts as a function of quality characteristics. The results indicate that between 60% to 65% of the variation in price in an assembly market in Andhra Pradesh can be explained by a set of six relevant quality characteristics, i.e., hundred seed weight, shelling percentage, oil content, percentage of damaged seeds, percentage of shrivelled seeds, and percentage of scarified pods. Although the breeders are aware of these quality characteristics, the results of this study will enable them to choose an optimal mix of these quality characteristics. However, more studies of this type are required to verify the results in other areas of the country before general conclusions are drawn and recommendations to breeders made.

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