Proceedings

5th National Peanut Research Conference

Conference sponsored by
PEANUT IMPROVEMENT WORKING GROUP
and AGRICULTURAL RESEARCH SERVICE,
U.S.D.A., Norfolk, Va., July 15-17, 1968

Proceedings Published by Research Division,
Virginia Polytechnic Institute, Blacksburg,
Va., 24061; July 1969

Proceedings

FIFTH NATIONAL PEANUT RESEARCH CONFERENCE

Sponsored by

Peanut Improvement Working Group and
Agricultural Research Service, U.S.D.A.

Held at

Golden Triangle Motor Hotel
Norfolk, Virginia
July 15-17, 1968

Research Division
Virginia Polytechnic Institute
Blacksburg, Va. 24061

CONTENTS

Page Intentionally Left Blank

I
Peanut Variety Improvement in the U.S.A.

W. K. Bailey[1]

During the past 15 years, changes in varieties of peanuts grown in the United States have been extensive. Of the 10 classified varieties described in U. S. Department of Agriculture Farmers' Bulletin No. 2063 issued in 1954, only three are now grown to an appreciable extent and acreage of these is decreasing rapidly.

The first organized efforts at variety improvement were selections from commercial seedstocks, which began some 15 years after the turn of the century and are continuing today. Purposeful peanut variety improvement through controlled crosses began in Florida in the late 1920's, in Georgia a few years later, in North Carolina in the middle 1940's, in Texas in the early 1950's, in Virginia later in the 1950's, in Oklahoma in the middle 1960's, and in Alabama in 1968. Irradiation breeding began in North Carolina in 1949.

As a direct result of these programs, 24 improved varieties have been released to peanut growers during the past 28 years. Of these improved varieties, 12 were selections from commercial stocks, two were selections from peanuts introduced from foreign countries, nine were from controlled crosses, and one was developed by irradiation. An estimated 90 to 95 percent of peanuts now planted in the United States is improved varieties.

Variety Improvement Procedures

During the early years improved varieties were line selections from commercial stocks. As short a time as three to five years ago, selections from commercial stocks or introductions made up about half of the acreage of the improved varieties grown. In the future, variety improvement will come increasingly from controlled crosses among cultivated peanuts. Eventually crosses between cultivated peanuts and certain of the wild species of *Arachis* might be a basis for variety improvement, but appreciable impact of varieties developed from interspecific crosses appears unlikely at the grower level for another 20 years or longer.

The use of irradiation, chemicals and other mutagens in peanut variety improvement is receiving increasing attention in this country and abroad. North Carolina has made an extensive effort during the past 19 years to explore the

[1]Oilseed and Industrial Crops Research Branch, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Md.

potential of irradiation for such a purpose. Irradiation breeding has yet to make an appreciable impact at the grower level in the United States. However, peanut breeders have a continuing intense interest in the potential usefulness of irradiation and other mutagens in peanut variety improvement.

Long-Term Nature of Breeding

Peanut variety improvement by crossing different types and varieties is a longtime undertaking. The cultivated peanut is a tetraploid with 40 somatic chromosomes. The inheritance of many of the characters of economic importance is complex, and up to eight generations are required following a cross before selections from progenies of crosses achieve an acceptable degree of genetic stability. Usually 12 to 15 years may elapse after a successful cross is made before an improved variety developed therefrom begins to make an impact at the grower level.

Twelve to 15 years will be the minimum time involved even if the breeder happens to choose the right lines to use in his crossing program the first time around. So little is known of the nature of the inheritance of economically important characters that breeders have little logical basis for choosing varieties to use in developing an improved variety with predetermined characteristics.

We are investigating the possibility of utilizing the favorable winter environment of the tropics to grow an extra generation of peanut breeding lines each year and thereby shorten the time between the making of a cross and the release of a new variety to growers. By growing an extra generation a year in all but the final stages of a breeding program, we should be able to reduce by three or four years the time required for the development and release to growers of an improved peanut variety.

Attributes Sought in Improved Varieties

Among the principal attributes sought in improved varieties are higher yield potential; uniform maturity of seed; resistance to insects, diseases and toxin-producing molds; resistance to visible and concealed damage of microbiological origin; adaptation to mechanical harvesting; superior flavor, texture, and keeping quality; improved shelling and processing quality; enhanced nutritional value; and greater consumer appeal. Consumer acceptance is of critical importance, and high yield potential is not far behind.

Germ Plasm for Variety Improvement

Only a few varieties of peanuts were in commercial production in the United States 35 to 40 years ago when intensive breeding began. Breeders soon sought peanuts from foreign countries to supplement local stocks for use in

their breeding programs. An estimated 75 to 80 percent of peanuts now grown in the United States have been derived wholly or in part from peanuts introduced from foreign countries, and this proportion will probably increase in the future.

New peanuts are being sought wherever the crop is grown the world over. More than 3,000 accessions of cultivated peanuts have been introduced, with some 2,400 coming in during the past 10 years. In addition, several hundred accessions of wild species of *Arachis* have been obtained, largely from South America. This widely diverse introduced germ plasm has recently been augmented by 255 new accessions of cultivated peanuts, and 117 new accessions of wild species of *Arachis,* collected in South America by two Crops Research Division scientists on a trip that ended in June 1968. New germ plasm will continue to be sought wherever publications and personal contacts indicate the existence of materials that might be of interest and value to our peanut research scientists, in their efforts to develop improved varieties of peanuts.

In addition, our peanut breeders have an estimated 2,000 breeding lines in various stages of development, and North Carolina has a collection of more than 15,000 genetic stocks derived largely from irradiation research. Thus, our breeders collectively have access to more than 20,000 different lines of cultivated peanuts and several hundred accessions of wild species of *Arachis* for use in their breeding and genetic research.

Frustrations in Variety Improvement

Thus far one of the most frustrating experiences of peanut breeders in this country has been their failure to find, in our cultivated peanut germ plasm, any appreciable resistance or tolerance to major insect pests or diseases that could be used in the development of improved varieties with resistance to these pests. This is in sharp contrast what we find with most of our other important crop plants.

Insects and diseases, including nematodes, cause losses in peanuts estimated at more than 30 percent of our production. With such an opportunity for improvement, sizeable chunks of our cultivated peanut germ plasm are now being systematically screened for immunity, resistance, or tolerance to such pests as Cercospora leafspots, peanut rust, peanut mottle virus, peanut stunt virus, nematodes, southern corn rootworm, thrips, lesser cornstalk borer, leaf-ragging insects, and certain stored-products insects.

Certain wild species of *Arachis* have been reported to be immune or highly resistant to such pests as Cercospora leafspots, peanut rosette, peanut rust, northern rootknot nematode, spider mites, and possibly peanut stunt virus. Unfortunately these resistant wild species cannot be crossed successfully with cultivated peanuts. Intensive research is underway in North Carolina and elsewhere to correct this situation so that valuable genes can be transferred from

wild species to cultivated peanuts and incorporated into desirable commercial varieties.

Another frustrating experience for breeders has been their inability to develop, by controlled crossing, improved varieties of Spanish peanuts that have a yield potential higher than that of Spanish types that just "happen" or develop by natural selection. Starr is our only Spanish variety developed by controlled crossing that equals or slightly surpasses Argentine in yield in certain of our producing areas. Argentine is a selection from a Spanish peanut that was introduced from Argentina. Certain new selections of Argentine that are now in final stages of evaluation have a yield potential substantially higher than that of Argentine now being grown.

The reasons for lack of progress in Spanish peanuts improvement by controlled crossing are unknown. Most of our improved varieties of Virginia type peanuts that have been developed from controlled crosses have Spanish peanuts in their ancestry. Many of the characteristics of Spanish peanuts are recessive in their inheritance. Perhaps our breeders have not yet worked with large enough segregating populations to have had a reasonable opportunity to find a Spanish type with superior attributes.

Evaluation of New Peanuts

A serious limiting factor in peanut variety improvement and evaluation is the lack of objective procedures for identifying and measuring such highly subjective qualities as the flavor, texture and aroma of roasted peanuts and peanut products. A critical need exists for the development of objective measures of peanut quality that can be used with confidence by individual research scientists. In addition we urgently need a peanut quality evaluation facility to which breeders could submit small samples of their most promising advanced breeding lines for evaluation of their shelling, blanching and processing properties. At such a laboratory the work should be so conducted that the most effective known procedures of quality evaluation would be applied in such a manner that all segments of the industry, from grower to end-product manufacturer, would have full confidence in results thereof. Such a facility and service would make it possible for us to identify advanced breeding lines with superior or inferior shelling and processing quality in the early stages of their agronomic evaluation rather than near or following possible release to growers, thereby greatly increasing the efficiency of peanut variety improvement programs and increasing industry-wide confidence in such programs.

Contribution of Improved Varieties to Grower Income

For more than two decades prior to the 1940's the average yield per acre of peanuts in the United States varied little. By the late 1940's average yield began to increase, and in 1967 was nearly 2.8 times the average yield in 1947.

This increase is not the result of a striking breakthrough in research. Nor is it a result of highly favorable weather conditions throughout the entire peanut belt every year. The yield increase can be attributed largely to more widespread use by growers of higher-yielding varieties and improved production practices.

I estimate that 20 to 25 percent of this increase in yield per acre can be attributed to use of higher-yielding varieties. At present prices and level of production this increase in yield attributed to improved varieties has an annual on-farm value of $60 to $75 million. Present prospects indicate that within the next three to five years growers will have about a 10 percent higher yield potential than the most productive varieties of each market type available today. Through developments such as these, peanut breeders are making a major contribution to increasing the efficiency of peanut production, and thereby enhancing the opportunity for the crop to become more competitive in the market place.

Peanut variety improvement in the United States is a joint undertaking of the Agricultural Research Service of the U. S. Department of Agriculture, the Agricultural Experiment Stations of the principal peanut-producing States, and the peanut industry. The participation of the Agricultural Research Service in this work is in close cooperation with the State Agricultural Experiment Stations.

II

A Technique Using Isotope Dilution For Quantitation of Flavorful Carbonyls in Roasted Peanuts

W. Y. Cobb[1]

SUMMARY

Radioactively-labeled (^{14}C) flavor compounds are added to an aqueous slurry of peanut product prior to reduced-pressure distillation. The example used is benzaldehyde, which has previously been shown in the carbonyl fraction of roasted peanut volatiles. The carbonyl is converted to its corresponding 2, 4 dinitrophenylhydrazone, and separated from other material present by thin-layer chromatography. Recovered material is quantitated with the use of ultraviolet spectroscopy. The native aldehyde is calculated with isotope monitoring data, via isotope dilution. This method is adaptable to flavor compounds of sufficient volatility to be recovered under 5 mm Hg and 65°C, and which are stable or can be converted to stable form for purification. The potential for quantitation of several components during an experiment is briefly discussed.

INTRODUCTION

Chemical characterization of food flavors has necessitated the development of microtechniques for isolation and purification. Such analytical tools as gas chromatography and mass spectrometry have proven to be excellent devices for separating and identifying the isolated flavor mixtures (Teranishi et al., 1963; Mason et al., 1967; Gianturco et al., 1966, Self et al., 1963) have shown, however, that the volatile aroma components of a number of foods exhibit similar qualitative composition. These workers stated that differences in flavor of certain foods may rest more on the relative quantitative pattern of the chemical components than on the qualitative presence of one or more unique components. Such an analogy might be drawn for the flavor differences among roasted peanuts, chocolate, and coffee. Carbonyls and substituted pyrazines have been demonstrated in the flavor isolates of all three products (Mason et al., 1966; 1967; Rizzi, 1967; Boyd et al., 1965; Giantureco, 1966), yet it is quite evident each has its own unique flavor and aroma properties.

[1]Department of Food Science, North Carolina State University, Raleigh, N. C. 27607.

The object of the present research was to develop a technique for quantitation of flavor components in peanut products. Isotope dilution seemed a likely tool, as variations in physical conditions of fractional distillation, extraction and chromatography of flavor compounds as well as the degradation or interaction of components during isolation, could be accounted for in one step. Benzaldehyde, a flavorful carbonyl found in roasted peanuts (Mason et al., 1967) was taken as the example. This compound would be difficult to quantitate under most circumstances due to its relative instability.

EXPERIMENTAL PROCEDURE

Reagents

All solvents were reagent grade. Those utilized for dilution of labeled aldehyde, carbonyl analysis, or extraction of hydrazones were rendered carbonyl-free by refluxing with 2,4 dinitrophenylhydrazine and trichloroacetic acid, followed by distillation.

2,4 dinitrophenylhydrazine reagent (2,4 DNP-HCl) was prepared by dissolving 5×10^{-3} moles hydrazine per liter of 2N HCl.

Unlabeled benzaldehyde, UB, was vacuum distilled, sealed under nitrogen, and stored overnight in the dark at 0°C. Gas-liquid chromatography (GLC) indicated a purity exceeding 99%.

Labeled benzaldehyde (carbonyl ^{14}C, spec. act. 21.4 uc/mg) was obtained from Nuclear Chicago Radiochemical Division. The chemical purity by GLC was 99%. Radiochemical purity of the aldehyde semicarbazone was 100%. Upon removal from the shipping vial the isotope was mixed with freshly-distilled UB and the mixture was redistilled. Two hundred microliter quantities were sealed under dry nitrogen in single service vials. The vials were wrapped in aluminum foil and stored in the dark at 0° C until use. Specific activity of the stored labeled aldehyde, LB , ranged from $1\text{-}2 \times 10^4$ dpm/mg, the final activity being determined by the quantity of UB in which the isotope was mixed prior to distillation.

Apparatus

Magnesium thin-layer chromatographic plates were prepared according to the procedure of Schwartz (private communication, 1967). Baker magnesium oxide ("Suitable for chromatographic use"), analytical grade Celite and water (7:3:50, w/w/v) were slurried, spread onto 20 × 20 cm plates in 500 μ layers, and allowed to stand for two days at room temperature

prior to use. Silica gel PF plates were prepared in 375 μ layers immediately prior to use and dried at 100° C for one hour. Samples were applied to preparative thin-layer chromatograms with a TLC Sample Streaker from Applied Science Laboratories.

Radioactive monitoring was accomplished with a Packard Model 3002 Tri-Carb Liquid Scintillation Spectrometer equipped with automatic external standardization. The scintillation medium was prepared by dissolving 4.0 g 2,5 diphenyloxazole (PPO) and 0.05 g 1,4-bis-2-(5-phenyloxazolyl)-benzene (POPOP) in 500 ml toluene. Ten milliliters of this solution were mixed with an additional 10 ml of toluene containing the hydrazone to be monitored. The isolated derivative was usually counted for 100-min intervals, which allowed compilation of sufficient counts to have a statistical counting error of less than 1.5%. When free aldehyde was monitored prior to distillation, sufficient toluene was added to the solution to be counted to make a 10 ml volume. Phosphor was then added, and the sample was counted.

A Cary Model 15 ultraviolet-visible spectrophotometer was used for measurement of adsorption spectra.

USDA-approved plastic food color guides for peanut butter were obtained from Magnuson Engineers, Inc., San Jose, California.

Procedure

A flow diagram of the procedure is given in Figure 1. Commercial peanut butter or freshly-roasted extra large Virginia-type peanuts ground to the consistency of peanut butter were used in the experiments. The color grade of each blend was determined prior to distillation by visual comparison to the color guides. The peanut product was slurried with distilled water in a blendor, 500 g product plus two to one water per change. Quantities of peanut butter used ranged from six kg in early experiments to as little as 1.5 kg in the last experiments. The peanut slurry was added to a twenty to one reservoir carboy. A slight positive flow of nitrogen was maintained in the carboy during the subsequent holding period.

A weighed quantity (100 mg ± 0.5) of labeled benzaldehyde was made to 100 ml volume with ethanol. Three to five ml of the thoroughly-mixed solution were added to the reservoir carboy. An identical volume was pipetted into each of three screw-cap vials for radioactive monitoring. One ml of the aldehyde solution was diluted to 50 ml with benzene, and the carbonyl content was determined on three aliquots employing the procedure of Henick et al. (1953). Concentrations of isotope were determined from a standard curve prepared simultaneously, using freshly distilled UB. Specific activity of

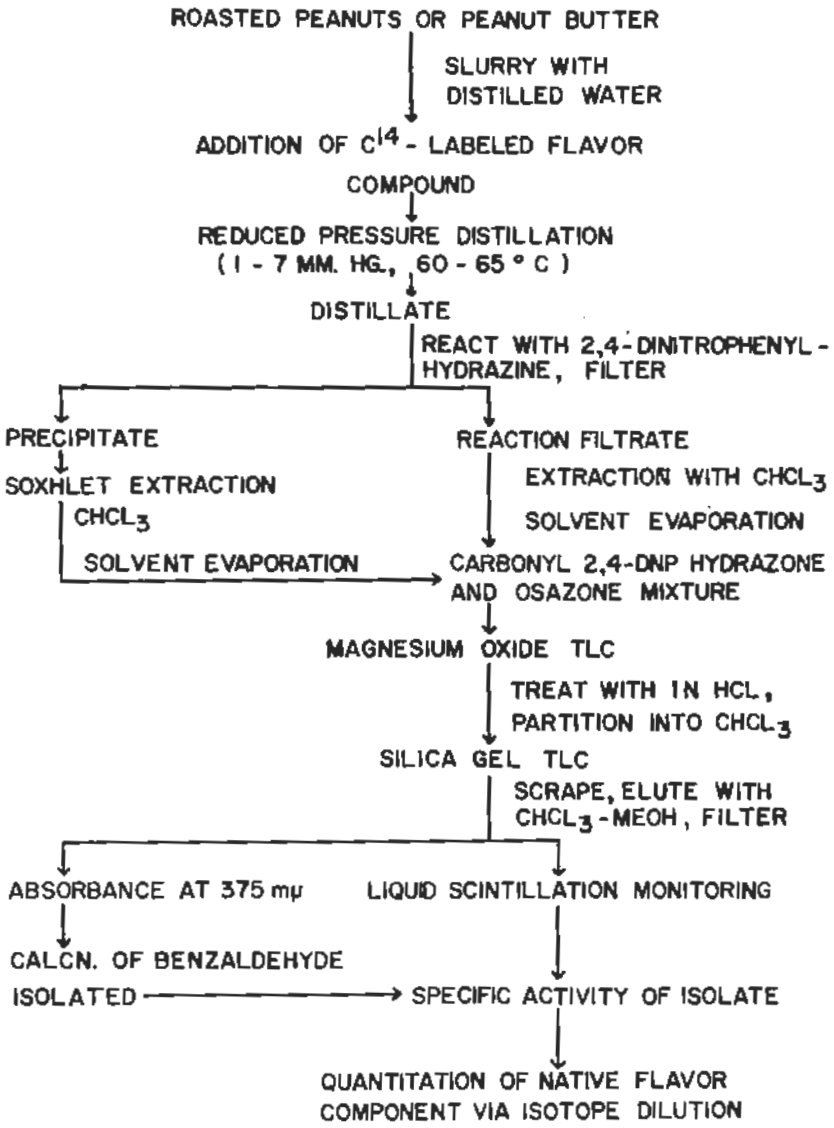

FIG. 1. FLOW DIAGRAM. QUANTITATION OF BENZALDEHYDE FROM ROASTED PEANUTS VIA ISOTOPE DILUTION.

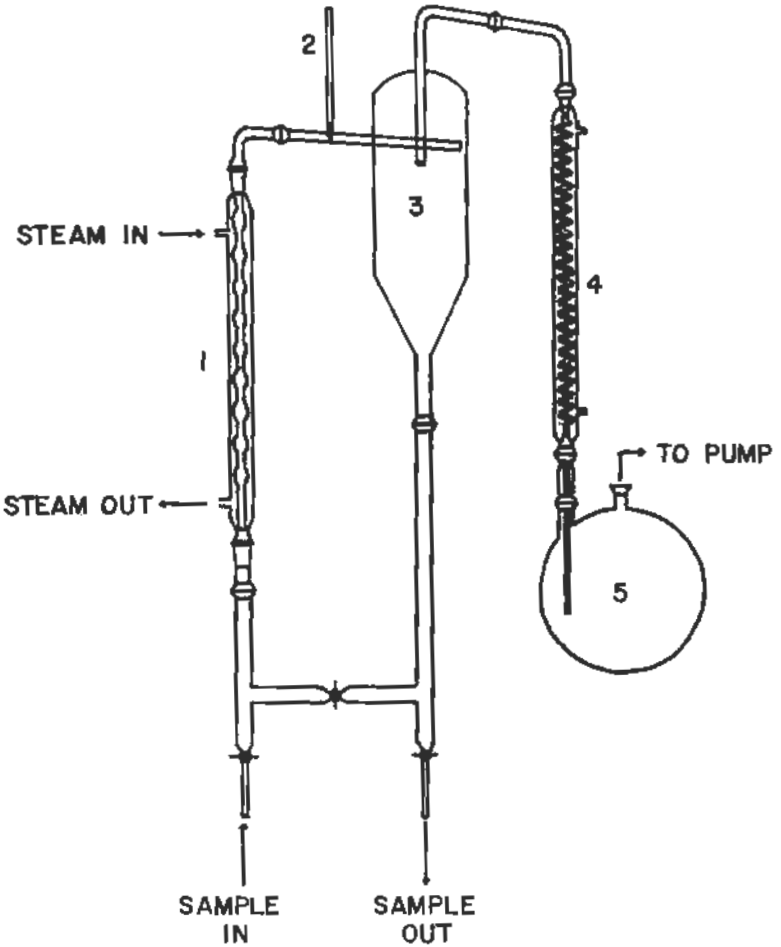

FIG. 2. LOW PRESSURE CYCLONIC EVAPORATOR. (1) HEAT EXCHANGER; (2) THERMOMETER; (3) CYCLONIC EVAPORATION CHAMBER; (4) GRIFFIN CONDENSER; (5) WET ICE TRAP.

the isotope was determined from the scintillation and quantitative carbonyl data. An increase in specific activity of isotope in excess of 5% of previous samples from the same lot was taken as evidence of oxidation, and the results were invalidated.

Following addition of the isotope to the carboy, the contents were stirred for 15 minutes, to insure complete dispersion of IB.

The slurry was fractionally distilled in a cyclonic evaporation apparatus adapted from Lindsay et al. (1965) and Bartholomew (1959). A sketch of the apparatus is shown in Figure 2.

This apparatus was maintained at 1-7 mm Hg pressure during the distillations, with 5 psi steam pressure at the inlet of the heat exchanger. The distillate trapping system included two wet ice traps for the aqueous distillate, followed by several traps containing dry ice-ethanol or liquid nitrogen. The latter traps were placed in the train as a means of protecting the pump from aqueous vapors, as only the distillate from the first wet ice trap was employed in further experimentation. The distilling chamber was designed to hold approximately three to one of slurry per charge. Temperature of the slurry rapidly rose to 60-65 °C, at which point the charge was allowed to cycle until reduced to about half its original volume. The residual liquid from each spent charge was drained into a waste flask attached to the system. Three to four to one of distillate could easily be obtained from an original ten to one of slurry.

The aqueous distillate obtained was combined with an equivalent quantity of the 2,4 DNP-HCl reagent. This mixture was stirred for 72 hours, at which time 2,4 pentanedione was added to react with excess hydrazine reagent. The solution was then filtered. The lemon-colored filtrate was extracted several times with 0.1 volumes of chloroform. The precipitate was extracted from the filter paper in a Soxhlet extractor using chloroform. The combined extracts were then evaporated to dryness.

The hydrazone mixture was thereafter submitted to preparative thin-layer chromatography. Initial separations were made on magnesium oxide plates developed in hexane-$CHCl_3$ (85:35). The benzaldehyde area was removed from the plate into water, released from the adsorbent with 1N HCl, and extracted into chloroform. Chromatography on silica gel plates with a system of CCl_4:$CHCl_3$ (17:3) followed. The upper end of each plate was left exposed to the atmosphere in the manner of Libbey et al. (1964) such that there was continuous long term movement of solvent across the plate. Six to seven hours development offered a sufficient separation to recover the benzaldehyde band easily from the plate. The adsorbent was subsequently mixed with $CHCl_3$-MeOH (5:1) and filtered through sintered glass. Solvent was removed under vacuum, then the derivative was made to volume with $CHCl_3$. The adsorption spectrum from 350-400 mu was obtained to assure purity, then the adsorbance at the visible maximum (375 mu) was obtained. Similarly, a sample of the solution was evaporated to dryness in a counting vial. The residue was dissolved in ten ml of toluence, phosphor solution was added, and the solution was monitored for radio-activity.

Concentration of aldehyde recovered was calculated from the formula (Day et al., 1960):

$$\text{Mg aldehyde} = \frac{A \times MW \times 10^3}{\epsilon \times \text{Dilution Factor}}$$

where A = adsorbance

MW = molecular weight (1.06×10^2 for benzaldehyde)

ϵ = molar adsorptivity index

Native benzaldehyde in the product was calculated from the formula (Aronoff, 1956):

$$M_1 = \frac{M^* (S^* - S_\epsilon)}{S_\epsilon}$$

where M^* = mg isotope added to system prior to distillation

S^* = specific activity of isotope

S_ϵ = specific activity of isolated aldehyde

Control distillations with distilled water were conducted by adding known quantities of both IB and UB to 10 l distilled H_2O, and proceeding through the entire isolation procedure. Control experiments with the roasted peanut system were divided into two parts. In the first part only IB was added to the system prior to distillation. In the second part known quantities of IB and UB were added prior to distillation. Isolation and quantitation of the aldehyde in both systems was then performed. The recovery of added aldehyde was determined by the difference between part one and part two.

RESULTS AND DISCUSSION

Isolation of flavor compounds from natural systems by such techniqnes as low temperature vacuum distillation (Lindsay et al., 1965), steam distillation (Tharp and Patton, 1960), solvent extraction (Patton, 1961; Arnold et al., 1966), and headspace analysis (Bassett et al., 1962) involves disadvantages for quantitation such as poor yields, alterations in natural ratios of flavor components, artifact production and possible reaction of components during isolation. The value of isotope dilution lies in the fact that once a known quantity of pure isotope is added to a system, native and labeled compound can be expected to behave similarly. In the present system, it is assumed that the fineness of particle size overcomes the factor of entrapment of native aldehyde in micelles. The flavor molecules are of such size that any isotope effects in reactions during isolation would be minimal. As indicated by Aronoff (1956): "It will be noted that quantitative isolation of M (labeled additive) is not necessary, but that *purified* M is mandatory. Indeed, M need not be isolated in weighable quantity if an indirect method of obtaining the mass, e.g. spectrophotometry, may be used". Precautions were

thus taken to keep benzaldehyde as free as possible from the effects of oxygen and light. Rapid weighing, mixing under nitrogen, and immediate pipetting were practiced. Variation in the specific activity within lots of benzaldehyde was found to exceed 5% in only one instance.

The benzaldehyde band on silica gel plates was quite discrete and this material indicated π max - 375 mμ. Jones et al. (1955) reported: π max = 378 mμ, $\epsilon = 2.83 \times 10^4$. Authentic benzaldehyde 2, 4 DNP hydrazone prepared in this laboratory and recrystallized to constant melting point (238-39° C) was found to have: π max - 376 mμ, $\epsilon = 2.99 \times 10^4$. Calculations were made on the basis of the latter data.

Table 1 lists the results obtained from studies on efficiency of the method. The distilled water control experiment yielded 106.7% recovery of UB. The critical necessity of immediately following one another in adding IB and UB to the system was reflected in a single experiment. In this experiment UB was added approximately 20 min. prior to the isotope. Recovery of the unlabeled compound was less than 25%, indicating that although the system was under nitrogen pressure, dissolved oxygen and/or trace metals were acting to rapidly oxidize the dilute solution of aldehyde. It is not known whether the situation would be as critical in the peanut slurry.

Data on recovery of added UB in the control peanut system (C-2b) was dependent on the accuracy of quantitation of native aldehyde in the product (C-2a). Any error in quantitation of native aldehyde would subsequently be reflected in the calculation of recovery of unlabeled compound, in addition to any normal experimental error in the C-2b distillation. In view of this, the recovery of 103.5% is considered quite acceptable. Recoveries of greater than 100% on both distilled water and peanut control systems, however, lead to speculation that in spite of all precautions some aldehyde oxidation is occurring prior to monitoring of free carbonyl. This can be seen in the fact that although the number of radioactive disintegrations would not decrease, less than a theoretical amount of free aldehyde would be found in the carbonyl analysis. In calculating specific activity, therefore, the result would be high.

Table 2 indicates some preliminary results obtained on quantitation of native benzaldehyde from the peanut products. The concentration of native benzaldehyde may be related to the extent of roast. The USDA color grade of the product indicates the approximate heat treatment given the peanuts; however, the time of storage after processing of the commercial peanut butter was unknown, so cannot be taken into account in this work. The effect of roasting conditions on concentration of several aldehydes of flavor significance is under further investigation.

Table 1. Efficiency of Recovery of Benzaldehyde (^{14}CHO) in Control Systems

Experiment	Sample	USDA color Grade No.	ADDED ALDEHYDE IB (mg.)	ADDED ALDEHYDE UB (mg.)	ADDED ALDEHYDE Spec. Act. (dpm./mg.)	RECOVERED ALDEHYDE Wt. (mg.)	RECOVERED ALDEHYDE Spec. Act.	Native UB (mg./kg.)[a]	Recovered UB (mg.)	% Recovered UB
C-1	Distilled Water	-	3.17	3.18	15,254	0.07	7,362	-	3.39	106.7%
C-2a	Commercial Peanut Butter	2	4.94	-	16,728	0.95	11,499	1.53	-	-
C-2a	Commercial Peanut butter	2	5.65	6.39	15,311	2.19	6,380	1.53b	5.58	103.5%

[a]Also expressed as parts per million

[b]Value taken from C-2a

With the complexities of food systems, one faces much difficulty in quantitation of flavor components. The method described herein seems readily adaptable to such situations. As described for carbonyls in peanuts, the method could be used for quantitation of several components simultaneously. The resolution of mixtures with the thin-layer chromatographic method is indicated for this. The method should also be adaptable to other components of roasted peanuts or other food systems, providing methods for purification and quantitation are available.

The multitude of volatile components isolated from roasted peanuts makes the task of quantitative flavor analysis an unenviable one; yet it is possible in many instances to select componnds on the basis of their aroma properties. By careful selection it may be possible to apply quantitative procedures in such a manner as to elucidate the innermost mysteries of peanut flavor chemistry.

Table 2. Native Benzaldehyde in Peanut Products

Sample	*USDA Grade No.*	*Conc. Aldehyde (mg/kg)*
Freshly Roasted	4	3.08
Freshly Roasted	3	1.26
Commercial Peanut Butter	3-4	0.09
Commercial Peanut Butter	3-4	2.09
Commercial Peanut Butter	2	1.53

LITERATURE CITED

ARNOLD, R. G., LIBBEY, L. M., and DAY, E. A. 1966. Identification of components in the stale flavor fraction of sterilized concentrated milk. J. Food Sci. 31:566.

ARONOFF, S. 1956. "Techniques of Radio-biochemistry", pp. 35-39. Ames, Iowa State College Press.

BARTHOLOMEW, W. H. 1949. All-glass laboratory long tube evaporator. Anal. Chem. 21:527.

BASSETTE, R., OZERIS, S. and WHITNAH, C. H. 1962. Gas chromatographic analysis of head space gas of dilute aqueous solutions. Anal. Chem. 34:1540.

BOYD, E. N., KENNEY, P. G., and PATTON, S. 1965. The measurement of monocarbonyl classes in cocoa beans and chocolate liquor with special reference to flavor. J. Food Sci. 30:854.

DAY, E. A., BASSETTE, R., and KEENEY, M. 1960. Identification of volatile carbonyl compounds from cheddar cheese. J. Dairy Sci. 43:463.

DeBERSAQUES, J. 1963. Relation between the adsorption and the quenching of liquid scintillation samples. Inter. J. Appl. Radiation Isotopes 14:173.

GIANTURCO, V. M., GIAMMARINO, A. S. and Friedel, P. 1966. Volatile constituents of coffee. Nature 210:1358.

HENICK, A. S., BENCA, M. F. and MITCHELL, Jr., J. F. 1954. Estimating carbonyl compounds in rancid fats and foods. J. Am. Oil. Chem. Soc. 31:88.

JONES, L. A., HOLMES, J. C., and SELIGMAN, R. B. 1956. Spectrophotometric studies of some 2,4 dinitrophenylhydrazones. Anal. Chem. 28:191.

LIBBEY, L. M. and DAY, E. A. 1964. Reverse phase thin-layer chromatography of 2,4 dinitrophenylhydrazones of n-alkanals and n-alk-2-ones. J. Chromatog. 14:273.

LINDSAY, R. C., DAY, E. A., and SANDINE, W. E. 1965. Identification of volatile flavor components of butter culture. J. Dairy Sci. 48:1566.

MASON, M. E., and JOHNSON, B. 1966. Flavor components of roasted peanuts. Some low molecular weight pyrazines and a pyrrole. J. Agr. Food Chem. 14:455.

MASON, M. E., JOHNSON, B. and HAMMING, M. C. 1967. Volatile components of roasted peanuts. The major monocarbonyls and some noncarbonyl components. J. Agr. Food Chem. 15:66.

PATTON, S. 1961. Gas chromatographic analysis of flavor in processed milks. J. Dairy Sci. 44:207.

PENG, C. T. 1960. Quenching of fluorescence in liquid scintillation counting of labeled compounds. Anal. Chem. 32:1292.

RIZZI, G. 1967. The occurrence of simple alkylpyrazines in cocoa butter. J. Agr. Food Chem. 15:549.

ROSS, R. H. and YERRICK, R. E. 1963. Quantitative interpretation of color quenching in liquid scintillation systems. Anal. Chem. 35:794.

SELF, R., CASEY, J. C., and SWAIN, T. 1963. The low boiling volatiles of cooked foods. Chem. and Ind. May 25:863.

TERANISHI, R., CORSE, J. W., McFADDEN, W. H., BLACK, D. R., and MORGAN, Jr., A. I. 1963. Volatiles from strawberries. I. Mass spectral identification of the more volatile components. J. Food Sci. 28:478.

THARP, B. W., and PATTON, S. 1960. Coconut-like flavor defect of milk fat. IV. Demonstration of δ-dodecalactone in the steam distillate from milk fat. J. Dairy Sci. 43:475.

WALTER, Jr., W. M., and PURCELL, A. E. 1966. Elimination of color quench in liquid scintillation counting of ^{14}C-Carotenoids. Anal. Biochem. 16:466.

ACKNOWLEDGEMENTS

The author is indebted to E. B. Williams for technical assistance in this work. Discussions of isotope procedures with W. M. Walter and A. E. Purcell greatly facilitated planning and execution of the research.

Page Left Intentionally Blank

III

Effects Of Windrow Orientation On Peanut Drying Rate And Equipment To Invert The Plants

George B. Duke[1/2]

Introduction

Freshly dug Virginia peanuts contain approximately 50 to 55 percent moisture. Combining is normally delayed 4 to 8 days after digging to allow the peanuts to cure and dry to about 25 to 35 percent moisture. Peanuts are then combined and placed in bins or wagons and artificially dried to 8 to 10 percent moisture.

A faster and more uniform method of drying peanuts in the field after digging and before combining is desired. Commercial peanut diggers leave the plants in different positions in the windrow. Some peanuts are exposed but off the ground, some are exposed and in contact with the ground, and some are underneath the windrow.

Drying of peanuts in the windrow is not uniform because peanuts underneath the windrow dry slower and contain more moisture than those exposed and off the ground. Peanuts under the windrow may mold during damp or rainy weather. Harvesting losses may be increased, when the peannts are lifted from the ground by the combine, if weather has damaged and weakened the stem connecting the peanut to the plant.

Review of Background Information

In 1964 Dickens and Pattee of North Carolina recorded moisture content of peanuts from random and inverted windrows. Peanuts were dug on five different dates from October 21 through October 30. Average moisture content after 4 days was 33 percent from random windrows and 26 percent from inverted windrows; after 8 days, 27 percent and 17 percent, respectively. In 1967 Butler, Pearman, and Williams of Georgia reported that peanuts dry faster and more uniformly from inverted windrows.

Field studies by the USDA machinery project at Holland, Virginia, comparing moisture content of random-windrowed Virginia type runner

[1]Agricultural Engineer, Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture, located at Holland, Virginia.

[2]The author wishes to express appreciation to C. Y. Kramer, Virginia Polytechnic Institute, Blacksburg, Virginia, for performing statistical analyses of data.

peanuts with that of peanuts from inverted windrows, were started in 1959. All windrows were inverted by hand because no commercial inverting equipment was available. After 12 days in the windrow, random-windrowed peanuts contained 26 percent moisture and inverted peanuts 15 percent moisture.

In 1960 after 6 days in the windrow, random-windrowed peanuts contained 29 percent moisture and inverted 21 percent moistnre. Following these preliminary observations, a more detailed experiment was conducted in 1962 and 1966.

In 1962 peanut moisture samples were taken over an 8-day period from four types of windrows--random, inverted, non-inverted (peanuts in contact with the soil), and vines clipped with a rotary mower prior to digging. Peanuts for moisture content determination were picked from three replications at 9:00 A.M., 1:00 P.M. and 5:00 P.M. The average daily moisture content of peanuts from the four types of windrows is shown in Figure 1. On a day-to-day basis peanuts from the inverted windrows contained less moisture than those from either of the other three windrows. Statistical analysis, however, did not show significant differences in moisture content within any one day or from a day-to-day basis.

In 1966 the moisture of peanuts from non-inverted windrows, in which all peanuts were in contact with the soil and underneath the windrow, was compared with moisture of peanuts from inverted windrows. Moisture samples were picked daily at 8:00 A.M. and 2:00 P.M. over an 8-day period from four replications. The average daily moisture conteut of peanuts from the two types of windrows is shown in Figure 2. Peanuts in the inverted windrow contained less moisture than those from the non-inverted windrow, on a day-to-day basis. Statistical data showed a significant difference in the moisture content between the two methods.

EQUIPMENT TO INVERT PLANTS

In the Southeast, several commercial peanut equipment manufacturers have constructed experimental diggers to invert plants. In Virginia, one company experimented with a digger-inverter in 1966 and sold several machines in the area in 1967. Experimental equipment to invert peanut plants is under construction at each of USDA's agricultural engineering research projects at Tifton, Georgia and Holland, Virginia.

The project at Holland constructed its first experimental digger-inverter in 1967. The base unit is similar to standard commercial two-row diggers and

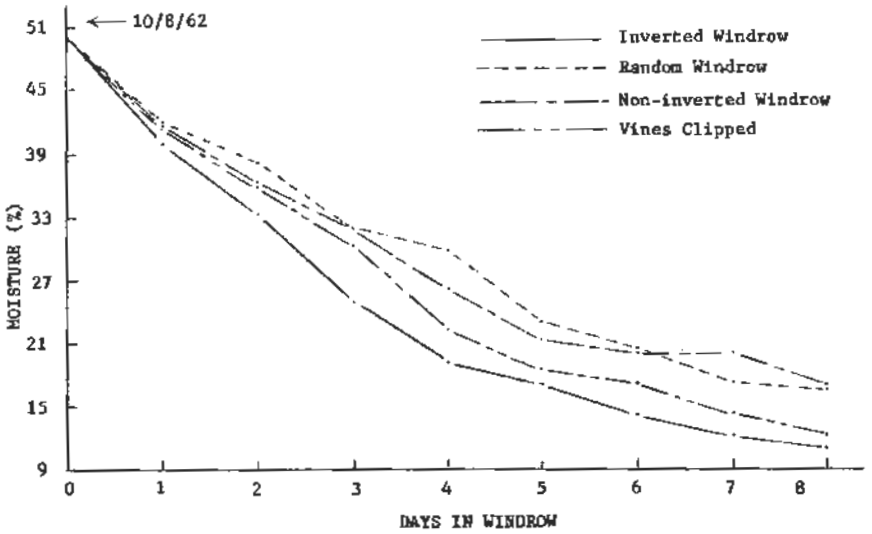

Figure 1. Effect of windrow on moisture content, 56-R peanuts.

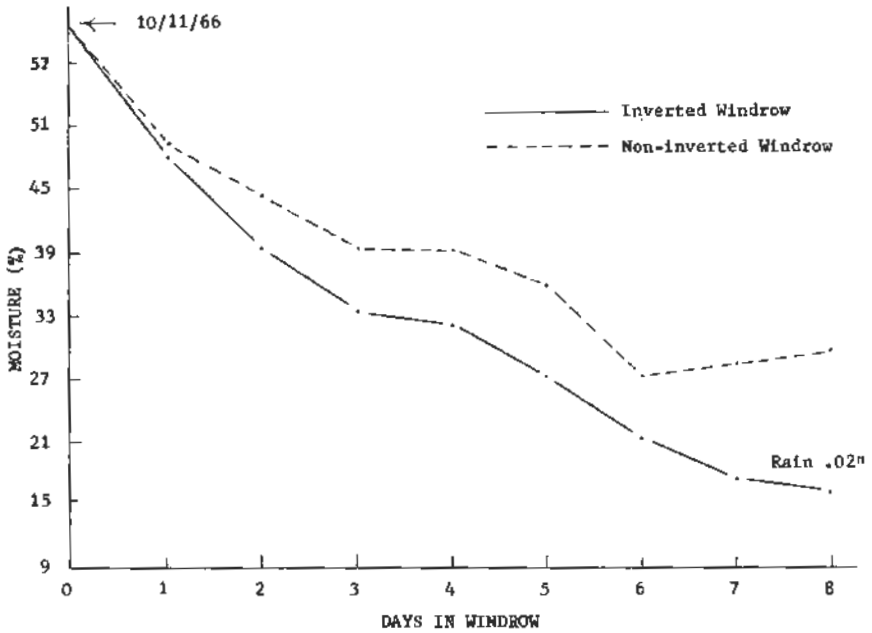

Figure 2. Effect of windrow on moisture content, 61-R peanuts.

consists of a three-point hitch, a two-piece digger blade assembly, an inclined slatted conveyor, and a windrowing attachment. A coulter is installed ahead of and between the two digger blades to cut the entangled vines between the two rows. Tines attached to the cross conveyor bars are shorter than those on commercial diggers to facilitate the release of plants from the discharge end of the conveyor. The conveyor, from center of lower shaft to center of upper shaft, is longer than commercial diggers by about 10 to 12 inches. The longer conveyor lifts the plants higher from the ground and provides additional clearance, from the point of plant discharge to the ground, for incorporating an experimental plant inverting attachment.

The USDA inverting attachment consists of the following components: (1) A 9-inch diameter roller, 28 inches long. The roller is centrally located crosswise of the digger approximately 13 inches below and 4 inches to the rear of the upper conveyor shaft. (2) Two belt conveyors, each 17 inches wide, installed over 8-inch pitch diameter sprockets spaced 52 inches on centers. One conveyor is installed on each side of the digger. The drive sprockets are installed on the same shaft supporting the 9 x 28 inch cross-mounted roller. The driven sprockets are installed higher from the ground than the drive sprockets, and the top side of the conveyor belt operates at an inclined angle of approximately 10°. (3) Two plywood deflector boards, each 10 inches wide x 51 inches long, are installed on edge and diagonally across each conveyor belt.

Operation of the two-row digger and inverting attachment is as follows: the slatted conveyor lifts the peanut plants from the ground, moves them upward and rearward, and discharges the plants from each row onto each belt conveyor. As the plants are moving rearward, they are deflected from the belt conveyor toward the center of the digger. The plants fall from the belt conveyor in an edgewise position, and an estimated 95 percent of the plants are completely inverted in falling to the ground.

Test Procedure

The experimental USDA digger-inverter described above was included in a continuing experiment of random-windrow type diggers to evaluate recovery yield, losses, and amount of soil left in the plants. One test was conducted at the Tidewater Research Station on September 26.

Four random-windrow type diggers were included in the test: (1) USDA with an inclined slatted conveyor and soil separation attachment[1], (2) a

[1]The soil separation attachment consisted of four shaft assemblies of elliptical wheels installed crosswise of the digger slightly below and at the rear of the discharge end of the slatted conveyor. Elliptical wheels are made of 1/4 inch thick plywood and spaced 3-1/2 inches on each shaft. Minor and major axes of each wheel are 8 and 12 inches, respectively.

commercial unit with star-shaped wheels[2], and (3) two commercial units with inclined slatted conveyors. All units were equipped with digger blades, three-point hitches and windrowing attachments.

A second digger test was conducted about 6 miles from the station on October 13 and included two random-windrow type diggers and three diggers that invert plants. Random-windrow diggers included the USDA unit described above and a commercial digger with standard type conveyor. The three types of digger-inverters were : (1) the same USDA digger-inverter used in the test on September 26, (2) an experimental digger-inverter from Tifton, Georgia, and (3) an experimental commercially designed peanut digger-inverter.

Test procedure for each digger consisted of selecting at random four replicated plots that were dug with each machine. Each plot consisted of two rows, 36 inches apart, 7.26 feet long (.001 acre). The following plot data were obtained: soil moisture, yield of peanuts on the plants (picked from the vines by hand), amount of peanuts left in the soil (obtained by sifting soil through 2 x 2 mech hardware cloth), and amount of soil in the plants (obtained by hand shaking the plants to separate adhering soil). All tabular results are the averages from four replicated plots.

Results

Each of the three types of peanut digger-inverters gave fairly good results operating the first year uuder Virginia conditions in Virginia runner type peanuts.

The USDA digger-inverter performed best operating in well-drained loamy sand soils, as did the others. The plants contained small quantities of soil and were completely and uniformly inverted. Too much soil remained in the plants and they were not completely inverted when this digger operated in less well-drained, finer-textured soils.

Type of equipment used and test results for September 26 and October 13 are shown in Tables 1 and 2, respectively.

Data from the first test (Table 1) show that recovery yield with the USDA inverter was not significantly different from that with two commercial random-windrow diggers, but was lower than that with a third commercial random-windrow digger. Digging losses from the USDA inverter were significantly less than from two commercial diggers, but were more than from a third commercial digger. The amount of soil left in the vines was not significantly different from that left by two commercial diggers, but was

[2]This commercial digger was equipped with three shaft assemblies installed crosswise of the digger and rearward of the digger blade assembly. On each shaft were star-shaped wheels, 13 inches in diameter, spaced 3-1/2 inches apart.

significantly less than that from one of the commercial diggers and significantly more than that from USDA digger with elliptical wheels.

Analysis of data from the second test (Tahle 2) did not show any significant differences among diggers in recovery field, digging losses, or amount of soil in the vines.

Discussion

Inverting peanut plants may offer several advantages over the random windrow. For example, the pods are exposed for better drying, pods should be less subject to molding, and harvesting losses may be reduced. Inverted windrows should be relatively free of excess soil. If the inverted windrow contains an excessive quantity of soil, reshaking may be necessary. From field observation, it is believed that reshaking inverted windrows to remove excess soil is less effective than reshaking random windrows; also the inverted plants are left in a random position. Considerable progress has been made in developing equipment to invert the plants. A peanut digger is desired that will completely invert the plants, free of excess soil, when operating in either dry or wet soil.

SUMMARY

Peannts inverted when dug contained less moisture on a day-to-day basis than those from random windrows. For example, in 1962 - after 4 days - random, 29 percent; inverted, 19 percent; after 6 days - random, 20 percent; inverted, 13 percent; after 8 days - random, 16 percent; inverted, 10 percent.

In 1966 moisture of peanuts in contact with the soil was compared with moisture of peanuts from inverted windrows. The results were: after 4 days - peanuts in contact with the soil, 39 percent; from inverted windrows, 32 percent; after 6 days - 27 and 21 percent; and after 8 days - 29 and 16 percent, respectively.

Peannt equipment manufacturers and USDA machinery projects at Tifton, Georgia, and Holland, Virginia, are developing and experimenting with peanut diggers to invert plants. Several diggers to invert plants were sold in Virginia in 1967 by one manufacturer.

The USDA machinery project at Holland constructed and tested its first experimental peanut digger-inverter in 1967. Essential construction features of the inverting attachment consist of a center cross-mounted 9-inch diameter roller, 28 inches long, two side conveyors, and two plant-deflecting boards. Under limited testing with Virginia runner-type peanuts, an estimated 95 percent of the plants were inverted with this equipment.

Table 1. Peanut digger tests, Holland, Virginia, 9/26/67.

Make	*Soil moisture percentage*	*Recovery yield lb/A*	*Digger loss lb/A*	*Soil lb/A*
USDA w/ elliptical wheels	11.4	2,814 a*	587 bc	2,092 c
Commercial A	12.0	3,238 b	283 d	26,530 a
Commercial B	12.8	2,512 a	723 a	9,375 b
Commercial C	11.7	2,560 a	696 ab	5,066 bc
USDA inverter (Va.)	11.5	2,763 a	564 c	9,500 b
Average	11.8	2,777	570	10,512

*Means followed by "a" are significantly different from those not having "a"; those followed by "b" are significantly different from those not having "b", etc. at the 0.05% level.

Table 2. Peanut digger tests, Holland, Virginia, 10/13/67.

Make	*Soil moisture percentage*	*Recovery yield lb/A*	*Digger loss lb/A*	*Soil lb/A*
USDA w/elliptical wheels	6.5	2,557	508	1,161
Commercial A	7.5	2,651	556	7,760
Exp. inverter (Ga.)	7.6	2,612	914	5,748
Commercial inverter	7.5	2,764	790	2,088
USDA inverter (Va.)	6.7	2,612	803	4,602
Average	7.1	2,639	714	4,271

Two random-windrow diggers and three experimental digger-inverters were tested in runner peanuts in Virginia in 1967. The equipment was operated in well-drained loamy sand soils. Recovery yield, pod losses associated with digging, and amount of soil left in the vines were not found to be significantly different for any of the diggers operating in this test.

LITERATURE CITED

BUTLER, J. L., PEARMAN, G. E. and WILLIAMS, E. J. 1967. Effect of Post-Digging Treatments on Factors Which Affect Peanut Quality. Proc. Peanut Improvement Working Group: 1967.

DICKENS, J. W. and PATTEE, H. E. 1964. Time-Temperature-Moisture Effects on Aflatoxin Production in Peanuts innoculated with a Toxie Strain of ASPERGILLUS FLAVUS.

IV

Problems for Peanut Research – Present and Future

R. W. Howell[1]

A few years ago there appeared an essay entitled "Research is a Sacred Cow." The implication was clear that "research" is a magic word. No wrong could be done under its guise. That era has passed. Nowadays, hard questions are asked about the importance, relevance, and need for research, and perhaps for agricultural research most of all. So it is timely that we discuss Problems for Peanut Research. What are the present trends? Can we recognize the problems - technical and otherwise - facing the peanut industry and peanut researchers? Can we evaluate them? If so, can we quantity their values to growers, processors, the economy, and society?

For several years we have been doing long-range planning of agricultural research, resulting from a request by the Senate Appropriations Committee in 1965 for an inventory of current research in agriculture and for a long-range study of future needs. The report, "A National Program of Research for Agriculture," commonly referred to as the "Long-Range Study (LRS)," was prepared by state and federal administrators and submitted in 1966. It defined 10 goals of agricultural research as listed in Table 1.

These goals were defined or subdivided further in the report, but not to the point of specific problems in a commodity such as peanuts. Rather, the report recommended the appointment of task forces of informed technical people to make more detailed studies of the status and need of research. There will be 34 of these task forces, 17 dealing with commodities such as peanuts and 17 with resources such as water or food safety. Most of the task forces have been appointed and some have completed their work. The task force on peanuts was appointed in March of this year. Its composition—members from state and federal institutions and advisors from industry -is shown in Table 2.

The 10 goals were defined further into 92 research problem areas (RPA). Those of special interest or relevance to peanuts are shown in Table 3.

Peanut Task Force

Table 3 also identifies the RPAs assigned to the Peanut Task Force. RPA 702, dealing with mycotoxins, was not included in the Peanut TF assignment.

[1]Chief, Oilseed and Industrial Crops Research Branch, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

The mycotoxin problem,without specific reference to peannts, was assigned to the Food Safety TF. The members of the Peannt TF, however, consider the mycotoxin problem in peanuts to be of such significance that a statement reflecting our concern will probably be included in the Peanut TF report.

The Peanut TF has held two meetings and has its report in a preliminary draft stage. The TF has studied current researeh and future needs for peanuts earefully. I believe it will develop a good evaluation of peanut rescarch. The current inventory of peanut research and proposed future areas of emphasis give some indication of past and future trends in peanut research. The inventory is shown in Table 4.

We have no inventory of industrial research on peanuts, but recognize that it is substantial. The LRS estimated industrial expenditures in all agricultural research to be 55.4% of the national total, or considerably more than state and federal expenditures combinecl.

Table 4 shows the major emphases in peanut research. Increased concern for mycotoxins has been a major trend in recent years. Mycotoxin work has been characterized by the finest cooperation and dialogue among industry, state, and federal groups. There have been no significant mycotoxin incidents. We have learned a lot about the chemistry of mycotoxins, the occnrrence of toxigenic fungi, the circumstances favoring infection and toxigenesis, and how to recognize and eliminate contaminated kernels. We know how to live with the myxotoxin threat in the United States. It continues to be a major concern, but not so imminent or frightening as a few years ago.

Spectre of Mycotoxins

But if we consider the food requirements of a hungry world, the spectre of mycotoxins dominates any plans or hopes for a major role for peanuts. We have here the anomaly of a marvelously nutritious and delicious commodity--a pound of which supplies more than a man's daily calorie requirement and more than twice his protein need — which is not highly regarded as a food in many countries. Peanut butter deserves ample credit for maintaining the health of young Americans during their years of finicky eating habits. Possibly the low estate of peanuts in the hungry parts of the world--euphemistically called the less developed countries--has a sound basis. Who is to say that taboos against peanuts are not due to mycotoxins? Much of the progress from our research on mycotoxins will be difficult to apply in the hungry nations. What is needed is prevention, or immnnity, or a device that will insure food safety in a society where sanitation may be primitive.

Table 1. Goals of Agricultural Research

1. Resource conservation and use
2. Protection of forests, crops and livestock
3. Production efficiency
4. Product development and quality
5. Marketing efficiency
6. Expand exports and assist developing countries
7. Consumer health, nutrition, and well-being
8. Raise level of rural living
9. Community services and environment
10. Basic research

Table 2. Peanut Task Force

USDA

R. W. Howell, Crops Research Div., ARS, Co-Chairman
W. K. Bailey, Crops Research Div., ARS
J. L. Butler, Agricultural Engineering Div., ARS
L. A. Goldblatt, Southern Utilization Div., ARS
R. S. Hutchison, Transportation & Facilities Div., ARS
M. M. Rayman, Coop. States Research Service

SAES

L. E. Hawkins, Southern Regional Director, Co-Chairman
M. H. Bass, Entomology Dept., V.P.I., Research Division
C. R. Jackson, Resident Director, Ga., AES
B. C. Langley, Supt. West Cross Timbers Expt. Sta., Tex., AES
Max Hinds, Staff Secretary

Industry Advisors

L. Atkins, Standard Brands, Inc.
J. W. Greene, Southeastern Peanut Asso.
S. C. Reagan, Southeastern Peanut Shellers Asso.
J. S. Sugg, North Carolina Peanut Growers Asso.

The continuing international concern about mycotoxins is indicated by a conference on toxic microorganisms, being sponsored by the Joint U.S.-Japan Cooperative on Development and Utilization of Natural Resources in Hawaii next October, and by a paper Dr. K. H. Garren presented at the International Phytopathology Congress in London in July.

So much for mycotoxins. There are other challenges to peanut researchers, especially in the United States.

I have shown you a summary of current research efforts on peanuts. What can we expect in the future? The LRS estimated the needs and available agricultural research manpower through 1977. Subsequently, the available manpower has been allotted to various commodities or resources. The projection as it relates to peanuts is shown in Table 5.

Specific Problem Areas

An increase of 49 scientific manyears (SMY) is projected. The Peanut TF is developing a number of specific problem areas which will require attention in the next decade. These can be grouped broadly into Protection, Production, Utilization, and Marketing. All of these categories have in common the objective of improving the competitive position of peanuts. This may be achieved, for example, by lowering production costs, increasing the efficiency of marketing, and developing new or improved products which will penetrate new segments of the market.

But, how to do this? How much can be saved or gained by success in a given piece of research? We are not accustomed to being asked such questions. But we must seek to answer them, because our research is justifiable to society only if it pursues desirable objectives and if the results are worth the cost to society.

It is easy to make superficial estimates of the value of some research. For example, losses in peanuts due to insects are estimated as about $13 million per year, including the cost of control measures. Losses due to diseases have been estimated as high as 25 percent of the crop value, and those due to weeds as about $50 million. These figures are estimates, maybe guesses. It is doubtful that losses from insects and diseases could be recovered in our present economy, even if the pests were eradicated. The cost of control measures might be reduced, but since there is a surplus of marketable peanuts, an increase in production due to eradication of pests would probably either lower the unit price or increase the cost of the government support program. Nevertheless, the figures represent a tangible potential value for research in these areas. Research on insects in peanuts, for example, could be worth up to $13 million a year or about $10 per acre, but no more, if the

Table 3. Research Problem Areas of Interest to Peanuts

RPA	
207	Insect control
208	Disease control
209	Weed control
307	Production efficiency
308	Mechanization
309	Systems analysis
405	Improved consumer acceptability
406	New and improved nonfood products
407	New and improved nonfood products
408	Market quality
501	Grades and standards
504	Marketing efficiency
601*	Expand foreign markets
701*	Avoid pesticide residues
702*	Mycotoxin

*Not assigned to Peanut Task Force

Table 4. Peanut Research - 1967 Inventory (Total Scientific Manyears:88.2)

RPA		*SMY*[1]	*RPA*		*SMY*[1]
207	Insects	5.7	406	New food products	14.9
208	Diseases	11.4	407	New nonfood products	4.1
209	Weeds	2.8	408	Market quality	7.0
307	Production efficiency	13.0	501	Grades and standards	0.5
308	Mechanization	6.5	504	Marketing efficiency	4.6
309	Systems analysis	0.1	702	Mycotoxins	16.5
405	Consumer acceptability	1.1			

[1]Scientific manyears in USDA and SAES.

Table 5. Projected Peanut Research Manpower

RPA	207	208	209	307	308	309	405	406	407	408	501	504	Totals
1967	6	11	3	13	6	0	1	15	4	7	1	5	72
5 years	6	15	7	16	6	2	1	21	3	7	1	3	88
10 years	8	20	9	28	7	2	3	27	3	9	1	4	121

estimates are correct. Actually, our task force members have been conservative in estimating the value of research and have recognized that research in the next few years will not eliminate all losses due to insects, diseases, and weeds

It is much harder to estimate the value of research on production efficiency or on improved quality. What are the components of production costs? How much progress in production efficiency can we expect from the research resources which will be available during the next decade? We cannot even guess intelligently unless we know what is limiting efficiency, what components of production cost can be most successfully attacked with research, and the value of success in such research. Increases in yield per acre are commonly cited as a very effective means of lowering unit costs of production. Many costs are nearly constant, it is said, so higher yield permits one to spread the per acre cost over more production units. To one who views economic problems and theory through a layman's eyes, this generalization seems a bit too simple. I believe a significant component of cost is land rental or interest on investment. Presumably this is related to land value and in turn to productivity. Will this component of cost remain constant if there is an increase in yield level? Similar questions occur with respect to the use of better seed, more expensive mechanization, and systems analysis. These are accepted as means of increasing efficiency, mainly by contributing to higher yields and therefore to lower unit cost. We have an urgent need for thorough studies of these and other components of cost, with special attention to opportunities to achieve tangible reductions in net costs of production.

Federal Acquisition Program

Various arrangements now provide that the federal government will acquire supplies of peanuts unsuitable or not needed for the edible trade. Most of you are familiar with the report on the peanut program recently issued by the General Accounting Office. The GAO estimated the 1966 cost to the government in administering the peanut program as $48 million. The cost of moving the government's stocks of peanuts into alternate uses is not always considered in equations leading to estimates of production value or the benefits to be derived from research.

We need to get production costs down so that peanuts can gain larger segments of the edible market and move more freely and profitably into other markets, specifically, the vegetable oil and meal markets. This will be no small achievement. The vegetable oil and meal market is not in the most vigorous condition. Soybean oil, which largely sets the market level, has recently been below 8 cents per pound. Oils which command a premium over soybean oil are higher. But the recent increase in supply of Russian sunflower oil in world markets has greatly intensified competition, and Russian

sunflower oil has been priced below soybean oil in Rotterdam. The situation is smilar with respect to meal. Urea and fish meal provide competition which is effectively preventing large gains in volume or advances in price. Can improvements in production efficiency reduce production costs of peanuts enough for them to be profitably competitive in the general oil market?

Is all of this reason for discouragement or for abandoning efforts to make improvements? Of course not. But it is only realistic to evaluate our problems, capabilities, and alternatives as thoroughly as possible, then to plan the use of our resources, including research resources, to get the best return.

Reaching Solutions

A key is recognition of the problem. It has not been one of our strenghts. I do not single out peanuts specifically, as I see this weakness in myself and in all of the groups with which I am associated. But peanuts are no exception. Not the inability to name problems. We are very good at that. Most of us can quickly produce a long list of problems, all urgent. But we are not very good at the analysis of problems including the value of a solution. We tend to think in terms of problems rather than solutions: "Leaf spot is a serious disease problem, costing X% of the value of the crop." It is hard to determine the reliability of the "X%" extimate, to conceive of the specific questions which must be answered to find a solution, how to find answers to the questions, what to do when the questions are answered, and, finally, how much more the crop would be worth if leaf spot were controlled than it is worth now.

We must be very critical of research proposals to insure that our research resources are effectively used. There is widespread belief that these resources are not being used effectively now. I would like to quote from Jacques Barzun, former provost and dean of faculties at Columbia University.

"Judging from what is being studied, it is clear that as a civilization we no longer kuow how to do anything. We can meet no situation without stopping work and studying. Nothing can be done today as it once was done. So we repeatedly analyze the familiar and suspend action."

We hope to see an increase of about 50 people in peanut research in the United States during the next decade. In the protection and production area an increase of 37 is projected. The assignments given these people must be relevant to the needs of our industry and society. They must be sufficiently defined to assure relevance, but not so narrow or specific as to deprive us of the maximum creativity of the individual scientist. Some of us are concerned

with unnecessary duplication of effort. With more people, there may be more cause for concern. If the projected manpower level is attained, there will be an average of nearly 10 percent protection and production research people for every state where peanuts occupy significant acreage.

I do not worry about duplication. We have and must maintain good communications--between industry and public agencies, between state and federal administrators, aud most of all between individual scientists. The thing that concerns me most is that our research will be good. We are pursuing the unknown. If we do it imaginatively and energetically, there will be no duplication.

The task of analyzing problems, described above, is oue for administrators and sponsors of research but not for them alone. This is especially a task for each individual scientist. His usefulness as a scientist, the contribution he will make to mankind in the only career he will ever have, depend squarely on how carefully he analyzes the problems facing him. These analytical questions are also being asked increasingly by legislators and taxpayers. Choices must be maile between the use of national resources for research and for other purposes. As an agricultural administrator, I want the problems of agriculture to be effectly analyzed and presented. But as a citizen and taxpayer, I want the choices to be right.

V

Yield Increases Create Pressure to Adjust Peanut Quota Policy

J. Paxton Marshall and Russell C. Schools[1]

A distinctive characteristic of American agriculture is its capacity to accelerate the rate of output per acre. Peanuts provide a prime example. During the decade of the 1930's, the highest average yield per acre for any year was 801 pounds, produced in 1937. Through the 1940's the highest average yield per acre was 861 pounds, achieved in 1941. The maximum average yield per acre during the 1950's was 1,197 pounds, produced in 1958. This 20-year, 400 pound, gain has been more than matched in the seven years 1960 through 1967. By 1967, the average yield per acre was 1,735 pounds.

The rise in yields has, of course, been influenced to some extent by the quota program. Passed in 1940, the quota program first reached the national minimum allotment of 1,610,000 acres in 1957. The result is that allotments have not been reduced since 1957. But the accelerating rise in output per acre exceeds consumption, with the result that the present support program has difficulties.

The Difficulties

Two major economic difficulties exist with the program. On the farm side the difficulty is price and its corollary, income. On the Commodity Credit Corporation side the difficulty is rising program cost. In 1961, 825,000 tons were produced and 705,000 tons were consumed. The support level was 85.6% of parity, and the price was $221 per ton. By 1967, the output was 1,236,000 tons and consumption approached 885,000 tons. Price was 75.2% of parity in 1967 or $227 per ton. Thus, between 1961 and 1967 the price (nationally) per ton of farmer stock peanuts moved upward by only $6 per ton. CCC costs moved from $12.1 million in 1961 to about $45 million by 1967. Both farmer price and CCC cost were directly affected by accelerating yields.

The Choice

When peanut producers petitioned the Secretary of Agriculture to grant a price increase on the 1968 crop, the above data were reviewed. The choices that the Secretary suggested to producers were to develop a new program to

[1]Extension Specialist, Public Policy and Extension Agent, Farm Management, respectively, Extension Division, Virginia Polytechnic Institute, July 1968.

correct the existing situation at the farm level as well as the CCC level, or to continue with 75% parity level for the 1968 crop as stipulated in the legislation. Three criteria were set forth for any new program: (1) that farm income be maintained or increased, (2) that government costs be stabilized or reduced, and (3) that adequate supplies be provided for consumers at fair prices.

The choices of the peanut growers were clear: attempt to do something about changing the program or continue under the present program. A series of meetings was called, and the three production areas sent representatives. They studied 17 program proposals.[1] The 17 proposals included acreage programs 4, diversion programs–3, poundage programs–4, and certificate programs–6. From this study emerged a certificate program that has been proposed and submitted to the Congress (H. R. 18213 and S. R. 3711). It is anticipated that a law may be enacted in time to require, as stipulated in the bill, the price of the 1968 peanut crop to be 80% of parity.

The Proposed Program

Some things might be said about what the proposed program does not do. It does not remove the 1.6 million acre minimum allotment from the law, and it does not affect the producer's option to produce 100% of his allotment at the minimum support level of 75% of parity.

The key to the program is the "recommended percentage". This is based on an estimate of the quantity of peanuts needed for domestic edible and commercial seed use, plus a reserve, for adequate supply. Over the years the term adequate supply has been interpreted to mean enough for needs plus about 20% of above needs. The estimated adequate supply is divided by estimated production, and the result obtained is the recommended percentage. The recommended percentage and the value of all certificates would be announced under the proposed program not later than February 15 of each year.

The recommended percentage may not be less than 85% of allotment in the first year. For each 2 per cent that the recommended percentage is below 1.6 million acres, the support level would move up by 1% of parity. The program operates through this built-in pricing mechanism to raise the returns to peanut growers at all levels of yield. Producers that harvest 100% of their allotted acreage would receive the minimum support, which would equal the

[1]J. Paxton Marshall, "Seventeen Proposed Peanut Programs Studied by Grower Representatives: A Review" (Department of Agricultural Economics, Extension Division, Virginia Polytechnic Institute, Blacksburg, Virginia) June 1968, Mimeo.

maximum loan of 75% of parity, and no certificates would be issued to them. A range of support level options will exist between any maximum support and 75% of parity. Certificates would be issued for the option selected, on the basis of actual production from harvested acreage, which, of course, is to equal the planted to harvest acreage. Within the support level range, producers may exercise their option to receive a lower value certificate on a higher proportion of the harvested acreage. This may be the optimum choice for many producers. Each grower will have to decide about his own allotment. Those growers that exercise their option to produce at the 85% level would receive support at 82.5% of parity.

In any year after the first year of the program the recommended percentage could not be set more than 5% below that of the previous year. The program may be administered to permit adjustments in the support option area in any year. When fully implemented in four or more years, the program would require a maximum price of 90% of parity for peanuts at the minimum recommended percentage, which is 70%.

Shellers would be required to pay the equivalent of 5% of parity for certificates the first year. The value of the certificate in any succeeding year would be at least 5% and could be increased for any year by an amount not to exceed 1%. Since shellers could not be passed more than 1% of the parity price of peanuts in any year after the first, the maximum cost of certificates would not exceed 8% at the end of four years. Shellers would not purchase certificates for an amount in excess of 15% of parity. A minimum of 11 years will be required to transfer the cost of the program if the maximum of 1% annually is passed to sheller certificates.

The proposed program authorizes extra certificates to be issued at the higher price level for any type of peanut that may be or is estimated to be in short supply in any harvest year. These extra certificates for type would have the maximum value of certificates issued in that year. All extra certificates to increase peanuts by type would be financed through the program and not by the sheller.

Crop disaster certificates will be available for peanut growers. No crop insurance is presently available on peanuts in some areas. In any year in which the grower's intended-to-harvest acreage produces less than 40% of the projected yield he will receive a certificate in an amount equal to the difference between the quantity actually harvested and the projected quantity to harvest on the allotted acreage. The value of the crop disaster certificates will not exceed the maximum difference between the loan price and the support level selected by the grower.

Shellers are interested in the proposed program from, among other things, the standpoint of tonnage that will be produced. The program proposed will stabilize the tonnage produced and may at some point reduce that tonnage below the 1967 level by about 100,000 tons. This could mean that minimum production may be about 1.1 million tons. If this estimate is correct shellers will continue to utilize their equipment at near to present levels, and should anticipate a minimum of actual curtailment under the proposed program. The distribution of the curtailment cannot be determined in advance.

Impact on Consumer

Manufacturers encouraged "gradualism" in transferring the cost to the consumer. Thus, the proposed legislation contains a provision for passing a maximum of 1% of parity annually to the consumer by raising the value of the certificate. How consumers will react to a price rise remains an unknown factor. On at least one occasion, however, price moved up $26 per ton in one year, 1961, without a decline in consumption. But many factors affect demand, and it cannot be predicted with certainty that the consumption of peanuts will continue to expand under the proposed program at the present rate of 3.6% annually--about 3 times the 1.2% increase in population.

An analysis of the proposed program shows that under it, farm income will be increased or maintained while government costs will be stabilized or reduced. Estimates of farm net income indicate that net income can expand in the first 5 years under the proposed program by 20%, and that government costs will be less in every year than under the present program. Cost of peanuts will move up for consumers, but it should be recognized that during the 1950's producers paid 90% of a fair price, i.e. 100% of parity, for peanuts. While consumer income has been expanding, peanut prices have actually been declining relative to consumer income and to other factors.

The proposed program increases the number of areas where producers can bargain. These concern particularly the recommended percentage and the transfer of program costs to the consumers. With the price increase built into the program, it is conceivable that growers may actually attempt to negotiate a reduction in the recommended percentage. The opportunity also exists to negotiate transferring program costs to the consumer. This part will bring the manufacturers into the negotiation and will serve to transfer any criticism about rising government costs to manufacturers and consumers.

More opportunities for decision-making are made available to the producers than would be available in conventional acreage cut, diversion or poundage programs. The opportunity areas include (a) the support level options, (b) the support option, (c) the harvesting option range, (d) the

option to use allotted acreage in other uses, and (e) an option to limit income source to market place.

Without a doubt, the major factor in determining the longevity of the proposed program, if it is enacted into law, will be the rate of increase in yield. If yield per acre continues to increase at a rate such as that of the last 8 years, another adjustment in the peanut quota program will be needed. The result could very well be a program based on poundage.

Page Intentionally Blank

VI

Research on Peanut Quality

Ralph S. Matlock[1, 2]

Has the quality of peanuts improved since the first National Peanut Research Conference (February 21-22, 1957) 11 years and 5 months ago, where the entire conference consisted of papers dealing with the relation of various phases of the industry to quality of raw peanuts for specific end uses? Currently we know more about those attributes of peanuts that make for suitability to specific end uses. However, it probably can still be said that quality is a much used, poorly understood term.

Emery, Perry, Golumbic (1966) and Sexton (1963) reported on 19 quality factors for which objective standardized methods of measurement have been or should be developed (Table 1). Four out of these 19 quality factors had no available method of measurement listed and it may be that the other methods listed need to be improved and standardized.

It is difficult to find raw peanuts that vary within narrow limits in flavor and composition. We plan to discuss examples of flavor difference caused by certain environmental and/or genetic conditions. Some of the difficilties we still face, in spite of the progress made, are that many quality factors are still ill-defined, the tools for measuring them are not known or developed, and perhaps we expect to get the highest quality for numerous end use products from the same bag of peanuts.

In order to evaluate the desirable characteristics involved in flavor, odor, appearance and texture, sensory tests are used. These tests are snbjective in nature and difficult to use.

There have been many attempts to describe flavor in terms of chemical properties. K. T. Holley suggested that an oil-protein ratio of 2:1 indicates good quality. Ratios outside these limits indicate low quality. Avera is confident that peanut butter made with Spanish peanuts of a high iodine number (approaching 100) is more subject to oxidative deterioration than peanut butter from peanuts with lower iodine numbers. The relationship

[1]Department of Agronomy, Oklahoma State University.

[2]Author acknowledges financial assistance from Corn Products Company; USDA, ARS, Southern Utilization and Development Laboratory and Oklahoma Peanut Commission and the Department of Bio-Chemistry, Oklahoma State University, for oil and fatty acid data. Journal No. 1824.

found between iodine numbers and CLER scores (flavor) in the Skippy Research and Quality Control Laboratory was evident from samples submitted from the 1966 and 1967 grown crop (Tables 2 and 3).

In Table 2 the only sample that received a high organoleptic rating at the Skippy Research and Quality Control Laboratory was the sample of P-6, that had an iodine number of 90, compared to 101 for the other 4 samples. The mean CLER scores for the 5 entries were not significantly different in the Oklahoma Agricultural Experiment Station Laboratory.

Four samples from each of two locations in 1967 had higher organoleptic ratings in our laboratory than in the Skippy Research and Quality Control Laboratory (Table 3). All iodine numbers were above 100. Note the ratio of oleic: Linoleic was lowest for the P-6 sample (Table 2) in 1966, while the low ratio in 1967 (Table 3) did not have a comparably high CLER score. Better agreement among laboratories will be achieved with the development of more precise techniques and standardization.

Let us consider some of the evidence concerning hereditary and environmental influences on fatty acids and flavor. Crawford and Hilditch, in 1950, reported that variations in the proportions of oleic and linoleic glycerides in peanut oil are due to climatic conditions and soil type.

They reported:

	Oleic	*Linoleic*	*Ratio*
W. Africa	60%	20%	3.00
Natal Common	40%	35%	1.14
Valencia	40%	35%	1.14

Higgins, Holley and Pickett in 1941 reported considerable variability among 24 hybrid selections with respect to percentages of oleic and linoleic glycerides.

The following safflower data illustrate that it is possible to genetically change the fatty acid distribution of plants. Knowles and Puckman (1965) reported that a gene was found in a safflower introduction (UC57–147) from India that would change the proportions of oleic to linoleic acid in the oil of safflower when the introduction was crossed with US 10 and backcrossed twice to US 10.

Cultivar	*Palmitic*	*Stearic*	*Oleic*	*Linoleic*	*Oil*	*Iodine No.*
US 10	6.6	1.8	13.5	78.1	36	145
UC 1	5.3	1.2	78.3	15.2	36	90

Table 1. Peanut Quality Factors for Which Objective, Standardized Methods of Measurement Should be Derived

Quality Factor	*Type*[a]	*Available Methods Indicated*
1. Maturity	S	Spectrophotometric evaluation of expressed oil, sugar content, unsaturation of oil.
2. Resistance to mold growth	IS or S	None
3. Color	IS or S	Use of color "chips" similar to those used by the USDA for peanut butter.
4 Shape	S	Use of slotted screens with relatively small samples.
5. Density	Raw or Roasted	Beckman air pynometer, count per pound, sand displacement, fluctuation.
6. Concealed damage	S Raw or Roasted	Federal–State Grading Procedure
7. Milling quality	IS	Lab sheller
8. Blanchability	S	Lab blancher, hand blanching
9. Kernel hardness	S	Penetrometer
10. Texture of kernel	S	None
11. Tendency for radicle breakage	S	None
12. Pod thickness	IS	Micrometer or microscope measurement.
13. Pod fragility	IS	Impact tester
14. Mold Count	S	Direct count
15. Aflatoxin content	S	Chromatographic method
16. Infestation	IS	Direct Count
17. Skin Slippage Tendency	S Raw or Roasted	None
18. Flavor	S Raw or Roasted	Flavor panel evaluation of ground or roasted peanuts.
19. Chemical constituents	S Raw or Roasted	Moisture – Oven, moisture meter, distillation. Oil – Total, iodine value, fatty acid content, fatty acid composition, rancidity potential, Tocopherol content, Protein – Total Vitamin.

[a]S = Shelled peanuts; IS = Peanut in the shell.

It was found that the fatty acid characteristics of oleic and linoleic were determined by one factor pair. The recessive gene (ol) contributed to low oleic and high linoleic and the dominant gene (OL) to high oleic and low linoleic acid. Tables 4 and 5 illustrate the differences in certain peanut germ plasm with respect to fatty acid distribution.

In peanuts there is also evidence that this can be accomplished genetically. Genetic differences in flavor and texture have been reported among the various market types. Hereditary differences within a market type may also exist though we know the environment x genetic interaction can be great. Four entries of Spanish peanuts did appear to differ organoleptically when grown in the same environment and tested by the same organoleptic panel (Table 6). It may be of interest to discuss their characteristics.

P-606 (PI 268674), introduced from N. Rhodesia, is a Spanish type with sparse to moderate branching that was rated *poor* organoleptically.

P-529 (PI 261988), introduced from Paraguay, is a Spanish type with small seeds that received a *poor* organoleptic rating.

P-824 (PI 247375), introdnced from S. Africa, is a Spanish type with medium seed that received a *good* organoleptic rating.

P-678 (PI 268761) introduced from N. Rhodesia, is a Spanish type with *medium* fine branching that received a *good* organoleptic rating.

Table 2. Results for Peanut Samples from Variety Tests near Stratford, 1966

Okla. P-No.	*Alameda Index*	*Cler 1*		*Iodine No.*	*Light absorption at 450 mu*	*Oil (DWB)*	*Olecic:Linoleic Ratio*
		CP	*OAES*				
2	225	48	65	101	0.055	55.6	1.30
6	226	74	66	90	0.040	53.5	1.24
74	227	50	63	101	0.063	53.1	1.30
112	228	50	68	101	0.061	53.5	1.28
548	229	62	65	101	0.054	53.4	1.33
Mean	57	65					
$LSD_{.05}$		12					
C.V. (%)	–	22					

[1]C P = Corn Products, Skippy Research and Quality Control Laboratory

OAES = Oklahoma Agricultural Experiment Station

Table 3. Results for Peanut Samples from Variety Tests near Perkins and Ft. Cobb, 1967.

Okla. P-No.	CLER									
	Perkins		Ft. Cobb		Oil		Iodine No.		O:L Ratio	
	OAES	CP	OAES	CP	Perkins	Ft. Cobb	Perkins	Ft. Cobb	Perkins	Ft. Cobb
2	63	60	83	47	49.8	51.4	100.3	100.9	1.20	1.13
6	64	47	79	57	50.6	50.5	100.2	101.6	1.06	1.20
74	67	56	87	52	50.6	50.6	100.5	102.5	1.14	1.16
112	67	58	84	54	51.1	51.6	100.9	103.0	1.16	1.12
Mean	65	56	83	53	50.5	51.0	100.5	102.0	1.14	1.15

Table 4. Characteristics of Certain Peanut Germ Plasm, 1966.

Okla. P-No.	*P-151*	*P-6*	*P-295*	*P-928*
Cultivar	*Krinkle*	*Starr*	*P.I. 295662*	*Early Runner*
Origin	*Mutant*	*Sp. x P.I.*	*Venezuela*	
Type	*Spanish*	*Spanish*	*Spanish*	*Runner*
gms/100 seed	*35*	*40*	*43*	*55*
Oil Content (%)	52.5	50.6	52.3	52.3
Fatty Acid Dist. (%):				
Palmitic	10.5	15.1	11.5	9.8
Stearic	1.5	2.4	2.0	0.9
Oleic	41.4	40.6	42.7	48.0
Linoleic	37.8	36.1	35.2	35.8
Eicosenoic	0.5	0.4	0.5	0.6
Arachidic	1.9	1.7	1.3	1.4
Behenic	3.5	2.4	3.9	2.0
Lignocernic	2.8	1.2	3.0	1.5
O:L Ratio	1.30	1.12	1.21	1.34

Table 5. Oil Content and Fatty Acid Distribution by Type.

	Spanish	*Valencia*	*Bunch*	*Runner*
No. Tests	52	13	14	11
Oil %	50.4	50.3	48.0	48.8
Palmitic %	15.6	12.9	12.7	11.2
Stearic %	2.4	2.4	2.1	1.6
Oleic %	40.4	39.7	46.0	47.7
Linoleic %	35.6	37.0	32.8	32.3
Eicosendic %	0.6	0.7	0.9	1.0
Arachidic %	1.6	2.0	1.4	1.6
Behenic %	2.4	2.9	2.3	2.5
Lignoceric %	1.3	2.8	2.1	2.1
O:L Ratio	1.13	1.07	1.40	1.48

Table 6. Good—and Poor—Flavored Peanuts.

		Roasted		*Butter*
Okla. P-No.	*P. I. No.*	*Mean CLER Score*[1]	*Mean Roast Score*[2]	*Mean Preference*[3]
606	268674	22.2	1.7	5.4
529	261988	48.3	1.7	4.2
Std.	Argentine	69.1	1.7	2.2
824	247375	60.8	1.6	3.2
678	268761	67.2	1.6	2.4
	$LSD_{.05}$	11.2	N.S.	1.0
	C.V.(%)	22.5	9.7	30.8

[1]Above 60 = good flavor

[2]1 = Good, 2 = Excellent, 3 = Under, 4 = Over

[3]Low value = High flavor preference

Evidently, there are many environmental factors that contribute to flavor.

Differences in the distribution and amount of moisture available during critical growth periods may cause the same variety to vary with respect to the flavor of roasted peanuts and peanut butter samples. The flavor of the roasted peanuts as measured by CLER scores was lowest for Starr, Argentine, Dixie Spanish and Spantex for the tests of non-irrigated plantings near Stratford and Ft. Cobb (Table 7). The rainfall was 4 to 6 inches less from May through October at Stratford and Ft. Cobb than for the other locations in 1965.

We can illustrate the influence of another type of environmental factor on flavor, dealing with peanuts from a boron-deficient soil (Table 8).

Peanut butter samples made for a standard a check and 4 fertilizer treatments from a boron-deficient soil (Teller f.s.l.) near McAlester, Oklahoma, were evaluated organoleptically (Table 8). The internal kernel damage ranged from 1.6 to 20.7 percent. The peanut plots receiving 20-80-80

and 40-80-40 had kernels averaging about 19 percent internal damage compared with 10.5 percent for the untreated check. Peanuts from the plots receiving 20-80-40 plus boron (0.8 lbs/A) or gypsum (1000 lbs/A) had 1.6 and 5.0 percent internal damage, respectively. The panel members rated the peanut butter samples made of peanuts from the boron-and gypsum-treated plots superior to the 0-0-0, 20-80-80 and 40-80-40 treated plots. This was the first indication in our laboratory that flavor was influenced by fertilizer treatments.

Effects of Curing Treatment

Dickens and Khalsa (1966) reported that peanuts cured iu inverted windrows appeared to receive less mechanical damage and possess higher quality than plants cured in a random-oriented windrow. Data were obtained from four tests during 1964 and 1965 at three locations in Oklahoma (Table 9). The mean yield, grade, seed size and preference rank of peanut butter made from samples cured in the inverted and random-oriented windrows did not differ significantly in the four tests.

Many workers have reported the detrimental effects of fast and high-temperature curing on milling and organoleptic qualities (Beasley and Dickens, 1963; Cecil, 1963; Dickens and Khalsa, 1966). Data obtained to illnstrate the influence that curing treatment may have on the flavor of the roasted peanuts are shown in Table 10.

Peanuts were cured in the windrow and under controlled conditions at 90, 105 and 120°F. both in 1964 and 1965. The most noticeable changes were the increased percentage of splits and flavor changes of the roasted peanuts associated with curing treatments. In 1964 the average CLER score for the 240 samples evaluated showed the 90 and 105°F. curing treatments received the best scores by panel members (Table 10). The windrow-cured treatment was next and the peanuts cured at 120°F. were rated last. In 1965 the flavor at the time the peanuts went into storage was best for the windrow-cured treatment. Flavor scores were less desirable as the curing temperature increased (Table 10). Conditions for windrow-curing were good in 1965 while in 1964 cloudy, rainy weather occurred while the peanuts were curing in the windrow.

This does not necessarily mean that we should avoid artificial curing. Other workers have shown that peanuts can be articially cured without impairing flavor. The problem results from inadequate curing facilities when needed, inadequate controls and high moisture content. With proper curing, we should see an improvement in the flavor of the peanuts that we eat and the quality of seed that we plant as well as a reduction in mold development.

Table 7. CLER Scores for Roasted Peanuts Grown in 1965, by variety.[1]

Location	*Starr*	*Argentine*	*Dixie Spanish*	*Spantex*
Perkins	73.6	76.4	78.0	73.8
Stratford	55.0	51.5	66.6	58.8
Ft. Cobb (Irrig.)	76.2	77.2	77.1	63.3
Ft. Cobb (Non-Irrig.)	52.1	66.7	63.1	59.3
Mangum	74.4	74.3	72.2	55.3
Mean	66.3	69.2	71.4	62.9

[1] High scores are desired for roasted peanuts.

Table 8. Mean Preference, Percentage of Peanut Butter, Peanut Fertilizer Study near McAlester, Oklahoma, 1965.

Peanut Butter Numbers	*Fertilizer Treatment lbs/A*	*Mean Pref. Rank*	*Kernel Damage (%)*	*% Peanut Butter*	*Gms/ 100 Seed*
	$N\text{-}P_2O_5\text{-}K_2O$				
88, 94	0-0-0	4.2	10.5	87.8	39.4
89, 95	20-80-80	4.3	19.0	84.4	40.5
91, 97	40-80-40	4.1	20.7	88.1	41.7
90, 96	20-80-40 + Boron 0.8	3.0	1.6	85.7	41.3
92, 98	20-80-40 +	3.3	5.0	88.4	40.0
93, 99	Standard	2.3	0.0	86.7	38.5

Table 9. Mean Yield, Grade, Seed Size and Organoleptic Data for Peanuts from Inverted and Random–Oriented Windrow, 1964-1965.

Orientation in Windrow	*Mean Yield*	*Total SMK*	*Other Kernels*	*GMS 100*	*Peanut Butter Pref. Rank*
	lbs/A	%	%		
Inverted	1694	68.8	5.0	37.7	3.2
Random	1815	68.4	5.2	38.2	3.2
LSD.05	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	11.6	2.3	13.1	3.0	1.5

Table 10. Flavor of Roasted Peanuts.

Curing Treatment	*Mean CLER Scores**	
	1964	*1965*
Windrow	51.8	64.6
90° F.	65.2	49.8
105° F.	51.7	36.7
120° F.	39.1	23.7

*100 - (5 x number scored 1) - (4 x number scored 2) - (3 x number scored 3) - (0 x number scored 4). 1 = Bad off flavor; 2 = Low level off flavor; 3 = Low level flavor; 4 = Good peanut flavor.

Peanut quality research at several laboratories shows that immaturity results in reduced quality for most end uses (Sharon, 1963; Holley and Young, 1963). The progress made in finding a simple, accurate test for maturity has been encouraging. Three varieties were classified into mature and immature groups on the basis of the pigmentation of the interior pericarp. The mature and immature kernels of each variety were processed into peanut butter by roasting, blanching, splitting, removing germs, picking, salting and grinding. The peanut butter samples were exposed to a panel to determine the odor, flavor and preference rank in relation to a known and coded standard (Table 11). The oil content and fatty acid distribution were determined by a former member of this research team, M. E. Mason.

Briefly, the results were:

(1) Odor did not differ markedly except that more of the small, immature peanut samples were rated inferior to the standard by the panel members.

(2) The flavor and preference rank was best (as indicated by the lower score) for the mature followed by the large immature and small immatures.

(3) The oil content of the mature kernels was 4.4 percent higher than that of the large immatures and 13.6 percent higher than that of the small immatures.

(4) Oleic showed a sharp decline and linoleic showed an increase with immaturity.

Pang (1967) used the Friedman two-way analysis of variance by ranks and the Wilcoxon matched-pairs signed-rank test for analyzing the scores and ranks to study the influence of maturity and time of harvest on peanut butter quality (Table 12 and Figure 1).

The results were as follows:

(1) Flavor scores and preference ranks were less desirable for immature large and small peanuts. Mature and intermediate peanuts generally did uot differ significantly.

(2) Flavor score was most favorable at 138-152 days after planting for Argentine variety, Perkins, 1965 (Fignre 1).

Young, Mason and Matlock (1967) showed a notable decrease in arginine as the peanut matures. Methods to standardize the procedure for determining maturity are being studied. They include:

(1) Quantitative analysis of arginine by the Sakaguchi reaction.

(2) A visible separation based on pericarp, seedcoat color and thickness, and size of seed.

Table II.—Summary of Organoleptic Evaluations and Mean Oil content Fatty Acid Distributions of Mature and Immature Argentine, Dixie Spanish and Starr Peanuts.

	Organoleptic								
	Superior to Standard		Equal to Standard		Inferior to Standard				
Classification	Odor	Flavor	Odor	Flavor	Odor	Flavor	Pref. Rank	% Peanut Butter	Gms/ 100 Seed
Mature	0	7	30	33	70	60	3.8	84.7	40.1
Immature [1]	0	0	40	0	60	100	5.6	80.9	21.5
Immature [2]	0	0	10	0	90	100	7.1	77.6	13.8

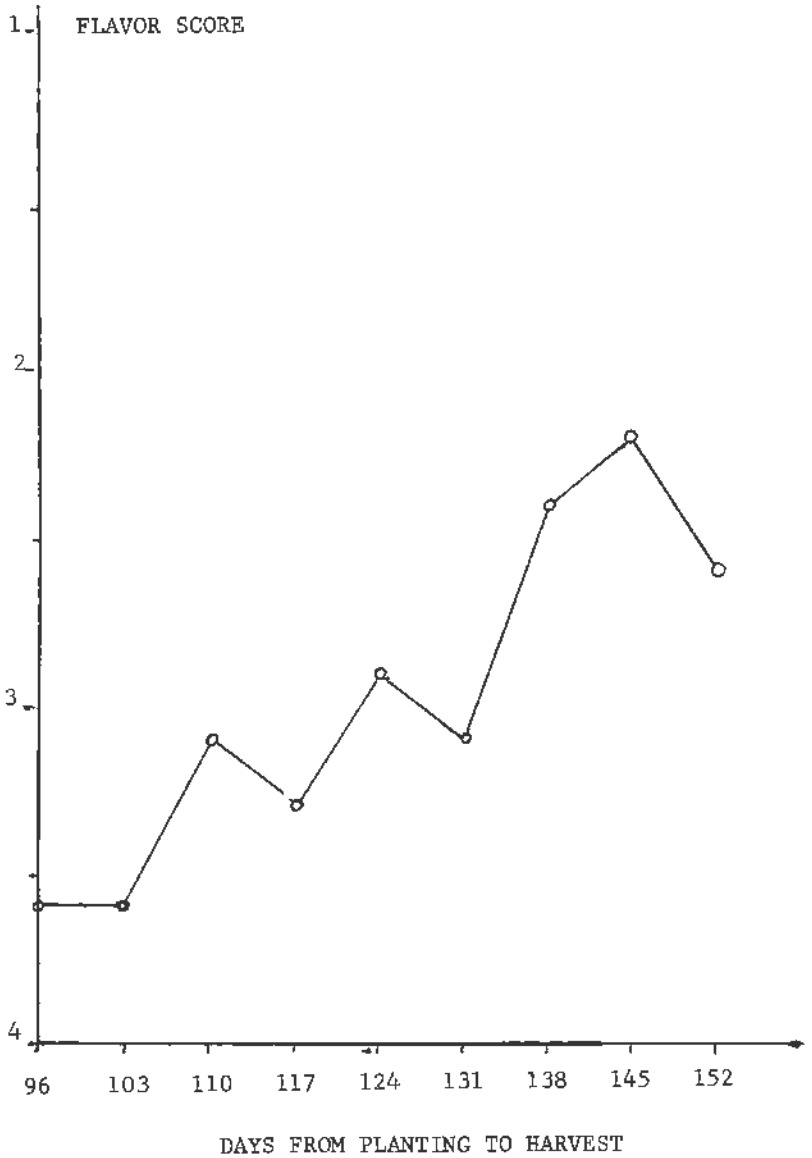

Figure 1. The Mean Flavor Scores of Peanut Butter for Nine Harvest Dates Averaged Over the Maturity Classes for Argentine Peanuts, Perkins, 1965.

Table 12. Flavor score and Preference Rank of Peanut Butter, 1965.

	Flavor Score		*Preference Rank*	
	Perkins	*Stratford*	*Perkins*	*Stratford*
Mature	2.09	2.73	2.26	3.37
Intermediate	2.79	2.65	3.06	3.55
Immature[1]	3.14	3.55	3.61	4.58
Immature[2]	3.86		4.62	
Std.	1.39	1.29	1.44	1.75
X^2r	56.2	22.4*	58.4*	26.4*

1 = Excellent; 2 = Good; 3 = Low; 4 = Off; 1 = Highest; 5 = Lowest.

[1]Held on 15/64 X 3/4 inch

[2]Through 15/64 X 3/4 inch

(3) A quantitative measure of a yellow pigment in the oil, that is found to be associated with immaturity.

(4) Determining of peptide content's relation to both maturity and flavor.

SUMMARY

The important objective of the peanut industry is to offer the customer peanuts in the form of peanut butter or in any form, even forms not yet thought of, to give him tasty, appealing, nutritious, and wholesome peanut products. The whole industry must make the peanut a more gratifying food for people to eat. It must smell good, look good, taste good and be good.

Today, shellers and end-users do not need to ask what varieties do you have, how, when and where these peanuts are harvested and cured or are they mature. Enough information is available for those who have sincere desires to improve the quality for a specific end use to say, "This is the X variety, it was dug with X amount of maturity, the peanuts were cured too fast or they were cured at high temperatures or vital dyes show these peanuts were frozen or exposed to severe mechanical injury at X stage of handling."

When we can repeatedly isolate factors and stages causing a particular off-flavor, we are in a more favorable position to eliminate those under our control.

VII

Operating An Effective Extension Peanut Program

J. Frank McGill[1]

Let me begin with the Georgia peanut crop value and its relationship to other crops in the state.

Since peanuts account for 23.4% of Georgia's crop income, it is logical that peanuts should receive heavy emphasis in the University of Georgia's research, teaching and Extension divisions – the 3-legged stool of the College of Agriculture.

Peanut research in Georgia (including state and federal) presently is done by 9.1 men in the following fields: agronomy, 3.0; engineering, 2.2; pathology, 2.1; entomology, 1.8.

The above listing does not include effort in food technology nor economic studies of peanuts.

By contrast, current Extension effort in Georgia on peanuts consists of work by 3.4 professional men, as follows:

Georgia's Crop Value – 1967

1. Peanuts	*$112 Million
2. Tobacco	99 Million
3. Corn	98 Million
4. Cotton	33 Million
5. Soybeans	32 Million

*23.4% of Georgia's crop income

[1]Extension Agronomist, Peanuts; Georgia Coastal Plain Experiment Station, Tifton, Ga.

	Discipline	*%Time Devoted To Peanuts*
J. Frank McGill	Agronomy	100%
L. E. Samples	Engineering	100%
James Miller	Agronomy - Weed Control	20%
John French	Entomology	50%
Sam Thompson	Pathology	50%
Harvey Lowery	Agronomy - Seed	20%

Of the 3.4 men listed above, 3.0 are located at the Coastal Plain Experiment Station at Tifton, Ga., in the heart of Georgia's 528,000 acres of peanuts. Better than 90% of this peanut acreage is located within a 100 mile radius of this station.

The County Agent is the key to the success or failure of our peanut program. Realizing this, we as subject matter specialists are primarily concerned with training the County Agent to give him the essential tools to provide local leadership for the Georgia Extension Peanut Program in each county in Georgia where peanuts are grown commercially. The Extension Specialist serves as the connecting link between research and the County Agent, and subsequently the 15,000 Georgia peanut growers -- our ultimate goal. It is mainly this link (the Extension Specialists) that I would like to center my remarks upon today.

The following statement is almost too elementary, yet in all of the many activities of an Extension program its importance may sometimes be taken for granted. It is simply this -- the forerunner of *any* effective Extension program is a dynamic and aggressive research program. The success of one depends in large measure on the other. If our Extension peanut program in Georgia has attained any degree of success up to this point, the aggressive research effort on peanuts is the "bedrock" of this success. The close-knit reciprocal working relationships that exists between Extension and researeh in Georgia can also be lifted up as an effective ingredient in our mutual effort to serve Georgia peanut growers.

In a nutshell, the role of the Extension Specialist is to "*weigh*" and make "*accurate*", *practical* application of new research findings. Having the facts, important as they are, is not enough. We must be an effective

communicator and salesman of practical ideas through the County Agents to Georgia peanut growers.

Grower Clinics

Each year during January, February, and March, subject matter specialists in Agronomy, Engineering, Pathology and Entomology assist County Agents with 38 county and area-wide grower clinics. Here the stage is set for the peanut crop year ahead. Average attendance has been 52 growers per clinic, or a total of 1976 growers. This represents more than 10% of the state's peanut growers. We have had little or no difficulty selling our peanut growers on sound information at these clinics. If the practice being recommended is backed up by good research information, 10% of the peanut growers will put it into practice. From there it's only a matter of time of short duration until the practice is in widespread use by Georgia peanut growers. Harvesting clinics, under the leadership of Extension Engineer L. E. Samples, are also held with County Agents in a similar fashion across the Georgia peanut belt, with particular emphasis on mechanization and peanut quality.

Bulletins and circulars serve as resource material in our Extension Peanut Program. They are revised every 3 years. Naturally, during this period, information relating to certain rapidly changing practices becomes obsolete. To bridge this "gap", judicious use is made of mimeographed peanut releases. These peanut releases contain the most complete and up-to-date information on specific practices relating to peanut production. County Agents have made excellent use of this tool by requesting additional copies to be placed among key leaders across each peanut county.

Very limited use is made of circular letters, due to their present over-use among County Agents. However, limited use is made of them to communicate with agents relative to belt-wide peanut problems, whereas the releases are used to disseminate most subject matter recommendations.

One of the most unique tools, and one which has received favorable comments from County Agents, is the information summary entitled "Peanut Pointers for 1968". This is developed for County Agents' use only and is made available on January 1 of each year. It contains any preliminary information, news of research underway and even some peanut philosophy. Agents have indicated this tool has served as an excellent guide to their county peanut program activities.

Field Tests

Demonstrations and field tests probably make up our most significant contribution to agents in the field. These tests may or may not be replicated.

Where replication is involved, our research counterparts generally take part in such tests at least to a limited extent. Assistance to County Agents in the field also consists of "trouble shooting" on problems which may range from chemical damage to seedling diseases to lightning damage. It is also the function of the Extension subject matter specialist to filter back any unusual field problems to the research counterpart. A recent example of such a problem is the presence of *Cylindricladium root rot* now definitely identified in 5 Georgia peanut counties.

Evaluation is an essential part of our peanut program. An annual survey is conducted among County Agents to determine what percentage of the growers is using certain recommended practices. This survey is summarized annually on a statewide basis and used as resource material by County Agents in their county peanut program planning boards.

In 1962, a special emphasis program, The Golden Peanut Program, was initiated in selected counties. Since then this program, which includes an intensified approach to peanut subject matter, making use of all mass media, has been conducted in all commercial peanut counties in Georgia. This year, 4 1-hour in-depth training sessions will be held in each of a group of selected counties. For these classes, County Agents will enlist a limited number of growers interested in studying peanut genetics and other basic principles of peanut production.

Since 1963, Extension Peanut Specialists in Georgia have provided county agents with "AA" service-ALWAYS AVAILABLE. This means day or night, in office or out of office. This has been made possible by the use of 2-way mobile ratio units that keep us in constant touch with the office. These units will receive messages within a 100 mile radius of headquarters and will send or receive within a 50 mile radius. More than 200 long distance calls have been relayed from headquarters to mobile units within the last 90 days.

Georgia peanut growers are becoming fewer and better informed large-scale business operators. The 1959 census listed 22,773 Georgia peanut growers, whereas by 1964 the total had dropped to 15,965. In the 1964 census 7,236 Georgia farmers were listed as having completed 1-4 years of college. A total was not available for the peanut area only.

The trend in research and Extension will be to answer an increasing demand for more specific information to solve specific problems – prescription treatments will take precedence over general recommendations. Both Extension and research will need to gear their programs to this trend if the challenge is to be met.

Change is sometimes slow and painful but this is the end produce of our efforts—a change that will bring about a better yield of higher-quality peanuts of the type and variety suitable for market demand.

Georgia growers have achieved a very impressive record of gains during recent years, as illustrated in yield figures listed below.

1962 - - - - - - 1130	1964- - - - - - 1670	1966 - - - - 1680
1963 1530	1965 1810	1967 . . . 2040

Nonetheless, there is still plenty of room for improvement, both in yield and quality.

Page Intentionally Blank

VIII

Variety Blends: A Consideration In Peanut Oil Improvement

A. J. Norden and D. H. Block[1]

ABSTRACT

An experiment was conducted to determine the feasibility of blending selected peanut varieties to produce oil of a specific chemical composition and to study the effect on yield and market value. Two peanut varieties (highly homozygous breeding lines) were grown alone and in a 1:1 blend at Gainesville, Florida in 1966. The varieties were similar in oil percentage, plant growth habit, and maturity, but differed in size of pods and seed, amount of the various unsaturated and saturated fatty acids, and yield potential.

Less than 2% variation was obtained in the oil content of the seed from the two varieties grown alone and in a blend. The unsaturation level of the oil from the blend (Iodine Value = 95), however, was significantly below that of the higher line (I.V. = 98) and significantly above that of the lower line (I.V. = 89). Similarly significant relationships were obtained for percentages of oleic and linoleic acid. The blend gave no advantage in yield when compared with the mean yield of the two varieties grown alone, but had 72% fancy pods and 35% extra large kernels compared with 54% and 31% for the smaller-seeded line, and 83% and 40% for the larger seeded line.

Insofar as chemical composition of peanut oil is concerned, it appears that selected lines or varieties may be blended at planting to render peanut oil with qualities desired for specific purposes. The results also indicate that blends could be used to obtain market acceptability of varieties that, because of certain physical characteristics, are marginal or unacceptable when grown alone. More information is needed relative to the physical problems involved in handling and processing blends before their value for commercial production is established.

INTRODUCTION

Manufacturers of peanut products have developed rigid chemical standards for the peanuts they utilize. Up to now they have been relatively safe in considering the peanut oil composition from the various market types as constant entities. Fore, *et al.* (1953) reported the average linoleic acid

[1]Associate Agronomist and Research Technologist respectively, Agronomy Department, University of Florida, Gainesville, Florida.

content of the oils of Spanish, Virginia, and Runner type peanuts to be 34.2, 29.6 and 22.0%, respectively. Jorand and Gillier (1964) differentiated the Virginia and Spanish types of peanut varieties into groups on the basis of their component fatty acids. A correlation exists between the linoleic acid content and the development of rancidity. Runner peanuts contain less linoleic acid and have a correspondingly higher order of stability. Crawford and Hilditch (1950) surveyed the range of variation in the component acids of peanut oils and found that linoleic acid content varied from 20% to 38% and that oleic acid content varied from 60% to 39%. They recommended that growers plant only varieties with low linoleic content when producing peanuts for oil.

The classifying of peanut varieties into types has resulted in some problems in recent years because peanut varieties derived from crosses between market types do not necessarily conform in chemical composition to the parental varieties. It is possible to obtain from a cross of Spanish x Virginia types, for example, a Virginia type variety that has oil with a chemical composition similar to that commonly found in Spanish peanuts. Such a line, although it may be superior in many ways, would not be acceptable to peanut-product manufacturers who expect a prescribed oil quality when they purchase Virginia type peanuts. One of the varieties used in this study (F416-2) is an example of this type of line.

Numerous experiments have been conducted comparing the yield of both cereal and non-cereal crop varieties grown alone and in various blends. The theoretical advantage of growing varietal blends is the fact that heterogeneity provides a broad adaptation base, and research has generally shown that the consistency of yield performance of pure line populations over years or in different environments was less stable than for blends. In the case of legumes, Allard (1961) reported this to be true for lima beans, Probst (1957) reported the same for soybeans, and Emery (1966) reported it for peanuts.

Shaalon, Heyne and Lofgren (1966) discuss a blend of two "pure lines" of winter wheat that has been successfully grown in Kansas under the name of Rodco. In this blend the two wheat lines complimented each other in a number of ways including the chemical characteristics of the gluten. No reports were found in the literature, however, on the use of varietal blends for oil improvement.

The objectives of this experiment were to study the effects of blending selected peanut varieties on oil quality and on the yield and market value of the peanuts.

EXPERIMENTAL MATERIALS AND PROCEDURE

The peanut varieties selected for this study were highly homozygous breeding lines that had been widely tested in Florida and in regional

experimental plantings. The variety designated in this paper as "A" is known experimentally as F 416-2 and vareity "B" has been tested under the number F 393-7. Both of these varieties are agronomically desirable and high-yielding. The varieties are similar in plant growth characteristics (both are alternate branching and prostrate), in maturity, and in oil content. The varieties complement each other in fatty acid composition of the oil and in the size of pods and seed. Variety "A" has pods and seed that are marginal in size between the designated market classes of Virginia and Runner types; and the oil has an iodine value of 98 to 100, which is higher than that normally found in Virginia peanuts. Variety "B" has larger pods and seeds that more adequately qualify for the premium prices paid for Virginia type peanuts: and the oil, in relation to that of other peanut varieties, is highly saturated with an iodine value of 86 to 89.

The crop was grown at Gainesville, Florida in accordance with Experiment Station recommendations. The experimental plots were replicated four times in a raudomized block design. The seed was hand-planted May 3, 1966 six inches apart in the row. For the 1:1 blend alternate seed of each variety was planted. The peanuts were irrigated to insure uniform emergence and excelleut stands were obtained in all plots. Rainfall was normal and at no time during the season was moisture stress evident.

Peanut yield samples consisting of the center row in each plot were dug by machine on September 1, 1966 and cured in stacks for six weeks prior to picking with a carding-type machine. Two samples from each replication were graded according to procedures of the U. S. Grading Service (1965). The value per net tou was computed on the basis of prices for peanuts established in August, 1966 by the Oils and Peanut Policy Staff, USDA Agricultural Stabilization and Conservation Service.

The oil content of the seed was determined by extraction with hexane, and fatty acid analyses were conducted following the procedure of Craig and Murty (1959). Iodine values were calculated directly from the fatty acid analyses, assuming complete esterification.

RESULTS AND DISCUSSION

Effect on Oil Quality

The mean effect of blending peanut varieties on composition of the oil is given in Table 1. Although the varieties differed by only 1½% in total oil content, they differed significantly in the composition of the oil. The oil of variety B was significautly more saturated, having an iodine value of 89, than the oil of variety A, with an iodine value of 98. The saturation level of the oil produced by the blend was intermediate, being significantly higher and significantly lower than that of the respective varieties grown alone.

Table 1. Effect of growing a blend of peanut varieties on the fatty acid composition of the oil. (Data represent the mean of 4 replications).

Measurement	*Variety* *A*	*A + B (1:1 blend)*	*B*	*Min. diff.*[1] *for sign. (.05 level)*
Percent Oil	50.9	49.9	49.4	N.S.
Iodine Value	98	95	89	2
Fatty Acids (%)				
Oleic	42.7	50.5	59.6	5.6
Linoleic	31.5	25.5	17.9	3.4
Palmitic	11.0	8.7	7.0	--
Stearic	2.9	2.9	3.6	--

[1]Minimum differences for significance were calculated by Duncan's (1955) method. (NS=not statistically significant;— = not analyzed statistically).

Oil composition is an important quality of peanuts. Peanut processors are aware of the fact that two varieties of peanuts may have the same amount of damage, minor defects and other official grade criteria, yet have markedly different properties when used in making peanut products. The major fatty acid components of peanut oil are mono-unsaturated oleic and di-unsaturated linoleic. Althongh the varieties in this study are both classified, botanically, as Virginia types, the fatty acid composition of variety A (43% oleic and 32% linoleic), more nearly resembles the composition of oil from commercial varieties of Spanish peanuts. The linoleic acid content in the blend was 6% lower than for variety A and 8% higher than for variety B. A similar significant but inverse relationship was obtained for the percentage of oleic acid.

The oil from variety A is prone to develop rancidity more rapidly than the oil from variety B or presumably from the blend. When oil samples were exposed to acclerated rancidity tests in 1963, variety A was rancid in 14 days, while variety B required 23 days to become rancid. Florigiant, by comparison, with an iodine value of 94, was rancid in 17 days.[2]

[2]R. B. French (unpublished 1963 data), Biochemist, Food Science Department, University of Florida.

Experimental evidence indicates that the fatty acid composition of the oil is determined largely by the genotype of the seed and to a much lesser degree by the environment. The results of this study indicate that, insofar as chemical composition of the oil is concerned, selected peanut lines or varieties may be blended to render peanut oil with qualities desired for specific purposes.

Effect on Yield and Grade Components

The mean effect of blending peanut varieties on yield, grade components, and on market value is given in Table 2. The blend gave no advantage in yield when compared with the mean yield of the two varieties

Table 2. Effect of blending peanut varieties on yield, grade components and market value. (Data represent the mean of 4 replications).

Measurement	*Variety* *A*	*A + B (1:1 blend)*	*B*	*Min. diff.*[1] *for sign. (.05 level)*
Yield, lbs./acre (SMK)	2192	2260	2530	273 lbs.
Grade Components:[2]				
Sound Mature Kernels (% SMK)	64	60	66	3%
Extra Large Kernels (% ELK)	31	35	40	3%
Other Kernels (%OK)	2.5	2.3	1.3	0.5%
Fancy Pods (%)	54	72	83	12%
Market value per acre (dollars)	391	408	455	50

[1]Minimum differences for significance were calculated by Duncan's (1955) method. Percentage of damaged seed and weight per seed were not statistically affected by blending.

[2] % ELK is the percentage of kernels riding on 20/64 by 1 inch screen; % OK is the percent of kernels not riding at 15/64 x 1 inch screen; % fancy pods is the percent of pods riding 34/64 inch spaced rollers.

grown alone. Variety B when grown alone produced more yield of sound, mature kernels than did variety A grown alone, and more than the blend. These yield results are not appreciably different from those reported by Patterson, et al. (1963) with oats, Shaalon, et al. (1966) with wheat, Probst (1967) with soybeans and Emery (1966) with peanuts.

To qualify for the market price for Virginia type peanuts, a minimum of 40% of the pods must ride rollers spaced 34/64 inch apart. Variety A, however, is marginal in this respect and sometimes fails to meet the minimum requirements for Virginia peanuts. A bonus factor in Virginia type peanuts is the premium paid for extra-large kernels. In these two aspects the blend with 72% fancy pods and 35% extra-large kernels is a significant improvement over variety A grown alone. The larger-podded variety B grown alone, however, had 83% fancy pods and 40% extra-large kernels. Emery's (1966) results showed that a blend of two peanut lines improved the market value of the peanuts in two out of three years. However, he concluded that the principal virtue of peanut blends is the stability over different seasons.

The usual physical disadvantages cited against blends, arising out of varietal differences in seed and plant characteristics and maturity, are to be expected in peanuts as well as in other crops. In addition, problems may be encountered in processing, such as obtaining uniformity in roasting and blanching. More information is needed relative to these factors for it to be possible to judge the value of variety blends for commercial peanut production.

LITERATURE CITED

ALLARD, R. W. 1961. Relationship between genetic diversity and consistency of performance in different environments. Crop Sci. 1:127-153.

Anonymous. 1965. Inspection instructions for farmers' stock peanuts. Fruit and Vegetable Div., Consumer & Marketing Service, U. S. Department of Agr., Washington, D. C.

CRAIG, B. M. and N. L. MURTY. 1959. Quantitative fatty acid analyses of vegetable oils by gas liquid chromotography. J. Am. Oil Chem. Soc. 36:549.

CRAWFORD, R. V. and T. P. HILDITCH. 1950. The component fatty acids and glycerides of groundnut oils. Jour. Sci. Food and Agric. 1:372-379.

DUNCAN, D. B. 1955. Multiple range and multiple F tests. Biometrics, 11:1-42.

FORE, S. P., N. J. MORRIS; C. H. MACK; A. F. FREEMAN; and W. G. BICKFORD; 1953. Factors affecting the stability of crude oils of 16 varieties of peanuts. J. Am. Oil Chem. Soc. 30:298-301.

JDRAND, J. et P. GILLIER. 1964. Quelques caracteristiques des types d' Arachides non cultivees. Oleagineux 19:231-236.

PATTERSON, F. L., J. S. SCHAFER, R. M. CALDWELL and L. E. COMPTON. 1963. Comparative standing ability and yield of variety blends of oats. Crop Sci. 3:558-560.

PROBST, A. H.; 1957. Performance of variety blends in soybeans. Agron. J. 49:148-150.

SHAALON, M. I., E. G. HEYNE, and J. R. LOFGREN. 1966. Mixtures of hard red winter wheat cultivars. Agron. J. 58:89-91.

IX

Effect of Inverting Peanuts on Kernel Temperature, Moisture Content and Losses[1]

G. E. Pearman and J. L. Butler[2]

Harvesting is, in many ways, the most critical operation in peanut production. With poor management or unfavorable conditions, quality can deteriorate and losses can occur to such an extent as to make production unprofitable. For the past several years, virtually all the peanuts in the Southeast have been dug with digger-shaker-windrowers. left in the windrow to dry and then harvested with combines. Due to the random nature of the conventional windrow, some of the nuts dry much more rapidly than others. Even when nuts are left in the windrow for as long as 7 days during good drying conditions, a wide range in moisture content exists.

During periods of inclement weather, the peanuts, especially those in contact with the soil, may mold. When poor weather conditions prevail, most of the peanuts will be harvested as soon as the weather clears. This results in a large quantity of high moisture peanuts being harvested during a short period. Commercial dryers may be overloaded to the extent that some peanuts may be held at buying points for as long as 3 days before dryer space is available. In addition to causing a general decrease in quality, this situation is very conducive to the production of aflatoxin, it is suspected. In view of this, the digging, windrowing and combining operations shonld result in a minimum of losses and the field-curing sequence should be that which provides the greatest enhancement to quality.

An experiment to determine the effect of windrowing methods on kernel temperatures. drying rate. digging and windrowing losses, peanut quality and aflatoxin development. was initiated in 1966 at Tifton, Georgia. This paper covers only the temperature. drying rate and loss aspects of the different treatments for 1967. These investigations are cooperative between the Agricultural Engineering Research Division and Market Quality Research Division, Agricultural Research Service, U. S. Department of Agriculture and the Georgia Coastal Plain Experiment Station.

[1]For presentation at and publication in Proceedings of Peanut Improvement Working Group Meeting, Norfolk, Virginia, July 15-16, 1968.

[2]Agricultural Engineers, Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture, University of Georgia, College of Agriculture Experiment Stations, Coastal Plain Station, Tifton, Georgia.

PROCEDURE

Three varieties of peanuts, Starr Spanish, Early Runner and Florigiant (Virginia-type).,were each planted on two different dates, four weeks apart, to provide different harvesting dates and weather conditions. These peanuts were produced by a local farmer, using recommended practices, so that healthy plants were maintained until digging time.

Each variety and planting was randomized for digging and windrowing with (1) an experimental inverter (I_e), (2) a commercial prototype inverter (I_c) and (3) random or conventional (C) windrow treatments. The randomization also included windrow exposure times of 0, 3, and 7 days prior to combining.

The experimental digger-shaker-inverter used chains to grip the peanut vines and carry them across an inverting pan. The commercial prototype digger-shaker-inverter used a horizontal turntable to invert the vines. A conventional digger-shaker-windrower was employed to form the conventional windrow.

The two inverters left the peanuts in slightly different positions in the windrow. The experimental inverter left most of the peanuts projecting above the vine mass, whereas the commercial prototype inverter left most of the peanuts on top or slightly down in the vines. Both, however, left a majority of the peanuts well above the soil surface. The experimental inverter left a more uniform windrow with a higher percentage of the nuts in a truly inverted position. The commercial prototype inverter had a tendency to cause clumping within the windrow and to cover some of the nuts with vines. This difference can probably be attributed to the point at which inverting occurs. The experimental machine completes all shaking before inverting, whereas the commercial prototype inverter has some shaking action after the vines have been inverted on the turntable. Thus, there is a tendency for the peanuts to be shaken down among the vines.

In each of the windrow treatments, 30-gage thermocouples were inserted into the center of the basal nut. In the random windrows, three different categories of peanuts were selected for temperature measurements. They were: (1) peanuts exposed to the sun and in contact with the ground; (2) peanuts shaded by the vine mass; and, (3) peanuts exposed to the sunlight and off the ground. In both the inverted windrows, thermocouples were inserted only in exposed or inverted peanuts. Two replications of kernel temperature data were recorded for each treatment.

In addition to kernel temperatures, air temperature within the windrow, soil temperature (just below the surface), and air and black globe

temperatures 6, 18, 30 and 42 inches above the soil surface were taken at 30-minute intervals during the field curing.

Hand-picked moisture samples, approximately 500 grams each, were taken immediately after digging. Each morning during the exposure period, subsequent samples were hand-picked from each (exposed, shaded, and exposed and in contact with the ground) of the 3 locations in the random windrow and from the inverted windrows.

Digging losses were determined by sifting the soil taken from a 6 x 7.26 foot area (1/1,000 A.) in each replication to salvage peanuts left in the soil. These were dried and the weight adjusted to a 7-percent moisture content basis for expressing digging losses.

RESULTS AND DISCUSSION

Effect of Windrow Position on Drying Rate

Figures 1-4 show the effect of windrow exposure time, soil moisture and position within the windrow on the moisture content of peanut pods (kernel and hull). The exposed peanuts from the random windrow and the two inverted windrows have been averaged to give only one curve for both inverted and exposed. Soil moisture and rainfall data have also been included on the curves. These results are from hand-picked, 500-gram moisture samples.

The first planting of Starr Spanish (Figure 1) was harvested on August 18. The average soil moisture was 1.5 percent and very good drying conditions prevailed for the first two days. During this period, both the inverted peanuts and those in contact with the ground and exposed to the sun dried at a more rapid rate than did the peanuts shaded by the vines. All pods increased in moisture content after 0.90 inch of rain on the afternoon of the second day. The inverted peanuts apparently absorbed more moisture, but dried the fastest after the weather cleared up.

The second planting of Early Runners (Figure 2) was harvested on September 18 with dry soil conditions and extremely good drying weather. Under these conditions, there was practically no difference in drying rate for the first five days. For both 6 and 7 days exposure, both the ground and shaded kernels reached lower moisture levels than did any of the inverted windrows. This was probably due to close contact of hot, dry soil with the pods, whereas the inverted pods were held up off the soil by the vines.

The first planting of Florigiants (Figure 3) was harvested on September 6, four days after 0.43 inch and two days after 0.80 inch of rain which delayed the harvest beyond the judged maturity date. This delay and rain

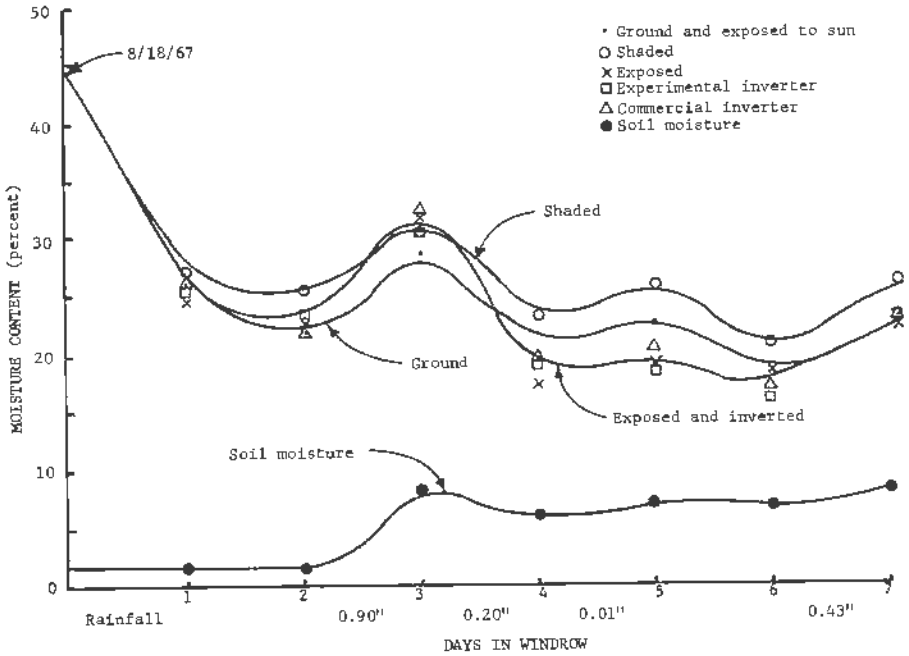

Figure 1. Effect of windrow position on moisture content of Starr Spanish. Poor drying conditions.

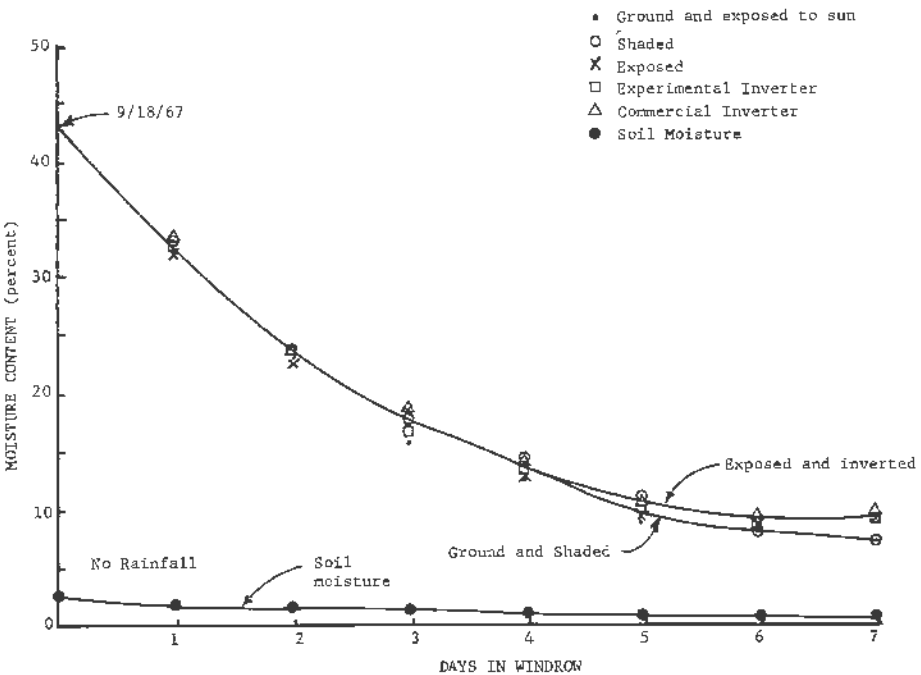

Figure 2. Effect of windrow position on moisture content of Early Runner. Good drying conditions.

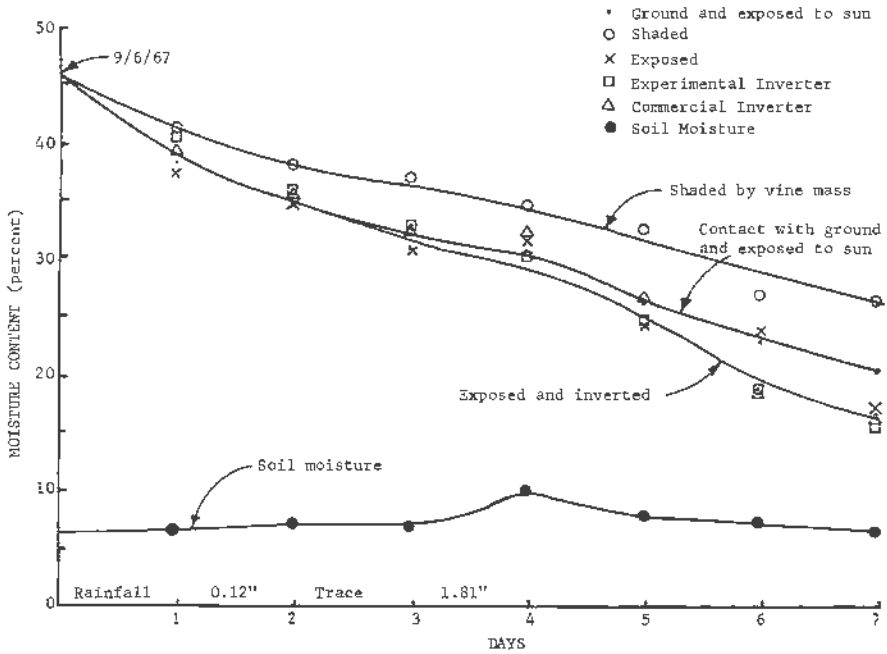

Figure 3. Florigiant drying rates as affected by windrow type and peanut position. Poor drying conditions.

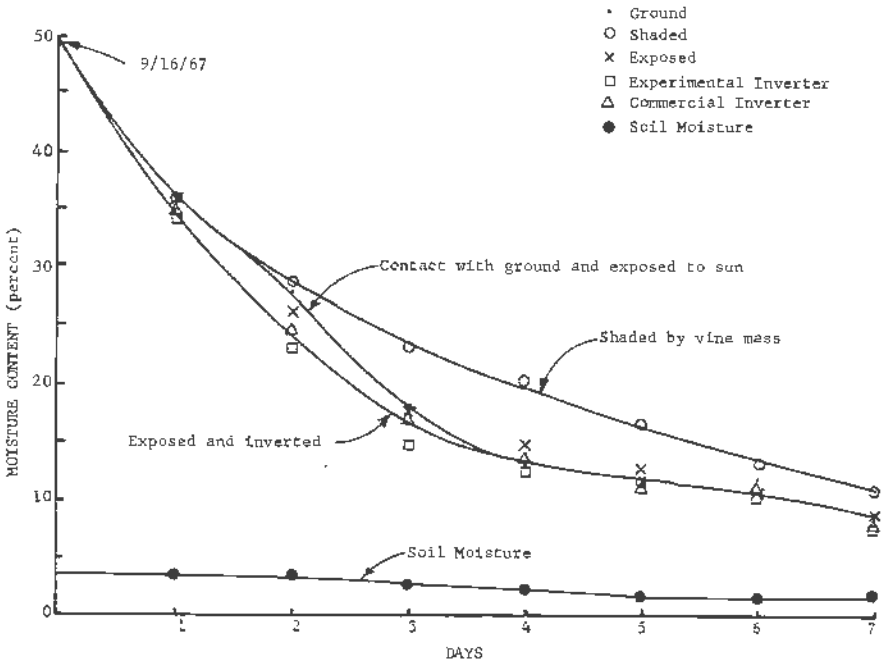

Figure 4. Florigiant drying rates as affected by windrow type and peanut position. Good drying conditions.

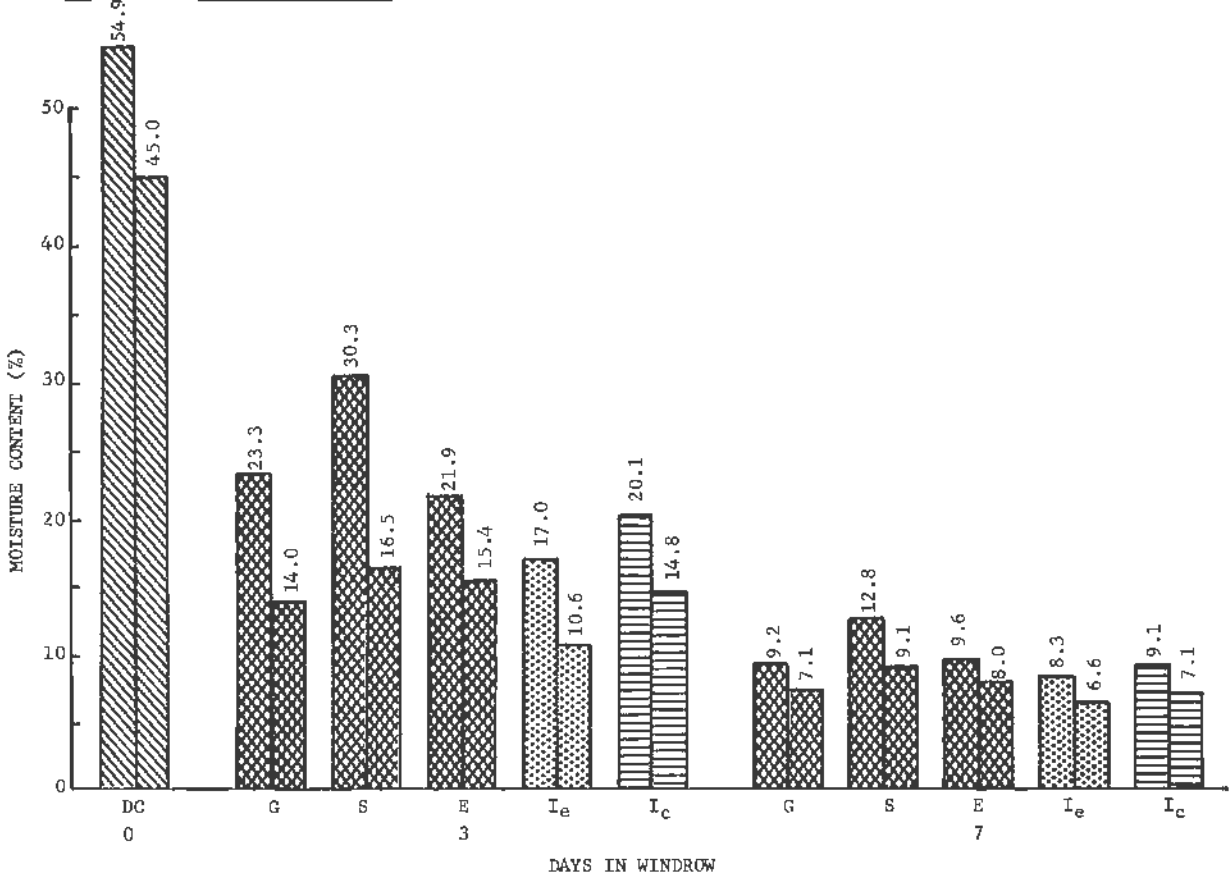

Figure 5. Range in moisture content for various windrow positions, Florigiant, 9/16/67.

resulted in high soil moisture and very poor digging conditions. All peanuts dried at a slow rate due to 0.12 inch, a trace, and 1.81 inches of rain on the first, second and third days of exposure. After the rain stopped and the weather cleared, the inverted peanuts dried at a much faster rate than did either the shaded peanuts or those in contact with the ground and exposed to the sun. This was probably due to the wet soil conditions.

On September 16, the second planting of Florigiants (Figure 4) was harvested. The inverted peanuts dried faster initially but as the soil began to dry, the peanuts in contact with the soil caught up with them. At all times, both the inverted peanuts and those in contact with the ground and exposed to the sun were drier than those shaded.

Effect of Windrow Position on Range in Moisture Content

To evaluate the uniformity of drying within the three windrow types, the lowest and highest 500-gram, hand-picked moisture samples from the various positions were plotted in Figure 5. In general, the range in moisture content increased with exposure time for the random windrow, whereas it generally decreased for both the experimental inverter and the commercial prototype machine. The actual moisture content of the extreme samples is given above each bar graph. The range was usually higher for the peanuts which were rained on while in the windrow than for those which had excellent drying conditions. The Florigiants shown in Figure 6 had excellent drying conditions but there is considerably more variation in the moisture content within the random windrow than for either of the inverted windrows.

Effect of Windrow Type on Combine Moisture Content

The results of moisture samples taken from the combine are given in Table 1. There is considerable variation in moisture content among harvest periods due to the various weather and soil conditions which are given in the table. Due to the inclusion of vines and other foreign material, these vary slightly from the hand-picked sample.

The first harvest of Starr Spanish had several days of rain and very poor drying conditions. On both the 3- and 7-day combining, each of the inverted windrows was drier than the conventional or random windrow. The experimental inverter showed 3.9 and 4.1 percentage points less moisture after 3 and 7 days of exposure than did the commercial prototype inverter.

The second harvest of Starr Spanish, which had rain at digging time followed by clear weather, exhibited the same trends as the first harvest. Due to the clear weather, the difference was not as great as for the early harvest.

Table 1.—Effect of Windrow Type on Peanut Moisture Context.

Date	Peanut Type	Soil Moist	0 Day	Windrow Exposure Time (days) 3-Day C	3-Day Ie	3-Day Ic	7-Day C	7-Day Ie	7-Day Ic	Weather Conditions* Days of Windrow Exposure —2	—1	0	1	2	3	4	5	6	7
1967		%	%	%	%	%	%	%	%										
8/18	Sp.	2.0	44.1	31.7	24.7	28.6	27.4	16.8	20.9	.....	CLEAR		.....	.90	.20	.01	.....	.43	.....
9/8	Sp.	5.2	45.4	35.5	29.0	31.4	17.9	13.8	14.8	.....	.12	T	1.81	.....	.....	CLEAR		.....	.....
8/24	Ru.	7.3	44.8	30.7	22.9	24.2	17.5	9.2	11.1	.....	.43	.....	.....	.....	CLEAR			.....	.....
9/18	Ru.	2.5	42.9	16.4	15.6	15.2	6.9	7.0	7.5	.....	.....	.....	HOT AND DRY					.....	.....
9/6	Va.	6.5	45.4	34.8	34.6	33.0	20.7	16.3	19.1	.80	.....	.....	.12	T	1.81	.....	CLEAR		.....
9/16	Va.	3.5	49.2	20.6	15.8	17.2	8.6	7.6	8.8	.....	.....	.....	HOT AND DRY				.....	.....	.....
Average			45.3	28.3	23.8	24.9	16.5	11.8	13.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

C = conventional digger-shaker-windrower
Ie = experimental inverter
Ic = commercial prototype inverter

* Digits in table denote rainfall in inches.

The first harvest of Early Runner was dug one day after 0.43 inch of rain. This resulted in a wide range of moisture between the inverted and random windrow even though the weather was clear during the seven days exposure period. The soil moisture was very high, which resulted in the slow drying rate of the random windrow.

The second harvest of Early Runner was dug under extremely dry soil conditions. Clear, hot weather existed throughout the windrow exposure period. These conditions resulted in all three windrow types' drying at a very fast rate. After 7 days, the random windrow was slightly drier than either of the inverted rows. With some of the pods in contact with the hot, dry soil, it can be assumed that some reached a much lower moisture content.

The first harvest of Florigiants was exposed to considerable rainfall, wet soil, and cloudy weather conditions during the first three days of windrow exposure. This resulted in a slow drying rate for all three types of windrows. After 7 days, both inverted windrows were drier than the random windrow, with those formed by the experimental inverter being 2.8 percentage points drier than those of the commercial prototype inverter.

The second harvest of Florigiants was made during dry and hot weather conditions which existed throughout the 7 days of exposure. The inverted rows dried faster initially but after 7 days all had approximately the same moisture content.

When averaged across varieties, harvest dates and weather conditions, the experimental inverter and prototype inverter windrows had 4.5 and 3.4 percentage points less moisture than the random windrows after 3 days of exposure. After 7 days of exposure, these had 4.7 and 2.8 percentage points less moisture than the random windrow.

Kernel Temperatures

Figure 6 shows the average hourly temperatures reached by the late harvest of Florigiants at different positions during 7 days of exposure. Peak temperatures were reached between 2 and 3 PM EDT. For the shaded and exposed or inverted peanuts, peak temperatures of 94 and 106° F respectively were measured. The highest kernel temperature, 119° F, was recorded in peanuts exposed to the sun and in contact with the ground. Corresponding soil surface temperature and black globe temperature (6 inches above soil) were 122° F and 117° F, respectively. The weather conditions for this 7-day period were hot and dry with no rainfall.

The results from the temperature data show that of all peanuts, those in the shaded position always had lower peak temperatures; but these were also

Table 2.—Percent Losses as Affected by Variety and Exposure Time.

Date 1967	Peanut Type	Gross Yield #/Ar.	Soil Moisture %	Digging Losses %	Post Digging Losses 0-Day %	3-Day %	7-Day %
8/18	Spanish	3722	2.0	1.8	5.7	5.0	2.6
9/8	Spanish	2954	5.2	2.3	7.5	5.8	4.5
Average		3338	3.6	2.0	6.6	5.4	3.5
8/24	Runner	4612	7.3	8.1	4.2	6.3	4.1
Average for all							
9/18	Runner	3603	2.5	3.2	6.2	5.6	8.2
Average		4107	4.9	5.6	5.2	6.0	6.2
9/6	Virginia	5514	6.5	18.0	14.0	10.0	11.0
9/16	Virginia	4910	3.5	8.8	9.2	6.4	12.4
Average		5212	5.0	13.4	11.6	8.2	11.7
Average for all peannt types		4219	4.5	7.0	7.8	6.5	7.1

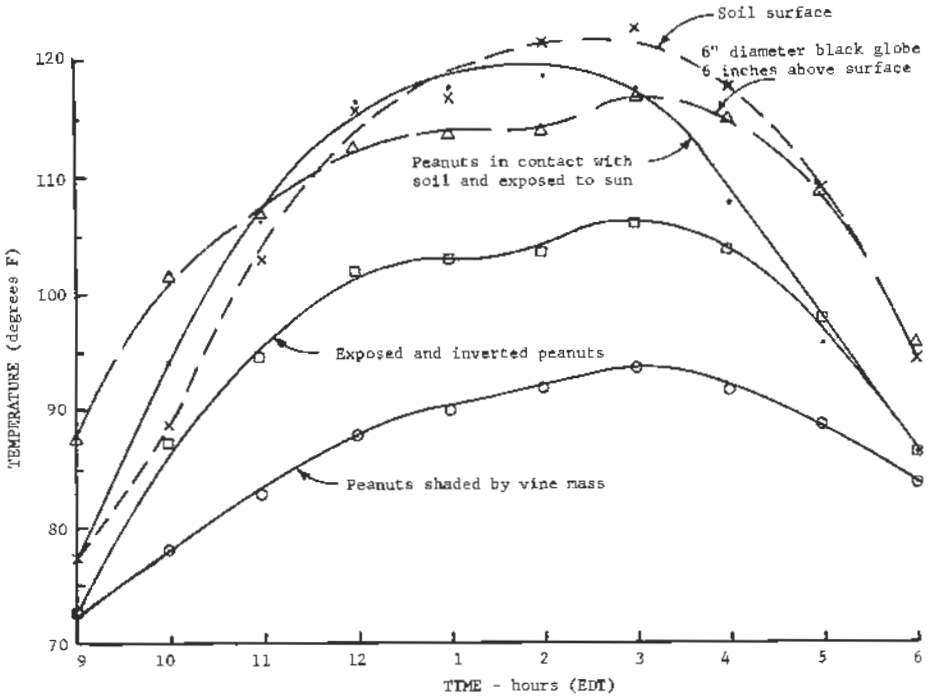

Figure 6. Kernel, soil and black globe temperatures observed during 7 days exposure of windrowed Florigiant peanuts (9/16/67). Good drying conditions.

in the poorest drying position during wet and rainy weather. The inverted peanuts had the fastest drying rate under most conditions and did not reach the extreme temperatures that some in the random windrow did.

Effect of Windrowing Method on Losses

Table 2 shows the effect of variety and exposure time on both digging and post-digging losses. The digging losses showed a large increase with an increase in soil moisture for all varieties. The Runner- and Virginia-type peanuts, which have large pods and generally longer pegs than the Spanish-type, appear to be more affected by soil moisture.

For the conditions in these harvests, the losses appear to decrease with increased exposure time for the Spanish. Conversely, losses of Runner peanuts increased with increased exposure time. The lowest losses with the Florigiants came after 3 days exposure in the windrow. The relationship between vine and pod moisture content is probably the controlling factor in the losses for all varieties. The short, tough pegs of the Spanish-type resulted in less loss from shattering when the windrowed peanuts were being combined.

Table 3.—Percent Total Losses as Affected by Variety, Type of Windrow, and Days Exposure

Date	Peanut Type	Window Exposure								
		0 Days			3 Days			7 Days		
		C	Ie	Ic	C	Ie	Ic	C	Ie	Ic
1967		%	%	%	%	%	%	%	%	%
8/18	Spanish	7.0	6.7	8.7	6.6	5.1	8.6	5.6	3.2	4.3
9/8	Spanish	9.5	10.1	9.7	6.9	7.7	9.6	5.7	7.4	7.3
Average		8.3	8.4	9.2	6.8	6.4	9.1	5.2	5.3	5.8
8/24	Runner	12.7	9.4	16.0	16.6	12.4	15.3	13.3	10.2	13.3
9/18	Runner	8.7	11.3	8.4	12.0	11.0	8.3	9.9	13.4	11.1
Average		10.7	10.4	11.7	26.2	31.7	11.8	11.6	11.8	12.2
9/6	Virginia	29.9	29.4	36.8	26.0	26.2	31.7	26.2	28.9	32.0
9/16	Virginia	15.9	19.3	18.9	13.0	14.5	18.0	18.4	20.7	24.5
Average		22.9	24.4	27.8	19.5	20.4	24.8	22.3	24.8	28.2

Table 2 gives losses as affected by exposure time, weather condition and peanut type. The total losses, both digging and post-digging, are given in Table 3. Averaging across exposure times and harvest conditions showed total losses to be 7.1, 11.5 and 23.9 percent for the Spanish-, Runner- and Virginia-type, respectively. The key factors in digging are the soil, vine and pod moisture contents.

The experimental digger-shaker-inverter had the lowest losses in the soil. However, its above ground losses were more than those from the conventional digger-shaker. This was probably due to the gentle lifting action of the chain-type experimental inverter which lifted the weaker pegs out of the soil. The losses from the commercial prototype were approximately the same as those from the conventional digger-shaker. These machines employ the same principle for lifting the vines from the soil. The commercial prototype inverter had the highest post-digging losses.

SUMMARY

Inverting the windrow has very little effect on the drying rate of peanuts during periods of good drying conditions. With poor drying weather and wet soil conditions, the inverted windrow dries at a much faster rate. Under these conditions, the inverted windrow showed as much as 10 percentage points lower moisture content after 7 days of windrow exposnre. Regardless of weather conditions, the inverted windrows had a much more uniform moisture content. Hot weather and dry soil conditions may result in the random or conventional windrow's drying at a slightly faster rate than an inverted windrow. Under these conditions, kernels in contact with the soil and exposed to the sun reached temperatures greater than 130° F. At the same time, the kernels in the inverted windrow reached 105° F while the kernels shaded by thc windrow were near the ambient temperature of 90°F.

Taste panel evaluation showed no apparent difference in peanut flavor between nuts from the inverted and random windrows.

There were uo significant differences in digging loss due to the type of digging and windrowing equipment. Losses were affected considerably by the soil moisture and peanut type. The Runner- and Virginia-type, which have large pods, have higher digging losses than the smaller pod Spanish-type. The Virginia-type had the highest losses. These higher losses are probably due to the long peg, which is more susceptible to breaking than a shorter peg.

It appears that the most desirable digging machine is one which will gently lift the vines, remove the excess soil, invert the highest percentage of the nuts, and leave them in a uniform windrow, supported as high off the ground, by the vine mass, as possible.

Page Intentionally Blank

X

The Nature and Source of Peanut Harvesting Loss

Richard W. Whitney and Jay G. Porterfield[1]

Peanut harvesting loss may occur in each of 3 common harvesting operations: digging, shaking, and combining. Measurements taken in North Carolina revealed digging losses of from 6 to 15%.[1] According to an ARS study on peanut harvesting effieiency, as much as 40% of the peanut crop may be left beneath the soil surface by the digger.[2] Losses attributed to combining have been reported as low as 3.9% and as high as 56% depending upon weather conditions. Although estimates have been made regarding the amount of loss, a need exists to determine more substantiated loss values for Oklahoma, as well as to define the sources and nature of the loss. This report deals with research directed at determining the quantity, quality, and sources of peanut harvesting loss.

Twenty farms in Caddo County, Oklahoma, were sampled for peanut harvesting losses during the harvesting season of 1967. Farms were selected on the basis of farmer interest and location in Caddo County, a major peanut-producing area of Oklahoma. All samples were from irrigated production and all but one were of the Starr variety.

Peanut harvesting loss was divided into 3 categories; digging, shaking, and combining. Digging loss was defined as all salable peanuts left beneath the soil surface after digging. Shaking loss was characterized as all peanuts lying on the soil surface following all shaking operations. Combine loss was the additional amount of peanuts found on the soil surface after combining. No attempt was made to evaluate losses caused by rodents or crows.

Three plot locations on each farm were selected and staked at digging time. After the final shaking operation, approximately 4 feet of the windrow at each plot location was moved back to permit sampling of the digging and shaking loss. An adjustable sampling frame was used to define the plot areas. The frame was 3 feet wide and one end adjustable to permit sampling various row spacings.

The shaking loss was collected from the soil surface within the frame first. Digging loss was sampled by removing the upper 4 to 6 inches of soil from within the frame perimeter and sifting it through the apparatus shown

[1]Respectively, Instructor, Professor, Agricultural Engineering Department, Oklahoma State University, Stillwater, Oklahoma 74074.

in Figure 1. The sifter consisted of a cylinder of flattened expanded metal fitted with sheet metal ends. A hinged portion of one end provided an opening for filling. The sifter was operated by a hand crank fastened to a shaft passing transversely through the cylinder (Figure 2). Most of the soil was satisfactorily removed from the peanuts with this device. Combine loss was determined by subtracting the average unit field shaking loss from the total unit loss found on the ground after combining.

Laboratory Procedure

All samples were counted and weighed in the field and returned to the laboratory. They were oven-dried at 185° F. for 30 hours and the composite moisture content (W.B.) of the shells and kernels was determined. The peanuts were then hand-shelled and graded for size. All kernels retained on a 15/64" round-holed sieve were identified as sound mature kernels. The mature kernel weights were adjusted for moisture content (W.B.) and the losses expressed in pounds per acre of mature kernels at this moisture content.

Digging loss constituted approximately 3% of the total average yield, or about 107 pounds per acre of in-shell stock at 7% moisture content (E.B.) (Table 1). These were peanuts which were not brought to the surface by the digger because of its failure to cut the tap root or because of the pegs' breaking. Sixty percent of the kernels in the digging loss were mature. The composite moisture content averaged 51.8% and the average dry kernel weight was 0.336 grams. The digging loss represented approximately 37% of all peanut harvesting losses.

Shaking loss averaged 2.4% of the average total yield, equal to about 85 pounds of in-shell peanuts at 7% moisture content (W.B.). Results indicated that 56% of the total shaking loss occurred the first time over the crop. The proportion of mature kernels found in the shaking loss averaged 62.4%, the composite moisture content (W.B.) was 50.1%, and the average dried kernel weighed 0.334 grams. The shaking loss represented approximately 30% of all peanut harvesting losses.

Combine loss made up the remaining 23% of the total peanut harvesting loss. Approximately 96 pounds of in-shell peanuts at 7% moisture content (W.B.) were lost per acre. This was 2.7% of the average total yield. The composite moisture content (W.B.) of this loss averaged 26.1%. Sixty-three percent of the kernels were mature. The mature kernels averaged 0.354 grams in dried weight.

Losses from 3 makes of combines and 4 makes of diggers were sampled during the tests. The combines were all very similar but 2 distinctly different

Figure 1. Sampling peanut digging loss.

Figure 2. Separating digging loss from soil, debris.

types of diggers were encountered. These were inverting diggers which leave the plants inverted in the windrow with the pods exposed to the sun, and non-inverting diggers which leave the plants in a random fashion in the windrow. Although no attempt was made to rate each machine, and no such rating was intended in this paper, data were analyzed to provide comparative values for the 2 different types of diggers. Loss data were analyzed for comparisons of % of total yield loss, % of mature kernels in the loss, composite moisture content, and mature kernel dried weight. Table 2 shows the relative values for each attribute.

Table I.—Comparison of Quantity and Quality Parameters for Digging, Shaking, and Combine Losses.

	Percent Total Yield	Equivalent Pounds of Farmer Stock at 7% M.C. (W.B.)	Percent of Total Harvesting Loss	Kernel Dry Weight Grams	Composite Moisture Content (W. B.)	Percent Mature Kernels
Digging	3.0	107.0	37.0	0.336	51.8	60.0
Shaking	2.4	85.0	30.0	0.334	50.1	62.4
Combining	2.7	96.0	23.0	0.354	26.1*	63.0

* Statistically different from the other two means at the .05 level.

Table 2. Inverting and Non-Inverting Diggers Compared in Four Attributes for Shaking Loss and Digging Loss

	Percent Total Yield Lost	*Composite Moisture Content (W. B.)*	*Percent Mature Kernels*	*Kernel Dry Weight Grams*
		(Average Digging Loss)		
Inverting	1.31	54.0	53.2	0.291
Non-Inverting	3.69	50.7	64.5	0.357
		(Average Shaking Loss)		
Inverting	0.64	59.3	54.6	0.286
Non-Inverting	3.08	46.5	66.7	0.355

Generally, the group of inverting diggers caused less loss than did the non-inverting. The differences are statistically significant only for the shaking losses but are consistent for both digging and shaking.

A larger percentage of mature kernels was found among the losses of the inverting diggers. The inverting digger losses were also higher in composite moisture content and lower in mature kernel dried weight.

Combine loss was about the same for both types of diggers. Non-inverting had an average of 2.6% loss (based on total yield); the inverting diggers had 3.0%. On the average, inverted peanuts were combined at about 8% less moisture content than non-inverted peanuts. Composite moisture content of the combine loss for inverting diggers averaged 20.4% (W.B.), for non-inverting diggers 28.6%.

Findings from this study support the following conclusions:

1. Peanut harvesting losses occurred during each operation. Approximately 3.0% of the total yield was lost while digging, 2.4% while shaking, and 2.7% while combining.
2. When two shaking treatments were used, approximately 56% of the total shaking loss occurred during the first treatment.
3. Losses caused by inverting diggers averaged less as a percent of the total yield, had fewer mature kernels, were higher in moisture

content, and had less average kernel dry weight than losses from non-inverting diggers. Losses sustained at combining time were about the same for both types.

4. Peanuts dug with inverting diggers were combined at an average of 20.4% moisture (W.B.) compared with 28.6% moisture (W.B.) for those dug with non-inverting equipment.

Literature Cited

[1]MILLS, W. T. and DICKENS, J. W., "Peanuts; Harvesting and Curing the Windrow Way," N. C. Agricultural Experiment Station Bulletin 405:1-19, 1958.

[2]BUTLER, JAMES L. and SAMPLES, LAWTON E., "Dig Peanuts for Profit," PEANUT FARMER, June, 1966.

XI

Developmental Changes in Peanut Lipid Fatty Acids[1,2]

R. E. Worthington[3]

A number of oil seed crops have been investigated in recent years to determine the changes in lipid composition associated with seed development. Included among those species studied are soybean (10), sunflower (2), rape (5), crambe (5), and castor (1,3). Although these investigations appear to have been motivated primarily by an interest in the metabolic processes associated with seed lipid biogenesis, the information obtained is also of practical interest due to the effect of oil composition on oil qnality. It is recognized that the characteristics of a seed oil are influenced by the relative proportions of the various lipid classes within the oil, by the arrangement of fatty acids within the molecules (8), and by the properties of the individual fatty acids.

In those species studied, both the relative amount of each class of lipid and the fatty acid composition within each class of lipid has been observed to change during seed development. The rates of changes in both amount and composition of lipid appear to be most rapid during the early stages of seed development.

In a study of the composition of developing peanut seed, Pickett (7) reported a crude fat content of 17% (dry weight basis) at about 2½ weeks after soil penetration by the gynophore. This value increased to 51.5% at 9 weeks. In a later study Schenk (9) reported values of 29% and 48% at 3 weeks and 10 weeks after soil penetration by the gynophore. The values reported by Pickett and Schenk were obtained with the Virginia Bunch 67 variety of peanuts.

In the present study we have determined the following; the contribution made by pericarp, testa, cotyledon, and embryonic axis to the fruit dry weight at 4 stages of development, the crude lipid content of each tissue type at 4 stages of development, the fatty acid compoistion of crude

[1]Approved as Journal Series Paper No.319, University of Georgia College of Agriculture Experiment Stations, Georgia Station, Experiment, Georgia 30212.

[2]This research was supported in part by the Corn Products Company.

[3]Assistant Professor, Department of Chemistry and Human Nutrition, University of Georgia, College of Agricultural Experiment Stations, Experiment, Ga. 30212.

lipids from testa, cotyledon, and embryonic axis, and the fatty acid composition of cotyledon and embryonic axis triglycerides.

MATERIALS AND METHODS

The peanuts used in this study were of the Virginia Bunch 67 variety and were grown in field plots at Experiment, Georgia during 1965 and 1966. The fruits were harvested, separated into 4 approximate age groups based on the descriptions given by Schenk (9), and were segmented into pericarp, testa, cotyledon, and embryonic axis. The age groups selected for study were 2-3 weeks, 4-5 weeks, 6-8 weeks, and 11-12 weeks (mature) following soil penetration by gynophore.

Tissue Weights

Peanuts representing each of four stages of development were segmented and dried for 24 hours at 95° C. The dry weight values were used in determining the contribution of each tissue to the total dry weight of the fruit at each stage of development.

Percent Crude Lipid

Freshly harvested and segmented tissues were freeze-dried for several hours and stored in a desiccator over magnesium perchlorate at 5° C for a period of several weeks. The dry tissues were weighed and extracted repeatedly with a 2:1 mixture of chloroform-methanol in a Waring blendor. The combined extract from each sample was evaporated under vacnnm and the lipid residue weighed.

Fatty Acid Composition

Lipid material to be used in the determination of fatty acid composition was obtained by extracting freshly harvested tissne segments with 2:1 chloroform-methanol in a Waring blendor. The extracts were transferred to separatory funnels, salt solution added to reduce emulsion formation, and the lower chloroform layer removed. The remaining aqueous layer was extracted with additional aliquots of chloroform; the chloroform extracts were combined, dried over anhydrous sodium sulfate, and reduced in volume under vacuum. The samples were transferred to one-dram vials, the remaining solvent was removed by a stream of nitrogen, and the samples were held under nitrogen at -20° C for further processing.

Thin-Layer Chromatography

Thin-layer chromatograms were made on silica gel G plates prepared according to standard procedures. Plates were prewashed in

chloroform-methanol (2:1) containing an antoxidant (6). After prewashing, the plates were air dried for 20 minutes, the sample material was applied, and the plates were developed in chloroform-benzene (2:1). The triglyceride band was scraped from the plate and eluted from the silica gel with chloroform.

Preparation of Fatty Acid Methyl Esters

Fatty acid methyl esters were prepared by treating tissue lipids with 3% sulfuric acid in methanol, followed by extraction of methyl esters with petroleum ether (4).

Gas-Liquid Chromatography

Methyl esters were determined on an F & M Model 700 gas chromatograph equipped with an Infotronics electronic integrator. Samples were analyzed on a butane-1,4-diol succinate polyester column by published procedures (11). Fatty acid composition was determined by normalization of peak areas and the values reported are therefore relative proportions of total fatty acids

RESULTS AND DISCUSSION

The contribution of each tissue type to total fruit weight is shown in Table 1. The pericarp contribution decreases from an initial 43% to 24% at maturity. The testa decreases from 12% to 2% while the cotyledon increases

Table 1. Contribution of Pericarp, Testa, Embryonic axis, and Cotyledon to Total Fruit Weight, by Type of Tissue (%, dry wt., Basis).

Age of Fruit[1]	*Pericarp*	*Testa*	*Embryonic axis*	*Cotyledon*
2-3 wk	42.9	11.6	2.0	43.5
		(20.3)[2]	(3.5)	(76.2)
4-5 wk	30.9	7.7	2.2	59.2
		(11.1)	(3.2)	(85.7)
6-8 wk	24.1	3.2	2.3	70.4
		(4.2)	(3.0)	(92.3)
Mature	23.7	2.2	2.1	72.0
		(2.8)	(2.8)	(94.4)

[1]Weeks after soil penetration by gynophore

[2]Percent contribution exclusive of pericarp

from 43% to 72%. Embroyonic axis contribution remains about constant at 2%. Seed kernel values, exclusive of pericarp, are shown in parenthesis in Table 1.

The values for percent of crude lipid, in each tissue at each stage of development, are shown in Table 2. The data presented in Tables 1 and 2 may be used to calculate percent kernel lipid at each stage of development. These values, presented in Table 3, are somewhat higher than those reported by Pickett (7) and Schenk (9), particularly at the early stage of development. The values reported by Pickett and Schenk were obtained by hexane

Table 2. Percent Crude Lipid by Age of Fruit and Type of Tissue, by Crude Lipid (%, dry wt. basis)

Age of Fruit	*Peri-carp*	*Testa*	*Embry-onic axis*	*Cotyl-edon*
2-3 wk[1]	1.3	5.1	51.4	40.3
4-5 wk	1.3	5.0	52.0	49.5
6-8 wk	1.0	6.4	49.5	50.0
Mature	0.6	2.9	51.3	52.2

[1]Weeks after soil penetration by gynophore

Table 3. Developmental Changes in Lipid Content of Peanut Kernels[1]

Age of Kernel[2]	*Lipid Content (%, dry wt. basis)*
2-3 wk	33.6
4-5 wk	44.6
6-8 wk	49.6
Mature	50.6

[1]Calculated from data presented in Table 1 and 2

[2]Weeks after soil penetration by gynophore

extraction, a procedure which probably resulted in incomplete extraction of polar lipids. The higher values obtained by chloroform-methanol extraction in the present study may also be due in part to the extraction of some carbohydrate materials by the more polar solvent.

Further calculations based on the data presented in Tables 1 and 2 show that the testa contributes about 1% to the total kernel lipid at the earliest sampling date; this value decreases to 0.2% at maturity. The embryonic axis contributes approximately 5% of total kernel lipid at the earliest sampling date and 3% at maturity.

Figure 1 shows the qualitiative difference in the make-up of crude lipids obtained from each of the four tissues. It is apparent that triglycerides predominate in cotyledon and embryonic axis lipid and that complex lipids are the major lipid class in testa and pericarp.

The gas-liquid chromatograms of the fatty acid methyl esters of crude lipid obtained from the four tissues at the 2-3 weeks stage of development are shown in Figure 2. The most striking difference is in the linolenic acid content. In general the fatty acid compositions of cotyledon and embryonic axis lipids are similar. The same is true for the testa and pericarp lipids. The gas-liquid chromatograms of cotyledon lipid fatty acids at four stages of seed development are shown in Figure 3.

The cotyledon crude lipid and triglyceride fatty acid composition is shown in Table 4. The values are essentially the same as might be expected since triglycerides constitute the major portion of cotyledon lipid. In each case there is a definite decline in palmitic, linoleic, linolenic, eicosenoic, behenic, and lignoceric acid, and an increase in oleic acid as the seed develops to maturity. The other fatty acids do not change appreciably.

A similar pattern of change is encountered in the embryonic axis crude lipid and triglyceride fatty acid distribution as shown in Table 5. We observe a decrease in palmitic, linoleic, and linolenic acid and an increase in oleic acid. Behenic acid does not change. As compared to the cotyledon lipid, the embryonic axis lipid contains 80-90% more palmitic acid, approximately 30% more linoleic acid, and about 10 times as much linolenic acid, with lower concentrations of stearic and oleic acid at the 2-3 week stage of development.

The fatty acid composition of testa lipid is shown in Table 6. This lipid is characterized by high levels of palmitic and linoleic acid and a much higher level of linolenic acid than in cotyledon and embryonic axis oil. A similar fatty acid pattern is observed in pericarp lipid (Table 7).

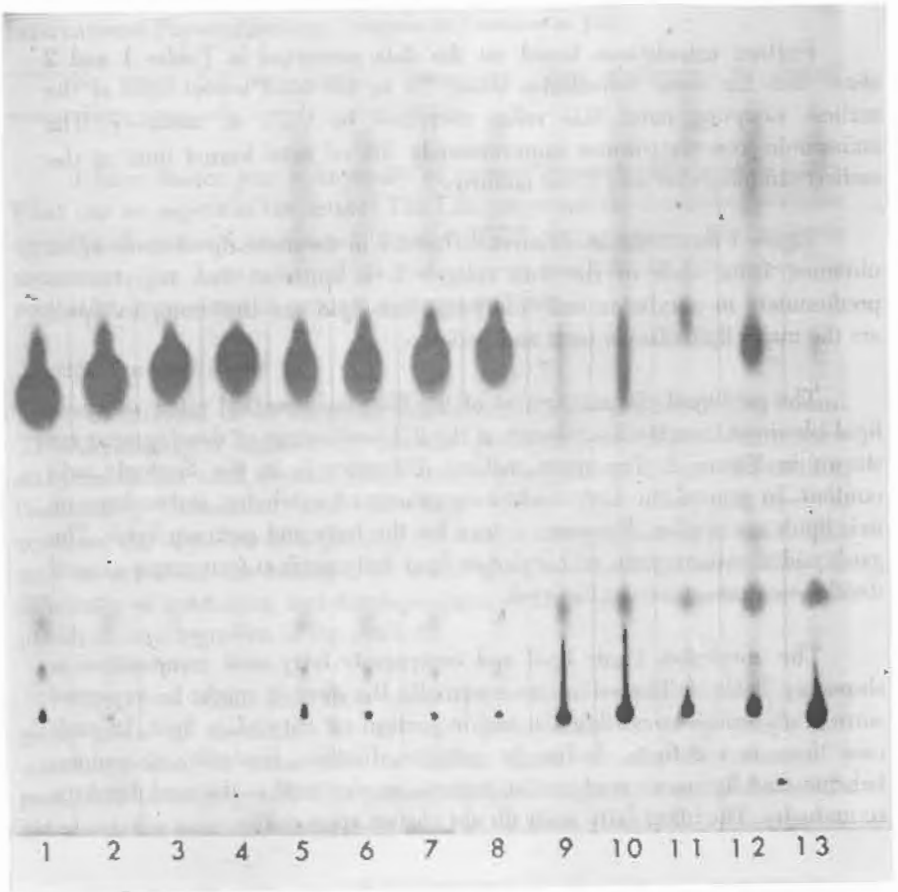

Figure 1. Thin-layer chromatogram of lipids obtained from peanut tissues harvested 2-3 weeks, 4-5 weeks, 6-8 weeks, and 11-12 (mature) weeks after soil penetration by gynophore. Cotyledon lipids: 1. 2-3 weeks. 2. 4-5 weeks. 3. 6-8 weeks.. 4. 11-12 weeks (mature). Embryonic axis lipids: 5. 2-3 weeks. 6. 4-5 weeks. 7. 6-8 weeks. 8. 11-12 weeks (mature). Testa (mature). Pericarp lipids: 13, 2-3 weeks. Complex lipids; R_f 0.00 Triglycerides: R_f 0.5.

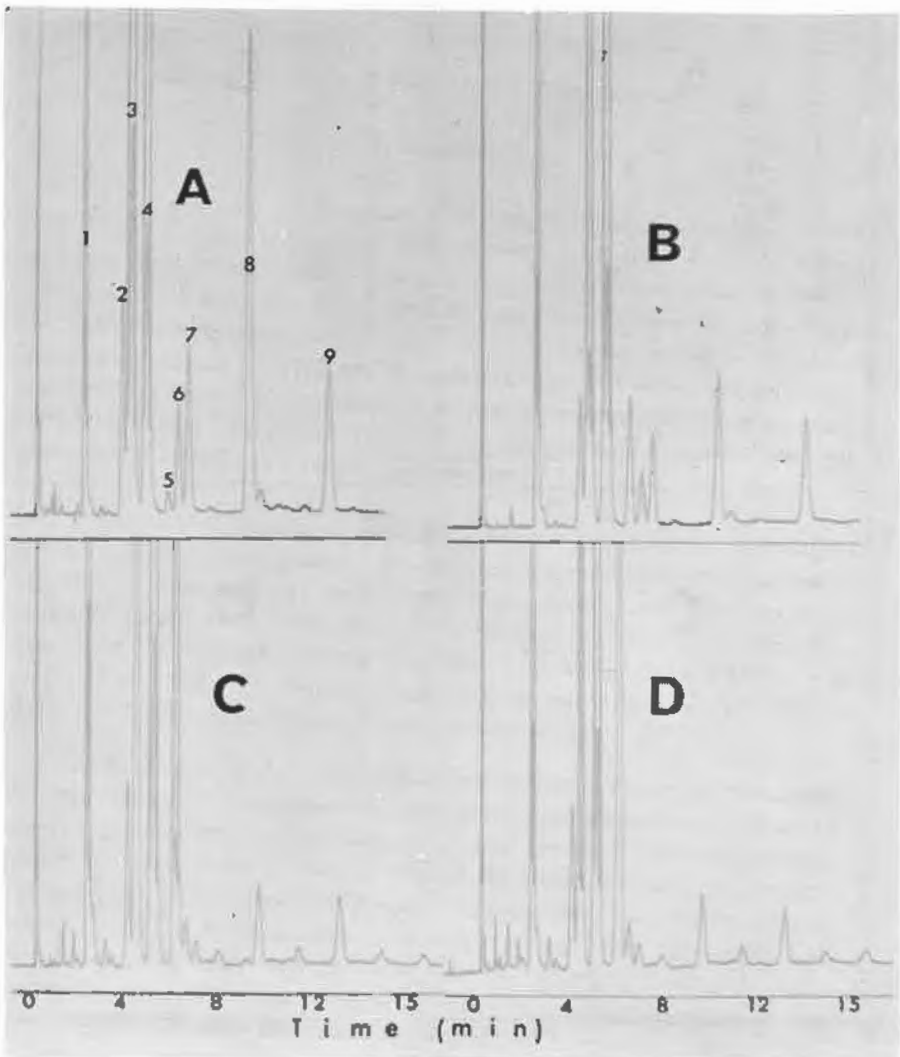

Figure 2. Gas-liquid chromatograms of peanut lipid fatty acid methyl esters. Seed harvested 2-3 weeks after soil penetration by gynophore. A. Cotyledon fatty acid methyl esters: 1. palmitic (16:0), 2. stearic (18:00), 3. oleic (18:1), 4. linoleic (18:2), 5. linolenic (18:3), 6. arachidic (20:00), 7. eicosenoic (20:1), 8. behenic (22:00), 9. lignoceric (24:0). B. Embryonic axis fatty acid methyl esters. C. Testa fatty acid methyl esters. D. Pericarp fatty acid methyl esters.

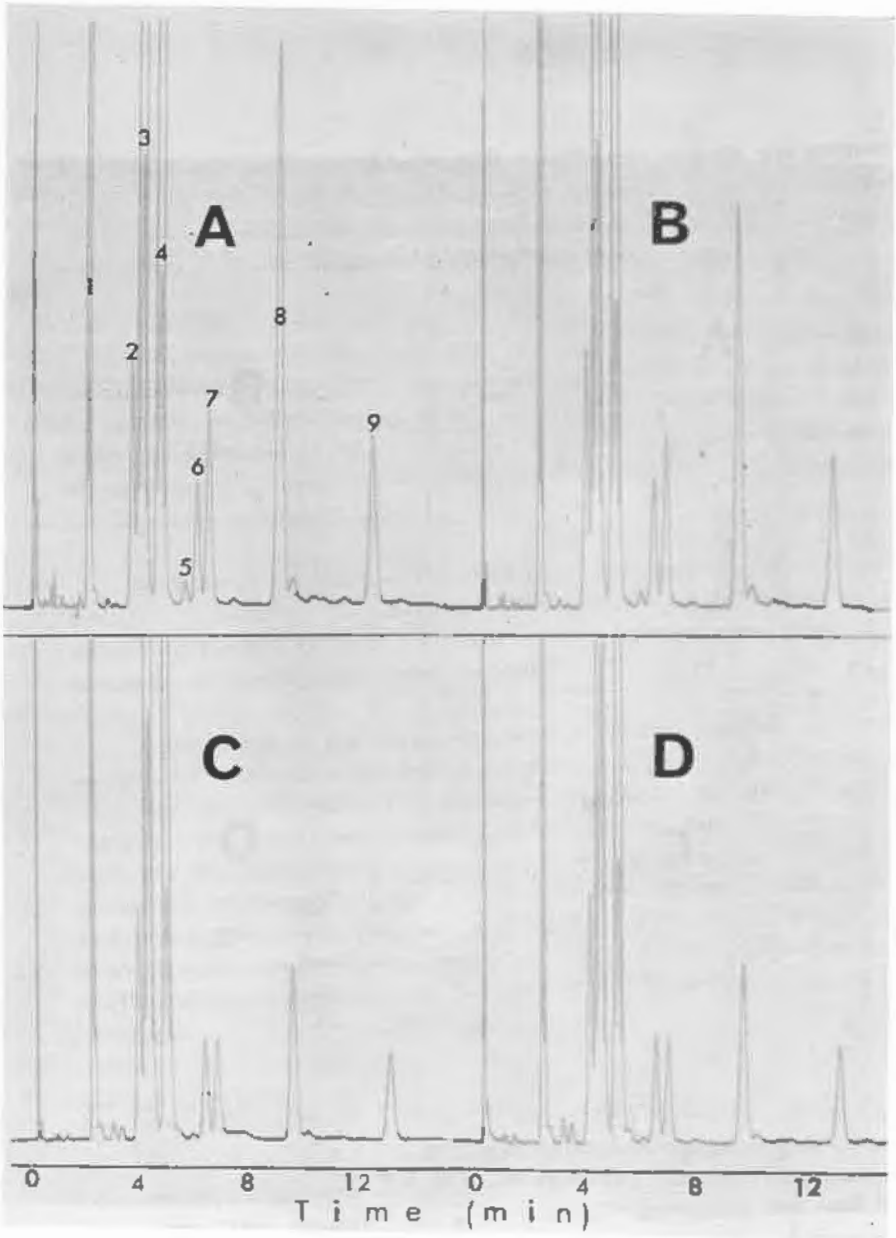

Figure 3. Gas-liquid chromatograms of peanut cotyledon fatty acid methyl esters obtained at four stages of seed development. A. 2-3 weeks after soil pentration by gynophore. Fatty acids are numbered as in Figure 2. B. 4-5 weeks after soil penetration by gynophore. C. 6-8 weeks after soil penetration by gynophore. D. 11-12 weeks (mature) after soil penetration by gynophore.

Table 4. Cotyledon Crude Lipid and Triglyceride Fatty Acids

Fatty Acid	*Fatty Acid Composition (%)*			
	2-3 wk[1]	*4-5 wk*	*6-8 wk*	*Mature*
16:0[2]	11.64	10.82	9.28	9.29
	(11.59)[3]	(10.46)	(9.40)	(9.21)
18:0	2.12	2.43	2.61	2.58
	(2.19)	(2.43)	(2.67)	(2.50)
18:1	41.19	45.50	50.46	52.10
	(43.33)	(47.20)	(51.25)	(52.71)
18:2	32.33	29.99	30.02	28.87
	(32.66)	(29.88)	(29.58)	(29.45)
18:3	0.17	0.10	0.02	0.02
	(0.19)	(0.10)	(0.03)	(0.04)
20:0	1.16	1.37	1.32	1.31
	(1.23)	(1.41)	(1.38)	(1.27)
20:1	1.89	1.85	1.31	1.22
	(2.15)	(1.97)	(1.39)	(1.26)
22:0	6.98	5.30	3.01	2.69
	(5.09)	(4.78)	(2.92)	(2.46)
24:0	2.20	2.41	1.65	1.53
	(1.56)	(1.79)	(1.39)	(1.10)

[1]Weeks after soil penetration by gynophore

[2]Number of carbon atoms: number of double bonds

[3]Triglyceride fatty acid values in parentheses

Table 5. Embryonic Axis Crude Lipid and Triglyceride Fatty Acids

Fatty Acid	*Fatty Acid Composition (%)*			
	2-3 wk[1]	*4-5 wk*	*6-8 wk*	*Mature*
16:0[2]	21.89	19.81	16.97	16.22
	(20.76)[3]	(17.42)	(17.07)	(15.55)
18:0	1.87	1.74	1.66	1.74
	(1.89)	(1.94)	(1.68)	(1.70)
18:1	26.43	28.42	35.67	37.84
	(27.70)	(30.69)	(35.90)	(38.38)
18:2	39.69	38.39	36.27	35.04
	(39.63)	(39.54)	(36.85)	(36.20)
18:3	1.68	1.41	0.68	0.60
	(2.04)	(1.40)	(0.68)	(0.60)
20:0	0.79	1.10	0.96	1.00
	(1.02)	(1.05)	(0.92)	(0.90)
20:1	1.40	2.00	1.85	1.92
	(1.82)	(2.01)	(1.90)	(1.77)
22:0	3.37	3.70	3.23	3.18
	(3.18)	(3.57)	(3.03)	(3.02)
24:0	2.62	2.95	2.33	2.20
	(1.96)	(2.38)	(2.01)	(1.90)

[1]Weeks after soil penetration by gynophore

[2]Number of carbon atoms: number of double bonds

[3]Triglyceride fatty acid values in parentheses

Table 6. Testa Lipid Fatty Acids

Fatty Acid	*Fatty Acid Composition (%)* 2-3 wk[1]	4-5 wk	6-8 wk	Mature
16:0[2]	26.56	22.28	20.29	16.81
18:0	2.03	2.53	3.22	3.43
18:1	9.04	12.05	16.37	28.26
18:2	41.20	41.85	39.12	32.27
18:3	16.11	14.10	10.69	5.90
20:0	0.62	0.78	1.20	1.57
20:1	0.26	0.48	0.45	1.10
22:0	1.24	1.84	2.89	3.92
24:0	1.25	1.66	2.16	2.79

[1]Weeks after soil penetration by gynophore

[2]Number of carbon atoms : number of double bonds

Table 7. Pericarp Lipid Fatty Acids

Fatty Acid	*Fatty Acid Composition (%)* 2-3 wk[1]
16:0[2]	25.24
18:0	2.39
18:1	13.28
18:2	38.19
18:3	13.59
20:0	1.06
20:1	0.59
22:0	1.92
24:0	1.35

[1]Weeks after soil penetration by gynophore

[2]Number of carbon atoms : number of double bonds

SUMMARY

The lipids of peanut cotyledon and embryonic axis are characterized by high levels of triglycerides and low levels of complex lipids. In comparison, the testa and pericarp lipids are primarily complex in nature and contain much higher levels of unsaturated fatty acids, particularly linolenic acid. Of the major fatty acids of cotyledon and embryonic axis, palmitic, linoleic, and linolenic acid decrease with maturity. Behenic acid decreases in cotyledon oil but remains fairly constant in oil from the embryonic axis. The level of oleic acid increases with maturity in both cotyledon aud embryonic axis oil.

Literature Cited

CANVIN, DAVID T. 1963. Formation of oil in the seed of Ricinus; communis L. Can. J. Biochem. Physiol. 41: 1879-1885.

GUNSTONE, F. D., and F. B. PADLEY. 1967. Glyceride studies. Part 7. The component glycerides of maturing sunflower seeds. Chem. Phys. Lipids 1: 429-433.

JAMES, A. T., H. C. HADAWAY, and JOAN P. W. Webb. 1965. The biosynthesis of ricinoleic acid. Biochem. j. 95: 448-452.

JELLIUM, M. D., and R. E. WORTHINGTON, 1966. A rapid method of fatty acid analysis of oil from individual corn *(Zea mays L.)* kernels. Crop Sci. 6: 251-253.

McKILLICAN, Mary E. 1965. Lipid changes in maturing oil bearing plants. IV. Changes in lipid classes in rape and crambe oils. J. Am. Oil Chemists' Soc. 43: 461-465.

NEUDOERFFER, R. S., and C. H. LEA, 1966. Antioxidants for the (thin-layer) chrometography of lipids. J. Chromatog. 21: 138-140.

PICKETT, T. A. 1950. Composition of developing peanut seed. Plant Physiol. 25: 210-224.

RAGHUVEER, K. G., and E. G. HAMMOND. 1967. The influence of glyceride structure on the rate of autoxidation. j. Am. Oil Chemists' Soc. 44: 239-24[illegible].

SCHENK, Roy U. 1961. Development of the peanut fruit. Ga. Exp. Stations Tech. Bul. N. S. 22, 53 pp.

SIMMONS, R. O., and F. W. QUACKENBUSH. 1954. Comparative rates of formation of fatty acids in the soybean seed during its development. J. Am. Oil Chemists' Soc. 31: 601-603.

WORTHINGTON, R. E., and K. T. HOLLEY. 1967. The linolenic acid content of peanut oil. j. Am. Oil Chemists' Soc. 44: 515-516.

XII

Effect of Combine Cylinder Speed and Feed Rate on Peanut Damage and Combining Efficiency

F. S. Wright[1]

INTRODUCTION

Approximately 90 percent of the peanut acreage in Virginia is now harvested by the windrow method. That is, peanuts are dug with commercial digger-shaker-windrowers and harvested four to eight days later with cylinder and/or carding type combines. Today the basic type of combine being manufactnred is the cylinder type combine.

Throughout the harvesting and handling operations, the peanuts are subjected to mechanical forces. These forces inflict damage to the peanut and reduce the kernel's protection from mold and insect contamination. Also, shelling of peanuts during the combining operation rednces the market value of the crop.

A laboratory study conducted by Turner (4)[2] indicated that the percent of hull damage and shelled peanuts (LSK) was directly proportional to the impact velocity and inversely proportioual to the moisture content of the peanuts when subjected to the impact forces. Khalsa (3) showed that the peanut moisture conteut at harvest affected the percent of LSK, hull damage, subsequent shelling damage, and seed germination.

The purpose of this study was to determine the effect of combine cylinder speed and feed rate on peanut damage and combining efficiency. This study was initiated at the Tidewater Research Station, Holland, Va. in 1966 (1).

EXPERIMENTAL PROCEDURES

Test Variables

The variables in the experiment were three cylinder speeds, two feed rates, and three exposure times (length of time in windrow). The three cylinder speeds were designated as slow, medium and fast. The medium

[1]Agricultural engineer, Agric. Engr. Res. Div., Agric. Res. Serv., U. S. Dept. of Agric., located at Holland, Va.

[2]Numbers in parentheses refer to references.

cylinder speed was the manufacturer's recommended speed, and the slow and fast speeds were approximately 27 percent slower and faster than the medium speed. The diameter of the four cylinders varied so that the periphery speed increased from front to rear except for the fonrth cylinder. At the medium cylinder speed setting, the cylinder periphery speeds were 1180, 1320, 1450, 375 fpm from front to rear, respectively.

Feed rate, or the rate at which the peanuts were fed into the combine, was varied by placing either one or two rows in one windrow. This provided a normal feed rate (two rows per windrow) and a one-half normal feed rate (one row per windrow). Tractor engine and ground speeds were maintained as close as possible to 1800 rpm (540pto) and 0.85mph, respectively.

Enough peanuts were dug in one day for harvesting at the three exposure times of zero, three and seven days after digging. All peanuts were shaken immediately after digging since one-third of them were harvested on the digging date. The exposure times provided peanuts for harvesting over a range of moisture contents. Peanuts for the last harvest of 10/10/66 digging date remained in the windrow eight days instead of seven days due to inclement weather.

Tests involving the above variables were conducted twice in 1966 and once in 1967. Each of the 18 test treatments was replicated four times in a completely randomized block experimental design for each digging date. The varieties of peanuts were 61R and 56R Virginia type.

Combine Setup and Sampling Procedure

A 1966 cylinder-type Roanoke combine was used. The drive arrangement to the cylinders, pickup unit, and pan and rack shaking unit was modified so that the speed of the four cylinders could be changed independently of the other components. Adjustment features of the combine such as breast springs, vine return unit, agitator bars, and main fan adjustment were not changed except for the main fan adjustment. The air flow from the main fan was decreased slightly from green harvesting (0 day) to harvesting after seven days in the windrow.

During combining a test sample of four to five pounds of peanuts was collected near the end of each of the 60 foot plots. The damage analysis to be described later was made from the test sample of peanuts. Prior to harvesting, samples of peanuts were hand picked and analyzed in the same manner as the test sample.

To determine combine losses all of the vines were collected in a sheet pulled behind the machine. These vines were examined by hand to determine

the percentage of peanuts that were on the vines and separated from the vines.

All samples of high moisture content were dried with ambient air for about 48 hours before adding heat. When supplemental heat was added, the air temperature was raised to about 10° F above ambient air temperature.

At harvest, a sample of peanuts was also collected from each plot to determine the moisture content (wet basis). The samples were dried in a forced-air oven at 180° F for 60 to 70 hours.

Analyses of Test Peanuts

Four factors were determined from the test sample to assess the mechanical damage to the plants. These factors were: 1. loose shelled kernels (LSK), 2. hull damage, 3. subsequent shelling damage, and 4. germination. The percentages of LSK and foreign material were determined from the four to five pound test sample before the test sample was subdivided into four parts.

Pods from one of the sub-samples (approximately 500 gms) were examined for visible hull splits, cracks, etc. These were classed as peauuts with "visible hull damage". The remaining "apparently sound pods" were submerged in a fast green dye solution (0.02 percent by weight) for 15 minutes. After the excess dye solution had dried the sample was hand shelled and inspected. Pods containing a trace of dye on the inside of the hull were classed as peanuts with "invisible hull damage". The types of hull damages were calculated as a percentage of the initial sub-sample weight.

Subsequent shelling damages were determined by shelling a sub-sample with a sample sheller and weighing the kernels which were skinned and split in the shelling operation. The shelling operation was conducted as described by the Federal State Inspection Service (2). An average grade was also determined.

From the third sub-sample, approximately 200 grams of peanuts were hand shelled for the germination tests. One hundred seeds (larger than 16/64 inch) from each replicated treatment were tested. Fifty seeds were placed on germination paper toweling (10 x 20 inches), two layers on the hottom and one layer on top of the seed kernels. The toweling was moistened, rolled up and placed in a 50-pound lard can. The can was placed in a forced-air oven with the temperature maintained at 25° x. The rolls of seed kernels were watered each day and a germination count was made after six or seven days. During 1967, a commercial germinator was used.

RESULTS AND DISCUSSION

The results presented below summarize the data obtained over two seasons and three separate digging dates. The digging dates and varieties were: Oct. 10, 1966 (61R); Oct. 21, 1966 (56R); and Oct. 11, 1967 (56R).

Moisture Content

The moisture content of the peanuts for the three digging dates and three exposure times (days in windrow) are presented in Table 1. Moisture content of the nuts ranged from a high of 62.5% at green harvest (0 day) to a low of 23.3% after eight days in the windrow. Due to less favorable weather conditions, the moisture contents of the peanuts from the second and third diggings were 37.3 and 35.4% after seven days in windrow, respectively.

Peanut Losses

Significant differences in the values for the peanut losses emerged from the various treatments. The total losses (Figure 1) for the slow cylinder speed were lower than the losses for the medium and fast cylinder speeds. Losses for the one-half normal feed rate were less than the losses for the normal feed rate. The peanut losses decreased with an increase in exposure time in the windrow.

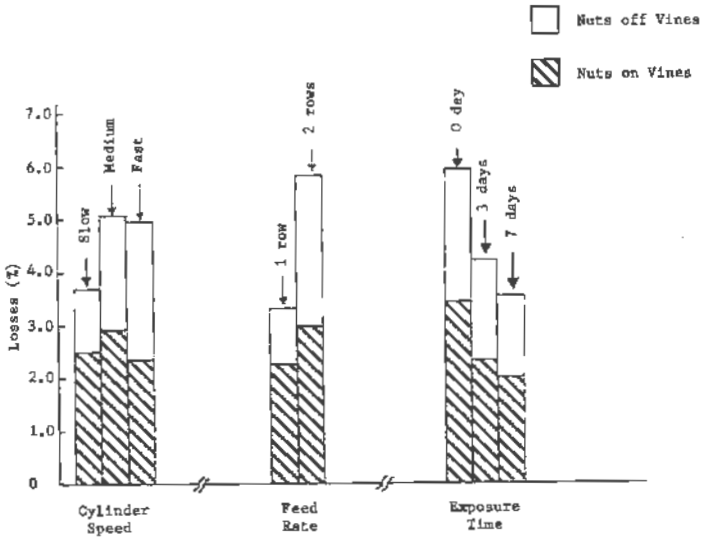

Figure 1. Peanut losses from rear of combine for three cylinder speeds, two feed rates and three exposure times averaged for 1966 and 1967.

Figure 1. Peanut losses from rear of combine for three cylinder speeds, two feed rates and three exposure times averaged for 1966 and 1967.

Table 1. Average peanut moisture content (%) at harvest for three digging dates and three exposure times, 1966 and 1967.

Digging Date	*Exposure Time* 0 day	3 days	7 days
10/10/66	54.7	37.4	23.3 [1]
10/21/66	61.6	44.8	37.3
10/11/67	62.5	44.0	35.4

[1] Eight days in windrow.

Table 2. Average values for peanut losses (%) from rear of combine for three digging dates, 1966 and 1967.

Digging Date	*Nuts on Vines*	*Nuts off Vines*	*Total Losses*
10/10/66	1.8 [1]	2.1	3.9
10/21/66	3.6	1.9	5.5
10/11/67	2.3	1.9	4.2
Average	2.6	2.0	4.5

[1] Average of 72 observations.

In general, the peanut losses on the vines and off of the vines were about the same (Table 2). The total losses over all treatments averaged between 3.9 and 5.5%.

Peanut Damage

Visible Hull Damage. The results in visible hull damage for the two diggings (10/10/66 and 10/21/66) are plotted versus moisture content at harvest in Figure 2. The values of the damage increased with an increase in the cylinder speed and remained fairly uniform with a change in the moisture content. Visible hull damage values for the third digging (10/11/67) were similar to those of the previous diggings except that the magnitude of the values was slightly higher (Table 3).

In general, the visible hull damage values for the normal feed rate were 2 to 4% less than the values for the one-half normal feed rate (Table 3). This

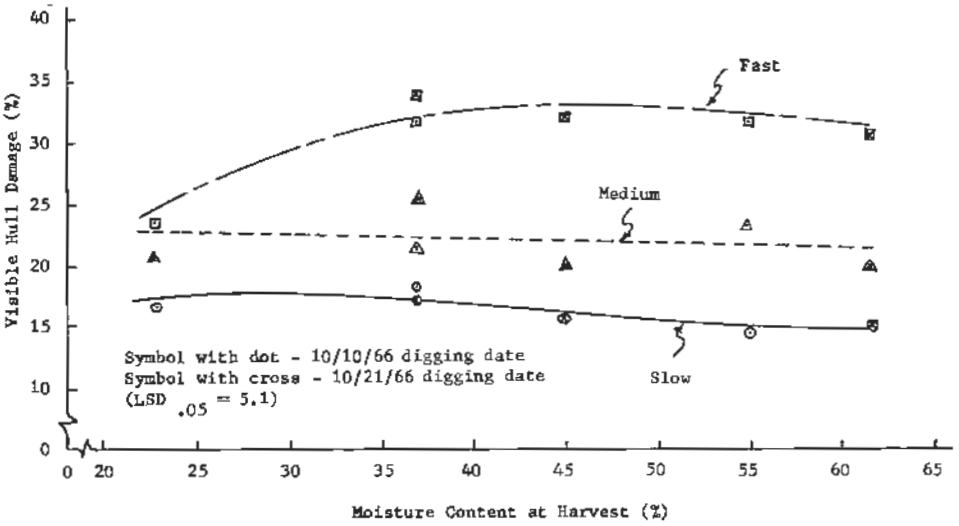

Figure 2. Visible hull damage versus moisture content for peanuts harvested at three cylinder speeds and a normal feed rate, 1966.

Figure 2. Visible hull damage versus moisture content for peanuts harvested at three cylinder speeds and a normal feed rate, 1966.

trend may be due to the fact that less vegetation was present in the combine to provide cushioning for the one-half normal feed rate harvest.

An overall analysis indicated that the average visible hull damage valne was 25.6% for the medium cylinder speed. The values for the slow and fast cylinder speeds were 29% less and 37% greater than the values for the medium cylinder speed, respectively. Therefore, a reduction in the visible hull damage can be made by reducing the cylinder speed of the combine.

Invisible Hull Damage. Values of the invisible hull damage from the combine samples showed no definite trends among cylinder speeds, feed rates, or exposure times (Table 4) for the three digging dates. The overall average value was 30.7%.

The values of the invisible hull damage for the hand picked samples increased with a decrease in the moisture content for the three diggings (Figure 3). No explanation can be suggested except possibly that drying of the peanuts in the windrow had sôme effect. With invisible hull damages reaching 27% more work is needed to help define the source of this damage, to see if these peanuts are susceptible to mold contamination.

Total Hull Damage. Since the visible and invisible hull damage values were considered separately, only the average values of the total hnll damage over all treatments are presented for each of the three digging dates (Figure 4). Somewhat different trends are indicated by each of the three curves. These trends are a reflection of the invisible hull damage values.

Table 3. Visible hull damage values (%) for three cylinder speeds, two feed rates, and three digging dates, 1966 and 1967.

Digging Date	*Feed Rate*	*Cylinder Speed*		
		Slow	*Medium*	*Fast*
10/10/66	1 row	15.4[1]	23.7	33.6
	2 rows	16.4	21.8	28.7
10/21/66	1 row	19.1	23.4	34.8
	2 rows	15.9	21.6	32.2
10/11/67	1 row	22.8	32.8	41.1
	2 rows	19.1	30.4	39.4
Average	1 row	19.1	26.6	36.5
	2 rows	17.1	24.6	33.4
	Average	18.1	25.6	35.0

[1]Average of 12 observations.

Table 4. Invisible hull damage values (%) for three cylinder speeds at the normal feed rate and three exposure times for three digging dates, 1966 and 1967.

Digging Date	*Exposure Time*	*Cylinder Speed*		
		Slow	*Medium*	*Fast*
10/10/66	0 day	30.2[1]	27.3	33.6
	3 days	24.2	38.2	26.7
	7 days	22.3	18.9	24.8
10/21/66	0 day	35.0	42.1	39.9
	3 days	43.9	38.8	36.9
	7 days	46.6	45.0	31.7
10/11/67	0 day	22.7	34.6	25.1
	3 days	26.5	16.8	16.9
	7 days	22.4	23.0	27.3

[1]Average of 4 observations. Average over three diggings = 30.7%.

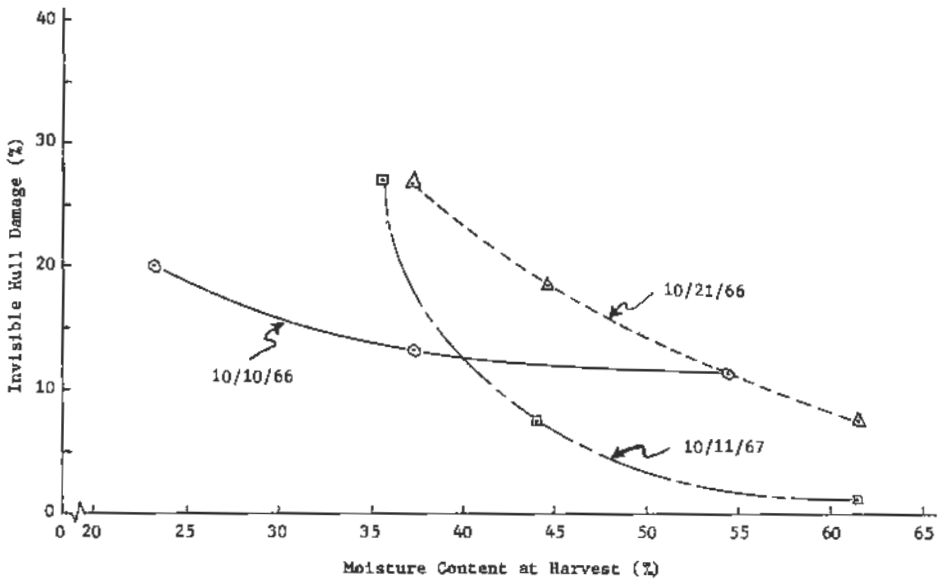

Figure 3. Invisible hull damage versus moisture content at harvest for hand picked peanuts, 1966 and 1967.

Figure 3. Invisible hull damage versus moisture content at harvest for hand picked peanuts, 1966 and 1967.

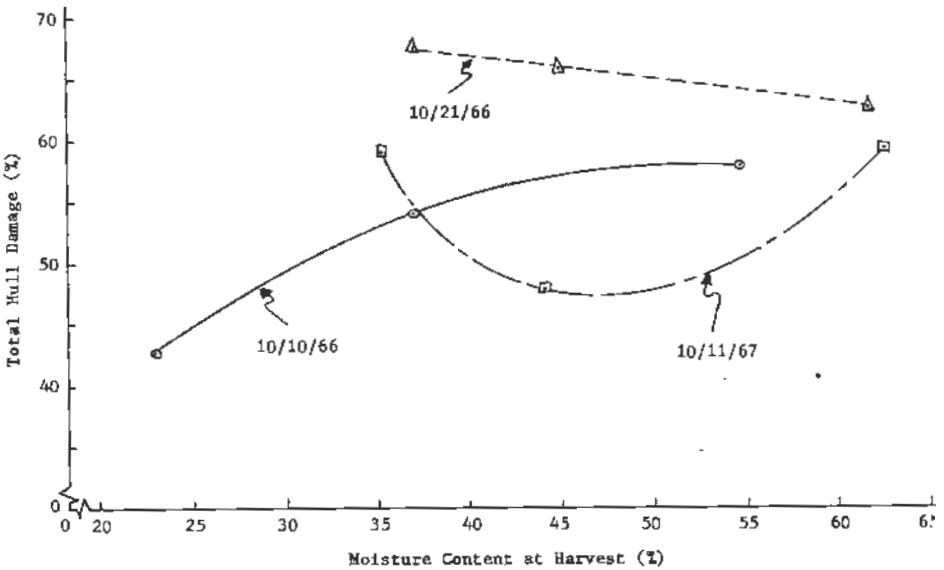

Figure 4. Total hull damage versus moisture content for combined peanuts, 1966 and 1967.

Figure 4. Total hull damage versus moisture content for combined peanuts, 1966 and 1967.

Values of the total hull damage ranged from 42 to 67% for the three digging dates. The overall average value was 57.2%.

Loose Shelled Kernels. In general, the percentage of loose shelled kernels (LSK) increased with a decrease in the moisture content (Figure 5 and Table 5). Likewise, the percentage of LSK increased with an increase in the cylinder speed.

Averaging over the exposure times and feed rates for the three digging dates, peanuts harvested at the slow cylinder speed had about 75% as many LSK as peanuts harvested at the medium cylinder speed. Peanuts harvested at the fast cylinder speed had about 165% as many LSK as peanuts harvested at the medium cylinder speed. No definite trend was evident between the two feed rates.

Shelling Damage. Subsequent shelling damage (percent of skinned and split kernels after shelling with sample sheller) decreased as the moisture content decreased (Figure 6 and Table 6). Over the moisture content range from 23 to 62% the shelling damage was 1.8% or less for peanuts harvested at the slow cylinder speed. Differences between the shelling damage values were highly significant for the cylinder speed and exposure time treatments, for each of the three digging dates.

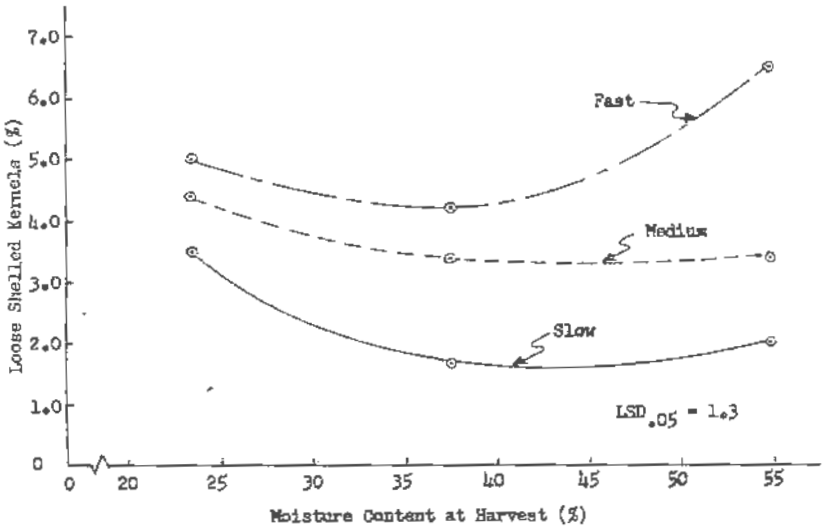

Figure 5. Loose shelled kernels versus moisture content for peanuts harvested at three cylinder speeds and averaged over two feed rates, digging date 10/10/66.

Figure 5. Loose shelled kernels versus moisture content for peanuts harvested at three cylinder speeds and averaged over two feed rates, digging date 10/10/66.

Table 5. Percent loose shelled kernels for peanuts harvested at three cylinder speeds and three exposure times for three digging dates (averaged over two feed rates), 1966 and 1967.

Digging Date	*Cylinder Speed*	*Exposure Time* 0 day	3 days	7 days
10/10/66	Slow	2.0[1]	1.7	3.5
	Medium	3.4	3.4	4.4
	Fast	6.5	4.2	5.0
10/21/66	Slow	1.8	2.7	3.7
	Medium	2.8	3.2	3.9
	Fast	5.9	4.9	6.5
10/11/67	Slow	1.9	2.4	3.8
	Medium	3.1	3.1	4.5
	Fast	7.0	6.0	7.1

[1]Average of 8 observations.

Table 6. Shelling damage (%) for peanuts harvested at three cylinder speeds and three exposure times for three digging dates (averaged over two feed rates), 1966 and 1967.

Digging Date	*Cylinder Speed*	*Exposure Time* 0 day	3 days	7 days
10/10/66	Slow	1.8[1]	0.8	0.5
	Medium	3.6	1.4	0.7
	Fast	5.1	1.3	0.6
	Hand picked	1.8[2]	1.0	1.0
10/21/66	Slow	1.0	0.7	0.7
	Medium	1.8	1.0	0.9
	Fast	2.4	1.6	1.7
	Hand picked	0.7	0.2	0.5
10/11/67	Slow	1.0	1.5	0.8
	Medium	1.4	1.5	1.0
	Fast	2.7	1.9	0.9
	Hand picked	0.6	0.5	0.6

[1]Average of 8 observations.

[2]Average of 4 observations.

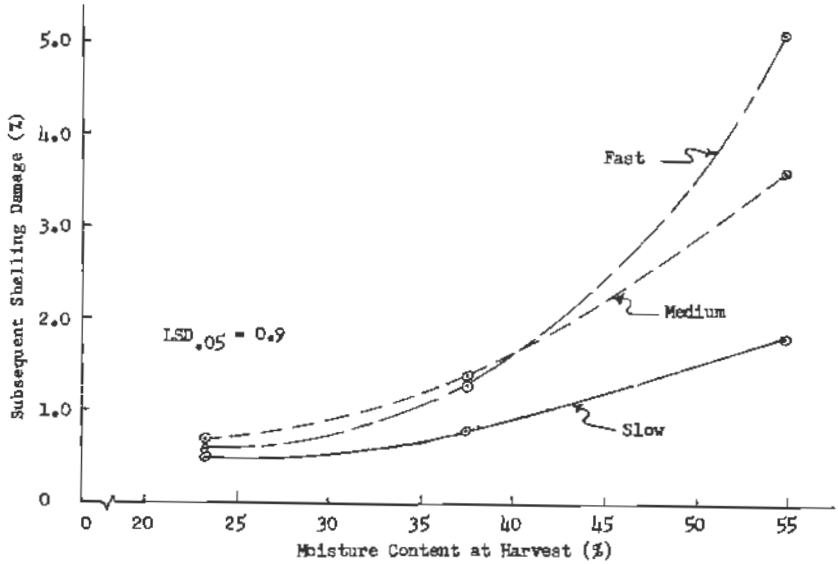

Figure 6. Subsequent shelling damage versus moisture content for peanuts harvested at three cylinder speeds and averaged over two feed rates, digging date 10/10/66.

Figure 6. Subsequent shelling damage versus moisture content for peanuts harvested at three cylinder speeds and averaged over two feed rates, digging date 10/10/66.

The shelling damage results indicate that the peanut kernels were damaged more when harvested green (freshly dug), however, the shelling damage value for peanuts combined at the slow cylinder speed was comparable to the shelling damage value for hand picked peanuts (Table 6).

Germination. Germination percentage for the digging dates (10/10/66 and 10/21/66) was not consistent in relation to the moisture content at harvest (Table 7). [Germination tests for the 10/11/67 digging date were not complete at this time.] In general, the results from the 10/10/66 digging date were believed to be more representative of expected trends (Figure 7). The germination percentage was lower for peanuts harvested at the higher moisture content and higher for peannts harvested at the slow cylinder speed. The germination values ranged between 48 and 90% for the combined samples (Table 7).

For hand picked peanut samples, the germination percentage was 96% or higher for all exposure times. This result indicated that peanuts can be artifically dried without decreasing the germination percentage.

Peanut Grade

The average grade for peanuts hand picked, combined and lost from the rear of the combine are presented in Table 8. The peanuts hand picked had

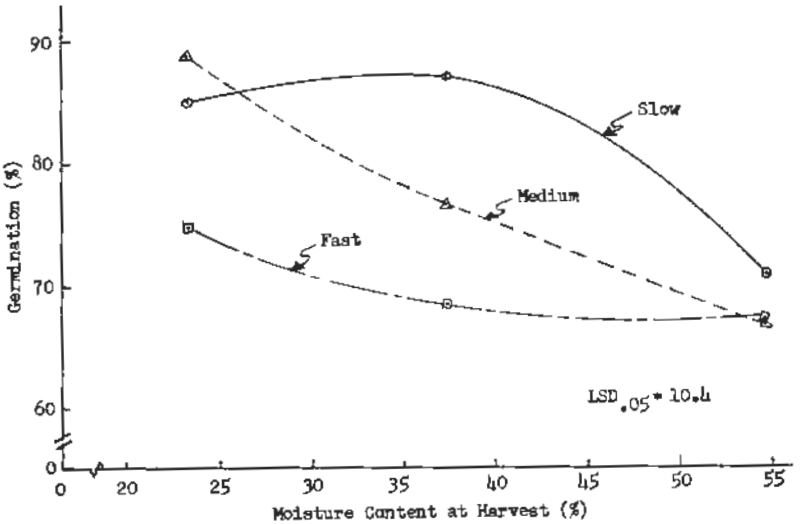

Figure 7. Germination percentage versus moisture content for peanuts harvested at three cylinder speeds and a normal feed rate, digging date 10/10/66.

Figure 7. Germination percentage versus moisture content for peanuts harvested at three cylinder speeds and a normal feed rate, digging date 10/10/66.

CONCLUSIONS

Based on 2 years' data with one combine, the results indicated that: (1) less total peanuts were lost from the rear of the combine at the slow cylinder speed, at the one-half normal feed rate, and at 7 days of exposure in the windrows; (2) peanuts harvested at the slow cylinder speed had less visible hull damage, less loose shelled kernels, lower subsequent shelling damage, and higher germination; (3) only slight damage differences were evident in results of one-half normal and normal feed rates; (4) moisture content at harvest did not affect the damage factors in the same manner, but in general, the peanuts harvested at intermediate moisture contents (35 to 45%) had less damage; and (5) invisible hull damage of combine peanuts was not related to combine cylinder speed, feed rate, or exposure time; however, the invisible hull damage of hand picked peanuts increased with a decrease in the moisture content.

Literature Cited

1. Annual Progress Report. 1966. Peanut production and harvesting machinery. AERD, ARS, USDA, Tidewater Research Station, Holland, Va.

Table 7. Germination (%) of peanuts harvested at three cylinder speeds and three exposure times at a normal feed rate for three digging dates, 1966.

Digging Date	*Cylinder Speed*	*Exposure Time* 0 day	3 days	7 days
10/10/66	Slow	71[1]	87	85
	Medium	67	76	88
	Fast	67	68	75
	Hand picked	96	100	99
10/21/66	Slow	86	73	78
	Medium	74	68	62
	Fast	72	48	62
	Hand picked	99	99	99

[1]Average of 4 observations.

Table 8. Average grade (%) for peanuts hand picked, combined, and lost from rear of combine, 1966 and 1967.

Grade Factors	*Hand Picked Peanuts*	*Combined Peanuts*	*Peanuts Lost on Vines*	*Peanuts Lost From Vines*
Foreign Material		6.8		
Fancy	74.4[1]	62.3		
E.L.K.	22.9	16.7		
S.M.K.	63.0	59.2	51.9	47.4
O.K.	5.9	8.5	10.7	11.5
Damage (V)	1.3	1.8	2.1	3.0
Hulls	29.8	30.5	35.3	38.1

[1]All data are an average over three digging dates (72 samples per digging date).

2. Farmers' Stock Peanuts. 1966. Inspection instruction. Fruit and Vegetable Division, U. S. Dept. of Agric., Washington, D. C.

3. KHALSA J. S. 1965. Harvesting damage to peanuts. M. S. Thesis, Dept. of Bio. & Agric. Engr., N. C. State Univ., Raleigh, N. C.

4. TURNER, W. K. 1963. Impact damage to peanuts and its effects on germination, seedling development, and milling quality. M. S. Thesis, Dept. of Bio. & Agric. Engr., N. C. State Univ., Raleigh, N. C.

ABSTRACT 1. EVALUATION OF CERTAIN FOOD INDUSTRY ANTIMICROBIALS AS POTENTIAL MATERIALS FOR CONTROL OF MOLD FUNGI ON PEANUT PODS[1]

George L. Barnes[2]

A variety of species of fungi, including the aflatoxin-producing *Aspergillus flavus* and other toxin producers, develop on and in improperly dried pods of the peanut (*Archis hypogaea* l.) following harvest, or during storage while awaiting final drying at processing plants. The most commonly encountered species, and some uncommon species of special interest, were used in agar plate tests.

Cultures of *Alternaria tenus, Aspergillus flavus, A. niger, Chaetomium globosum, Epicoccum nigrum, Fusarium moniliforme, F. oxysporum, F. solani, Penicillium* sp.. *Rhizoctonia solani, Sclerotium bataticola,* and *Trichoderma viride* were covered with water dilutions of test chemicals for 20 minutes. The cultures were drained aud 7 mm plugs were aseptically cut and placed on fresh peptoue-dextrose agar. Ten plugs per dilution were used. Average colony diameters were determined 48 and 72 hours later. Percent inhibition of growth was determined.

The chemicals used, for the most part, are approved by the Food and Drug Administration as antimicrobial agents for at least one food product. Potential commercial use of any chemical fouud to be highly effective is thereby enhanced. Compounds tested were sorbic acid, sorbose, potassium sorbate, sodium propionate, calcium propionate, sodium benzoate, ammonium benzoate, sodium diacetate, sodium dehydroacetate, acetic acid, sodium meta bisulfite, potassium meta bisnlfite, sodium nitrite, potassium nitrite, 2-amino butane, sodium hypochlorite and propionic acid.

Most of the compounds were relatively ineffective as growth inhibitors. Of the effective materials, the lowest dilutions completely inhibiting growth of most of the fungi were 2.5% sodium meta bisulfite, 2.5% potassium meta bisulfite, 5% propionic acid, 5% 2-amino butane, and 1.5% sodium hypochlorite. The lowest dilutions which killed all of the fungi were 5% potassium meta bisulfite, 5% acetic acid, 10% propionic acid and 25% 2-amino butane. The more active compounds will be tested for control of mold fungi on inoculated peanut pods.

[1]This research was supported in part by the Agricultural Research Service, U. S. Department of Agriculture, under Grant No. 12-14-100-9197(34) administered by the Crops Research Division, Beltsville, Md.

[2]Department of Botany and Plant Pathology, Oklahoma Agricultural Experiment Station, Oklahoma State University; Stillwater, Okla. 74074.

ABSTRACT 2. SUBSAMPLING MILL FOR SAMPLES OF PEANUT KERNELS

J. W. Dickens and J. B. Satterwhite[1]

A simple, compact subsampling mill was developed to simultaneously comminute and subsample peanut kernels for aflatoxin analyses at the rate of about 3 kg per minute. The subsampling mill achieved finer comminution of peanut kernels than equipment presently used in many laboratories. Very little oil was expressed from the comminuted material; the material was easily blended and subdivided.

Tests with samples containing known amounts of aflatoxin-contaminated kernels are presented to indicate the subsampling accuracy of the mill. Use of the mill is proposed for comminuting and subsampling a wide variety of granular material for aflatoxin or other types of analyses.

[1]Research Agricultural Engineer and Engineering Technician, respectively, Market Quality Research Division, ARS, USDA, North Carolina State University, Raleigh, North Carolina.

ABSTRACT 3. THE UTILITY AND STABILITY OF VIRGINIA PEANUT SEED MIXTURES

D. A. Emery, J. A. Benson and J. C. Wynne[1]

Virginia peanut seed mixtures were studied with four objectives in mind. The objectives and the results over a four-year period (1963-1966) are discussed.

Objective 1. To test the effectiveness of improving the yield of a quality commercial variety by adding varying proportions of a "booster" line which is unacceptable as a pure line.

Results – Mixtures of two-thirds Va. 56R and one-third booster (Fla. 393) increased the four-year mean for yield per acre *216 pounds, 84 pounds,* and *387 pounds,* respectively, over that of Va. 56R alone when harvested on or about September 20, October 5, and October 15. The same mixture did not increase the value per acre of Va. 56R when dug on October 5 but average gains of $15.00 per acre and $48.00 per acre were noted when the mixture was dug on September 20 and October 15, respectively.

[1]Respectively Professor, North Carolina State University, Department of Crop Science, Raleigh, N. C. 27607; Superintendent, Sandpoint Branch Experiment Station, University of Idaho; and Instructor, North Carolina State University, Department of Crop Science.

Conclusion – Seed mixtures may be used not only to increase yield but to give the farmer greater flexibility in harvest dates.

Objective 2. To change inherent kernel size distribution patterns by selections of seed mixture components.

Results – The variety NC2 is known to have a narrow range of kernel sizes. A large seeded late generation hybrid derived from a cross of NC2 x Ga 119-20 was blended with NC2 in one-fifth and four-fifths proportions in 1964 and again in 1966. Both mixtures and pure line components were evalnated in replicated trials in 1966. Seed size distributions of the mixtures compared with the pure line components indicated that the NC2 distribution was significantly different from the hybrid in the September 20 and October 15 diggings bnt not in the October 5 digging. NC2 was never significantly different from the mixture four-fifths NC2 - one-fifth hybrid. It was significantly different from the one-fifth NC2 - four-fifths bybrid mixture in the October 15 digging date only.

Conclusion – Heritability of peanut seed size is not high enough to use blends effectively when small changes in seed size patterns are desired.

Objective 3. To evaluate the stability of complex seed mixtures over seasons and locations.

Results – A mixture containing 15%, 28%, 27%, and 30% of four experimental lines was synthesized by actual seed count in 1960, 1961, 1962, and 1963. The four mixtures were grown in replicated trials at two locations in 1964-1967. The ranges of the fonr-year means over the four mixtures are listed below for five characters.

Character	*Mean Range Over Four Mixtures*
% Extra Large Kernels	3%
% Sound Mature Kernels	0%
Count per Pound of Seed	27
Yield per Acre	82 lbs.
Value per Acre	$10.19

Conclusion – The four mixtures show little environment by location interaction. This particular seed mixture appears to be no less stable than a pure line variety.

Objective 4. To study natural competition amoug genetically marked components of a seed mixture over generations.

Results – Competition among plants representing one normal and two irradiated backgrounds of a common inbred line and a single marked tester line has been evaluated over a two-year period. One of the irradiated background components has been reduced from 50% to 35% of the seed mixture after two years of field competition.

Conclusions are not valid at this time.

ABSTRACT 4. EFFECT OF CURING TIME AND TEMPERATURE ON THE DISTRIBUTION OF PHOTOSYNTHETICALLY ^{14}C LABELLED METABOLITES IN IMMATURE PEANUTS

H. E. Pattee and S. C. Mohapatra[1]

Photosynthetically labelled peanut kernels were used to study the time-temperature-moisture relationship of biochemical changes occurring during curing of immature peanuts. Radioactivity of the lipid fraction increased during the first six hours of curing at 50° C and during the first twelve hours at 20°C.

During subsequent hours of curing, the radioactivity decreased from 7.5 x 10^5 dpm/gm dry wt. at 50° C and 5.5 dpm/gm dry wt. at 20° C until it reached a nearly constant level of one-half the maximum values; 48 hours were required to reach the constant level at 20° C while only 24 hours were required at 50° C.

Radioactivity in the ethanol-soluble fraction decreased during the initial period of curing and then increased slightly until a constant level was reached. This effect was more evident at 20° C than at 50° C. Changes from anabolic to catabolic processes seem to be influenced by the moisture level of the peanut kernel.

[1]MQRD, ARS, USDA and N. C. State University.

ABSTRACT 5. INFLUENCE OF MATURATION AND CURING ON CHANGES OF CAROTENOIDS AND LIPOXIDASE ACTIVITY IN PEANUTS

H. E. Pattee, A. E. Purcell and Elizabeth B. Johns[1]

The effects of maturation and curing of peanuts on the carotenoid concentration, color, and quantity of extracted oil, and on lipoxidase activity were studied. The carotenoid level in the peanut kernel increased from 0.212

ug/kernel at the fourth week to 0.448 ug/kernel at the seventh week from pegging and then remained constant to maturity. The percent oil increased linearly from 23 percent at the fourth week from pegging to 56 percent at maturity. The carotenoid concentration in the pressed oil decreased from 4,400 ug per kg at the fourth week to 1,360 ug per kg oil at the eighth week from pegging.

At maturity the concentration was 480 ug per kg oil. Peanuts harvested 10 weeks from pegging and dried rapidly at 70° F and 50% R.H. had a higher carotenoid concentration (750 ug per kg oil) than those dried slowly in the windrow (308 ug per kg oil). A peanut lipoxidase system capable of decoloring carotenoids was also demonstrated and the activity was shown to increase rapidly with peanut maturity; cured peanuts have a significantly higher level of activity than uncured peanuts.

[1]ARS, USDA and N. C. State University

ABSTRACT 6. CURRENT PROCEDURES FOR PANEL EVALUATION OF PEANUT QUALITY

Jack L. Pearson[1]

Discussion of the present state of the National Peanut Marketing Research Laboratory's program for flavor-panel evaluation of peanut quality covers the two major areas of *Sample Preparation* and *Panel Procedures.*

Sample Preparation touches briefly upon (1) assuming valid pre-processing treatment and sampling procedures, (2) assuring appropriate uniformity among pre-roast samples, (3) uniform roasting procedures, (4) after-roast pickout, and (5) grinding and mixing.

Panel Procedures briefly covers (1) selecting and training panelists, (2) the panel's working environment, (3) presenting test samples, (4) evaluating panelists' observations, and (5) comparing panel evaluations and objective measurements.

[1]Research Horticulturist, Market Quality Research Division, Agricultural Research Service, U. S. Department of Agriculture, Albany, Georgia.

ABSTRACT 7. REMOVAL OF AFLATOXINS FROM OILSEED MEALS BY EXTRACTION WITH AQUEOUS ISOPROPANOL

Eric T. Rayner and F. G. Dollear[1]

Aqueous isopropanol was found to be an effective solvent for removal of aflatoxins from contaminated cottonseed and peanut meals. Extraction with six passes of 80% aqueous isopropanol at 60C resulted in complete removal of aflatoxins in both meals, as measured by thin-layer chromatography.

Under similar extraction conditions, the isopropanol-water azeotrope, 88% isopropanol by weight, removed 88% of the total aflatoxins in peanut meal, a reduction from 82 ppb to 10 pph, and 79% of the total aflatoxins in cottonseed meal, a reduction from 214 pph to 46 ppb. Lower temperatures were less effective with both solvent systems.

[1]Southern Regional Research Laboratory; New Orleans, Louisiana (one of the laboratories of the Southern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture).

ABSTRACT 8. SAMPLING OF PARTICULATE PRODUCTS FOR AFLATOXIN ANALYSIS

P. J. Tiemstra[1]

A model is proposed to describe the manner in which peanut lots can be contaminated with aflatoxin bearing kernels. The effect of two parameters, the percentage of contaminated kernels and the distribution of the kernels in the lot, was studied. The value of the first parameter (percent of contaminated kernels) is inversely proportional to the variance, i.e. there is more variability of the aflatoxin analysis as the percentage of contamination decreases. It is possible to decrease this variability by increasing the sample size.

The distribution curve of the model showed a skewed distribution to the low side of the aflatoxin content. Comparing this distribution pattern to a normal distribution pattern and log distribution pattern indicated that a log distribution pattern more closely approached the distribution pattern of the model. Therefore, log transformation of field data was analyzed in order to compare actual data with the model to determine which level of this particular parameter was closest to natural contamination. There are three important characteristics of log transformed data: (1) an arbitrary value has

to be assigned to zero aflatoxin analysis in order to give a rational number to the log value, (2) the variation is independent of actual level of aflatoxin in the lot, and (3) the average of the logarithim of the value is always lower than the arithemetic average. The standard deviation of the log aflatoxin of a number of peanut lots which were sampled and analyzed in triplicate had an average of 0.437, which corresponds to an 0.05% percentage of contamination when corrected for analytical and sample preparation variation.

The effect of hot spots on the sampling efficiency was the second parameter studied. A model in which all the contaminated kernels were assumed to be in four bags of an 800 bag lot was studied. If 25% of the bags are sampled, these four bags will be missed 31.5% of the time. Sampling 50% of the bags rednces to 6.2% the chance of missing these contaminated bags.

The effect of hot spots on the sampliug efficiency was the second parameter studied. A model in which all the contaminated kernels was assumed to be in four bags of au 800 bag lot was studied. If 25% of the bags are sampled, these four bags will be missed 31.5% of the time. Sampling 50% of the bags reduces to 6.2% the chance of missing these contaminated bags.

This study has indicated that improvement in the sampling plan can be made by a more extensive sampling of the units within a lot and increasing the size of the sample ground for further analysis.

[1]Director of Research, Derby Foods, Inc., Chicago, Illinois.

ABSTRACT 9. THEORETICAL INVESTIGATIONS OF THE ACCURACY OF SAMPLING FOR AFLATOXIN IN SHELLED PEANUTS

T. B. Whitaker and E. H. Wiser[1]

Within a population of shelled peanuts, aflatoxin may be concentrated in less than 0.5 percent of the peanuts. Those peanuts containing aflatoxin might have concentrations up to 1,000,000μg of aflatoxin per kg of peanuts. Because of the unusual distribution pattern, sample means vary widely and the true average level of aflatoxin in the population is difficult to estimate. The objective of this study was to determine the effect of sample size (N), the average level of aflatoxin (M), and the percent of the popnlation not contaminated with aflatoxin F (o) on sampling accuracy. Using model simulation, the negative binomial distribution was sampled on a digital computer, with the Monte Carlo techniqne. The negative binomial distribution was used to simulate the actual distribution of aflatoxin since it allowed for a high probability of zero counts along with small probabilities of large counts.

Results indicate the following:

(1) For a given M and F (o) value, sampling accuracy increases as the sample size N increases;

(2) For a given M and N value, sampling accuracy increases as the percent of non-contaminated peanuts F(o) decreases;

(3) For a given F(o) and N value, sampling accuracy increases as the average level of aflatoxin M decreases.

The results indicate that a relatively large sample size N, the exact size depending upon F(o), M, and the desired accuracy limits, would be required to estimate the average amount of aflatoxin M in a population of shelled peanuts. A sample of 10,000 peanuts drawn from a population where F(o) = 99.9% and M = 30 ppb would have a value falling between 0 and 180 ppb 99% of the time. For comparison, a sample of 100,000 peanuts drawn from the same population would have a value falling between 10 and 64 ppb 99% of the time.

The ability to describe quantitatively the effects of sample size on sampling accuracy gives added insight into the problems of sampling shelled peanuts for aflatoxin. This study will provide a foundation for an efficient sampling procedure to estimate whether the average level of aflatoxin (M) in a population of shelled peanuts is above or below a certain critical level (i.e. 30 ppb).

[1]Respectively U. S. Department of Agriculture, Agriculture Research Service, Market Quality Research Division, Biological and Agricultural Engineering Department, N. C. State University, Raleigh, North Carolina; and Biological and Agricultural Engineering Department, N. C. State University, Raleigh, North Carolina.