# Cottonseed Oil and Meal Utilization

**K. M. DECOSSAS, L. J. MOLAISON, A. de B. KLEPPINGER, and V. L. LAPORTE,**
**Southern Regional Research Laboratory,[1] New Orleans, Louisiana**

## Abstract

For five consecutive years world-wide production of cottonseed has set new highs, and cottonseed is more valuable as a source of food, feed, and fiber than ever before. However this paper is primarily concerned with the utilization of cottonseed oil and meal in the United States.

During the three-year period, 1963–65, U.S. farmers received about $300 million annually for 6.18 million tons of cottonseed. Annual U.S. crushings were 5.79 million tons, having produced 1.94 billion pounds of crude oil valued at $222 million, 2.72 million tons of meal valued at $174 million, and 1,609,700 running bales of linters valued at $41.2 million. Retail value of cottonseed products is estimated to have been $1.1 billion annually.

Changes in the U.S. cottonseed industry include shifts westward, to fewer and larger extraction plants and to the use of new and improved extraction techniques which involve solvents and high-speed expellers. The cottonseed extraction industry has a payroll of $38.2 million and consists of 188 oil mills in about 14 states, employing 8,400 people.

Cottonseed oil accounted for 11.5% of total 1965 U.S. factory consumption of 12.7 billion pounds of fats and oils. Some 62% was used in salad or cooking oil, 27% in baking or frying fats, and 8% in margarine. During the 1960–65 period, usage increased in salad or cooking oils, in baking or frying fats, and in inedible products but decreased in margarine, mellorine, and other edible products. Increases exceeded decreases, and total consumption of cottonseed oil in edible and inedible products increased from 1.28 billion lb. to 1.47 billion lb.

Practically all of the 2.76 million tons of cottonseed meal produced in the three-year period beginning October 1963 was used for feed. Relatively insignificant amounts were used as fertilizer on farms of cotton growers. Cattle, sheep, horse, and mule rations consumed 1.88 million tons, poultry rations 440 thousand tons, and swine rations 350 thousand tons. Cottonseed meal in cattle rations has had a downward trend since the early 1950's although usage in poultry and swine rations has increased. It is estimated that 1.52 million tons were used by feed manufacturers in the preparation of mixed feeds during the 1964–65 season, representing a steady increase over the past two decades and a 54% increase over 1962–63.

Domestic use of cottonseed flour has not changed appreciably during the past few years.

## Introduction

THIS PAPER IS A SEQUEL to one published four years ago on the status of the utilization of cottonseed oil and meal, specifically in the United States (1). It is an analysis of the information obtained during the past year on oil and meal utilization from the National Cotton Council, the National Cottonseed Products Association, the Agricultural Experiment Stations of the Cotton Belt states, the United States Department of Agriculture, oilseed processors, and feed manufacturers. Although there is much interest in the United States and foreign countries in the utilization of cottonseed meal products for food in long-range feeding of the world's population, these are of limited commercial importance in the United States and are consequently not included.

[1] So. Utiliz. Res. Dev. Div., ARS, USDA.

Cottonseed, with the possible exception of peanuts, is the most generally grown oilseed crop in the world. In 1965 about 25 million tons were produced in 56 countries (2,3). It is virtually the most readily available oilseed in the world. For four consecutive seasons, 1962–63 through 1965–66, world-wide production has set new highs (3,4), and cottonseed is more valuable as a source of food, feed, and fiber than ever before. Few raw materials are a source of so many major necessities of man and his domestic animals or are used in as wide a variety of products as cottonseed (5). Although its production is influenced by and is largely dependent upon demand for cotton fiber, cottonseed has itself contributed so much to the well-being of man that it is regarded as a valuable coproduct with potential for further development and utilization.

In the United States cottonseed production averaged 6,178,000 tons in the three-year period, 1963–65, with a farm value of about $300 million. Annual crushings were 5,785,000 tons, having produced 1.94 billion lb. of crude oil valued at $222 million, 2.72 million tons of meal valued at $174 million, and 1,609,700 running bales of linters valued at $41.2 million. Retail value of cottonseed products is estimated to have been $1.1 billion annually.

The changing cottonseed extraction industry has a payroll of $48.3 million and consists of 188 oil mills in at least 14 states, employing 8,400 people (6,7). This is a decrease of 158 since 1946 when 346 mills processed cottonseed. During this same period the average annual processing volume per mill increased from 9,000 tons to more than 31,000 tons, or about 250%.

Since 1951 significant shifts have occurred in the method of processing. New and improved extraction techniques, involving solvent and high-speed expellers, have been adopted. In 1951, 57% of the cottonseed was extracted by hydraulic presses compared with 31% by screw presses, and 12% by solvents (8). In 1964, about 8% was extracted by the hydraulic method, 46% by screw presses, and 46% by solvent techniques (9). A recent survey of mills by the National Cottonseed Products Association indicates that currently only about 2% of the seed are processed by hydraulic presses; 51% are done by screw presses and 47% by solvent techniques (10).

Another important change in the U.S. cottonseed industry has been brought about by the shift in cotton production from the Southeast to the Mississippi Valley, the Southwest, and the Far West. Some newer mills have been located in these growth areas. During the 1963–65 period 13.6% of cottonseed crushings occurred in the Southeast, 36.8% in the Mississippi Valley, and 49.6% in the Southwest and Far West. Since the paper approximately five years ago (1), the percentage of crushings in the Southeast has been about the same; there was a 5% increase for the Mississippi Valley and a corresponding decrease for the Southwest.

## Oil Utilization

Cottonseed oil's percentage of total U.S. factory consumption of selected fats and oils in major edible and inedible products continued to decrease between 1960 and 1962, as it did between 1956 and 1960. The percentage dropped from 12.7% of total U.S. factory consumption of 10.1 billion lb. of fats and oils in 1960 to 11.3% of 11.5 billion lb. in 1962. Subsequently, between 1962 and 1965, the share of fats and oils consumption held steady at about 11.3% except for a low of 10.7% in 1963. In 1965, U.S. factory consumption of 1.47 billion lb. of cottonseed oil in edible and inedible products was 11.5% of 12.7 billion lb. of all fats and oils used, the highest consumption of cottonseed oil in a decade (11,12). Because of the smaller

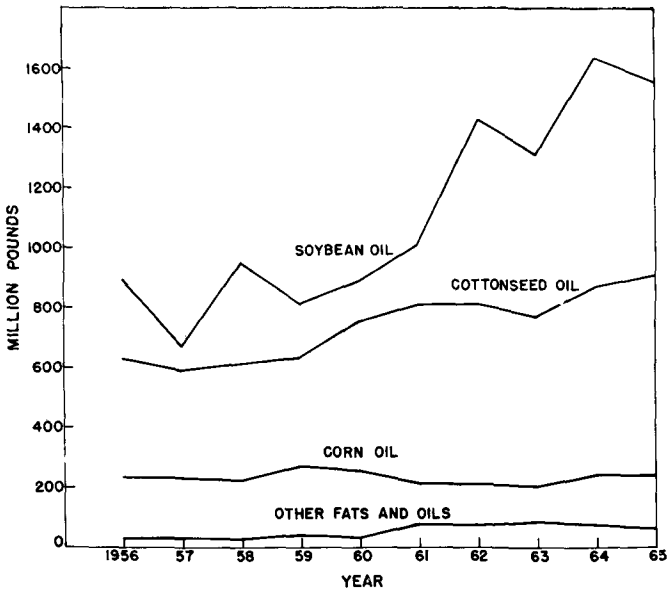


FIG. 1. US factory consumption of fats and oils in salad or cooking oils.

1966 cotton crop and smaller cottonseed oil carry-over, supply and consumption of cottonseed oil are forecast to drop at least 25% during the 1966–67 season (13).

*Salad or Cooking Oils* (Figure 1). Cottonseed oil is generally regarded as a high-quality cooking oil; it has a pleasant taste and performs well with regard to freedom from smoke and offensive odors. Salad or cooking oils have formed an increasing percentage of cottonseed oil consumption, having increased from 59% in 1959 to 62% in 1965. Since 1964, salad or cooking oils have displaced baking or frying fats as the largest single outlet for all fats and oils.

Cottonseed oil in these end-products increased from 752 million lb. in 1960 to 914 million lb. in 1965, but its percentage decreased from 39 to 33% of total fats and oils utilization. The decrease occurred because consumption of soybean oil almost doubled in the period 1960–65; utilization of 1.56 billion lb. in 1965 represented 56% of total fats and oils in salad or cooking oils. Much of this increase came with the marketing of an improved soybean cooking oil, developed by partial hydrogenation and winterization processes which have tended to overcome the problem of flavor reversion (14).

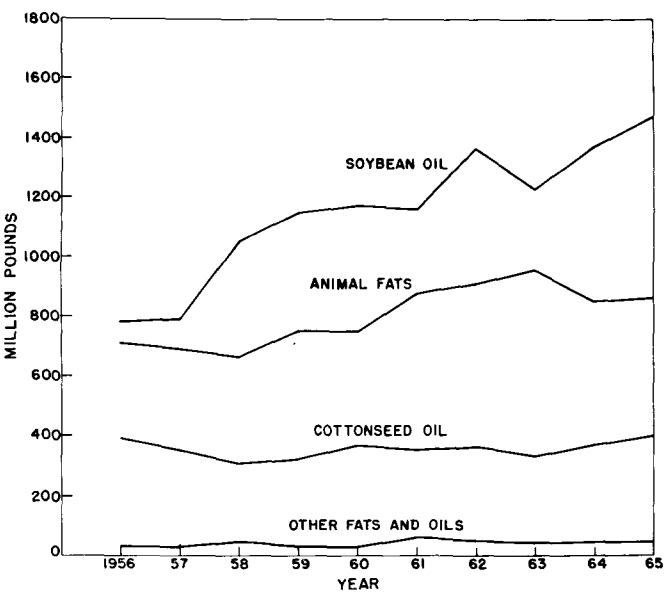


FIG. 2. US factory consumption of fats and oils in baking or frying fats.

Cottonseed oil use in salad dressing, mayonnaise, and related products decreased from 185 million lb. in 1960 to 156 million lb. in 1965, about the same as the consumption of a decade before. During the same period soybean oil use increased from 453 million lb. to 632 million lb. (15).

*Baking or Frying Fats* (Figure 2). Another 27% of cottonseed oil in 1965 was used in baking or frying fats. Utilization represented about 14% of fats and oils during the 1960–65 period, and it increased from 365 to 401 million lb. as soybean oil usage rose 26% from 1.17 to 1.47 billion lb. Cottonseed oil is blended with soybean oil and animal fats to improve texture, melting characteristics, and shelf life. During this period vegetable oils consumption has consistently been about two-thirds of the consumption of fats and oils.

*Margarine* (Figure 3). Less than 8% of the cottonseed

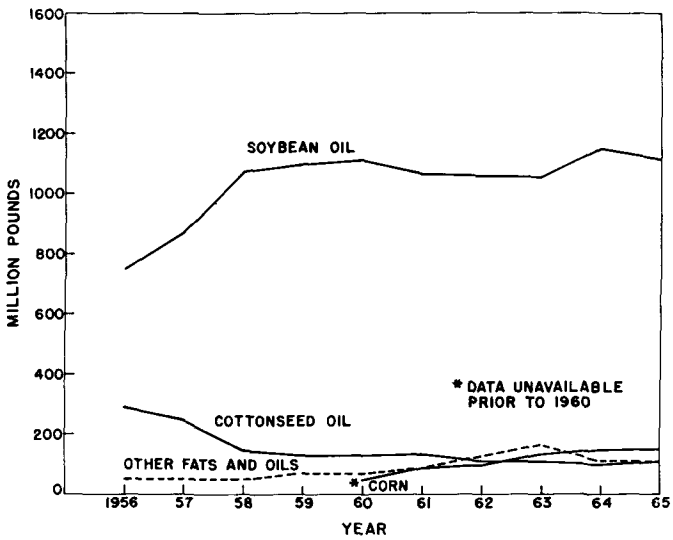


FIG. 3. US factory consumption of fats and oils in margarine.

oil in 1965 was in margarine, in which 1.5 billion lb. of fats and oils were used. Consumption in margarine declined slightly from 136 million in 1960 to 114 million lb in 1965. During that period, soybean oil utilization remained steady at about 1.1 billion lb, accounting for almost 75% of total consumption in 1965, down from 80% in 1960. Usage of corn oil tripled from 54 million in 1960 to 161 million lb. in 1965.

Although cottonseed oil provides creamy texture, long shelf-life, and good melting characteristics, its usage in margarine declined during the 1960–65 period. Higher costs relative to soybean oil and the heavy promotion of corn oil margarines were the principal factors responsible for declining consumption.

Margarine per capita consumption increased from 9.4 to 9.9 lb., but butter per capita consumption decreased from 7.5 to 6.5 lb. (16).

*Other Uses.* The use of cottonseed oil in mellorine continued to decline between 1960 and 1964, from 3.2 million to 1 million lb. Soybean oil increased from 7.7 million to 13.1 million lb., and animal fats consumption decreased from 4.6 million to 3.6 million lb. Consumption of cottonseed oil in other edible products, such as confectionery fats, whipped topping, and similar items, amounted to 11.3 million lb. in 1964, a decrease from 15 million in 1960.

Total usage in inedible products averaged about 6 million lb. through 1963, then rose to almost 16 million lb. in 1964. Inedible uses include fatty acids and other nonfood products.

In summary, cottonseed oil usage has increased in salad or cooking oils, baking or frying fats, and in inedible products during the period 1960–65, but it has decreased in margarine, mellorine, and other edible products (Figure 4). Because increases exceeded decreases, total consumption in edible and inedible products increased from 1.28 billion to 1.47 billion lb. during that period. However cottonseed oil's

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## • *Cottonseed Oil . . .*

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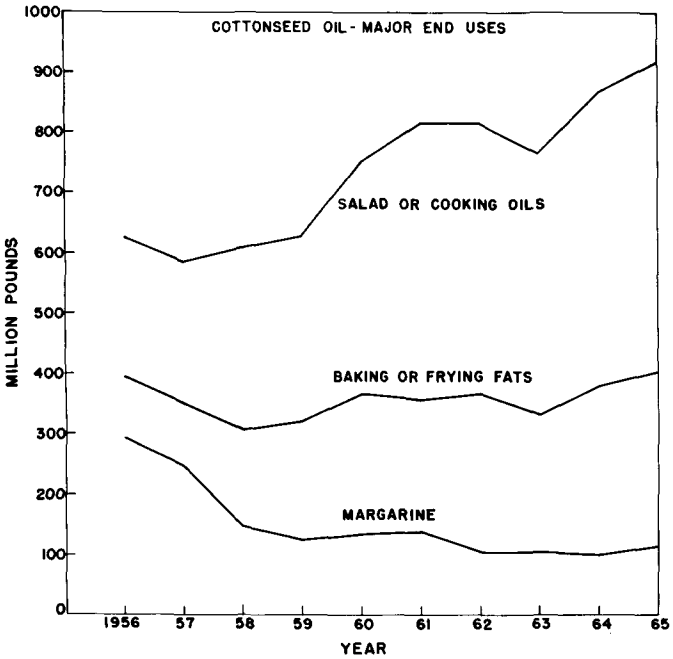


FIG. 4. Cottonseed oil—major end uses.

percentage share of total fats and oils used in edible products declined from 22% in 1960 to 19% in 1965.

*Exports.* About 370 million lb. of cottonseed oil were exported during the marketing year 1965–66, much the same as five years earlier. This was a drop from the 701 million lb. exported in 1964–65, reflecting shorter supply and higher prices.

### Meal Utilization

Practically all of the cottonseed meal produced in the United States is used for feed; only 30,000 tons are used annually as fertilizer on the farms of cotton growers. Consumption of cottonseed meal in cattle, sheep, horse, and mule feeding has gone down since the early 1950's whereas consumption in poultry and swine rations has increased (Figure 5). During the three-year period beginning October 1963, an average of 2.67 million tons of the 2.76 million tons of cottonseed meal produced annually was used in feeds. An estimated 1.88 million tons of this were used in cattle, sheep, and other livestock rations, 440 thousand tons in poultry rations, and 350 thousand tons in swine rations (Figure 6).

TABLE I

Manufactured Feed Statistics

| | 1962–63 | 1964–65 |
|---|---|---|
| Total manufactured feeds (est.) tons | 41,260,000 | 43,560,000 |
| Soybean meal (% of total) | 20.8 | 20.2 |
| Cottonseed meal (% of total) | 2.4 | 3.5 |
| Soybean meal, tons | 8,575,000 | 8,799,120 |
| Cottonseed meal, tons | 990,240 | 1,524,600 |

During 1964–65, 1,524,600 tons (or 56.7% of cottonseed meal for feed) were incorporated in mixed feeds. This represents a 54% increase over consumption in mixed feeds in 1962–63, when only 990,240 tons, or 38.2%, was used in manufactured feed (Table I).

A survey by the National Cottonseed Products Association reveals that over the long range there has been a steady growth in the percentage of cottonseed meal sold to feed manufacturers. The best available information indicates that 21% of the meal was sold to feed mixers in 1947 and that by 1966 this percentage had probably reached about 52% of total production.

*In the Southeast.* In North Carolina, South Carolina, Georgia, Alabama, and Florida (Figure 7) the average annual production of cottonseed during the 1963–65 period amounted to 936,300 tons, of which 785,200 tons were crushed, yielding 373,200 tons of meal.

In North Carolina cottonseed meal is used in almost all cattle feeds, both dairy and beef. Consequently, although the proportion of cottonseed meal used in poultry and swine rations has been decreasing, total consumption is probably remaining constant or increasing. Glandless cottonseed has been produced experimentally by the North Carolina Experiment Station, and glandless cottonseed meal is being evaluated at the Station by using rats in an attempt to develop gossypol-free cottonseed products of high quality for extending markets and reducing processing costs.

In the Department of Animal Science at Clemson University, cottonseed meal of 41% protein is used in beef cattle rations, but no cottonseed meal is used in swine rations. Studies are under way comparing whole soybeans with cottonseed meal in cattle-fattening rations.

In Georgia there has been no indication of change in meal utilization since the previous report. It had been indicated earlier that an increase in the finishing of beef cattle was to have meant somewhat greater utilization of cottonseed meal than had been true in the past.

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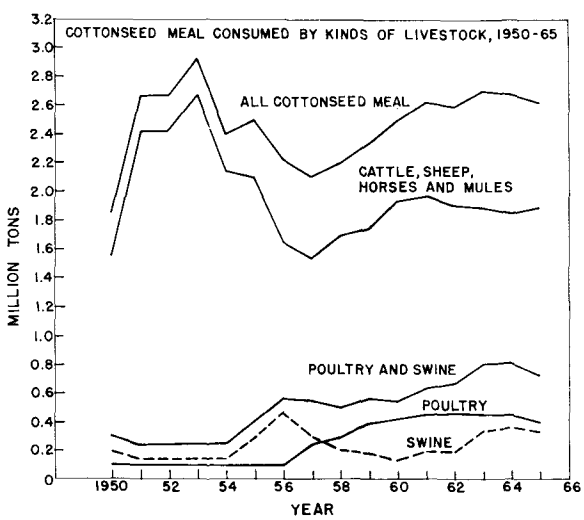


FIG. 5. Cottonseed meal consumed by kinds of livestock, 1950–65.

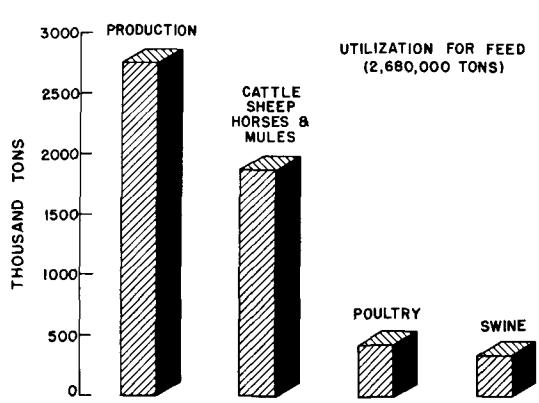


FIG. 6. Cottonseed meal 1963–64 through 1965–66 (3-season average).

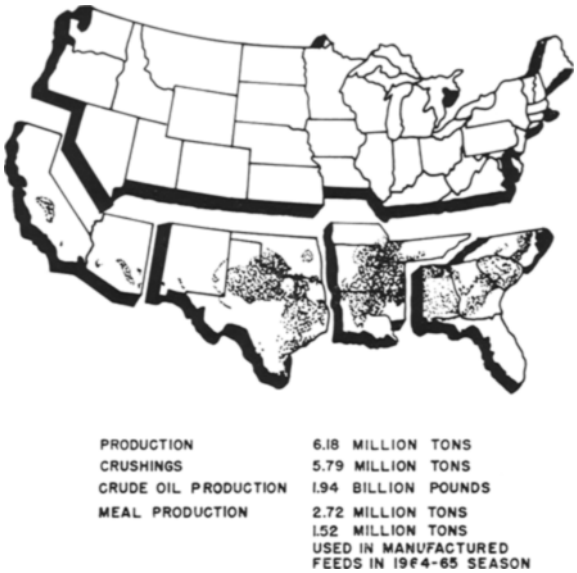


FIG. 7. Cottonseed in the United States, 1963–65 (3-year average).

In Alabama there have been no significant changes in the use of cottonseed meal in poultry and swine rations. It was reported previously (1) that cottonseed meal was used mainly in rations of beef and dairy cows, that very little was used in poultry rations.

Florida Agricultural Experiment Station studies have utilized cottonseed meal in cattle fattening and finishing rations.

*In the Mississippi Valley.* In Arkansas, Louisiana, Mississippi, Tennessee, and Missouri the average annual production of cottonseed during the period 1963–65 amounted to 2,158,000 tons, of which 2,128,000 tons were crushed, yielding 1,003,900 tons of meal.

In Arkansas cottonseed meal has been used as protein supplementation at the Agricultural Experiment Station in studies on the effects of varying protein levels in finishing rations for beef cattle. Later, cottonseed meal and hulls were used in studying various methods for placing yearling steers on full feed.

Cottonseed meal has been fed in Louisiana Experiment Station tests to determine the most efficient method of utilizing grass, stored roughages, and concentrates in the production of market cattle; in studies on wintering and finishing beef calves; and in studies on fattening cattle with all-concentrate, low-fiber rations for cost reduction.

In Mississippi cottonseed meal which contains 0.04% or less gossypol is used to a limited extent in formulating swine rations. At the Mississippi Agricultural Experiment Station it has been used in wintering and winter grazing studies, in brood-herd management, and in a study of the feasibility of feeding dry beef cows three times weekly.

There is no research under way in Tennessee pertaining to the utilization of cottonseed oil and meal. In the previous report the feeding of livestock was identified as the big use for cottonseed meal in Tennessee. Then it was being used extensively in livestock-feeding research studies of finishing rations for beef steers and of the wintering and fattening performance of beef steers which were fed enzymes.

In Missouri there has been little change in the use of cottonseed meal in livestock rations. Cost is a primary factor. Whenever and wherever its cost is less than soybean meal or linseed meal, it is especially used in cattle and sheep rations. Cottonseed meal has greater appeal in South Missouri than in North Missouri where soybean meal is preferred. In the poor grazing areas of South Missouri cottonseed meal to which large amounts of salt have been added is used in self-feeding of cattle. Salt limits the amount of meal that the animals eat. Cottonseed meal with lesser amounts of salt is used as a management aid for leading and rounding up cattle.

*In the Southwest.* In Texas, Oklahoma, and New Mexico the average annual production of cottonseed during the 1963–65 period amounted to 2,065,000 tons, of which 1,855,000 were crushed, yielding 863,500 tons of meal.

Texas continues to be the largest producer of cotton in the United States, having produced about 30% of U.S. production during the 1963–65 period. The livestock industry makes good use of the available supply of cottonseed meal and hulls in a continuing effort to supplement grazing for profit. Beef production consumes vast quantities of cottonseed meal and hulls in rations for finishing beef cattle.

Improved cottonseed meal with a gossypol content of 0.04% or less is being used in swine and poultry mixed feeds in Oklahoma.

New Mexico Experiment Station cotton breeders are starting some work on low gossypol cotton; however this is in the preliminary stage.

*In the Far West.* In California and Arizona the average annual production of cottonseed during the period 1963–65 amounted to 1,019,000 tons, of which 1,016,000 tons were crushed, yielding 481,200 tons of meal.

All of the meal produced in the West, regardless of method of extraction, contains 0.04% or less of free gossypol. It is consumed primarily in poultry rations in California. Most production is prepress solvent meal with a fat content lower than expeller meal, making the product more acceptable to poultry-feed mixers than to dairy or beef cattle-feed mixers. Protein content is standardized at all mills with a guarantee of not less than 41%. Standard protein levels are 41%, 44%, and 50%.

Total utilization of cottonseed meal in feeding cannot increase because of limited supply. However, during the past three to five years, there has been a shift toward use in poultry and swine rations. There has been a trend toward increasing the percentage of meal in poultry rations, including turkeys; in some cases it is fed as high as 20% of the total ration. One industry source has estimated that at least 65% of the prepress solvent meal produced in Arizona and California is consumed in poultry feeds, and the figure could be considerably higher. Another estimates that well over half of meal production in California goes into poultry channels. The remainder, both solvent and expeller, is consumed in dairy and beef rations, principally dairy.

Regional consumption pattern variations exist in the Calfornia-Arizona area. Northern California produces two-thirds of the State's poultry whereas the cattle-feeding industry represents a greater portion of the total livestock industry in the Southern California-Arizona area. In addition, cottonseed meal is shipped from California and Arizona to Utah for use in the broiler industry there.

In the 1965–66 season Arizona consumed only 15% of prepress solvent cottonseed meal produced in the West, but, as a result of a limited supply in the 1966–67 season, Arizona consumption increased to 20–25%.

The demand for cottonseed meal by poultry feeders has served to increase the over-all price structure. In years of short supply, such as the present one, poultry feeders are expected to consume their normal requirements, leaving beef and dairy feeders in some instances looking elsewhere for substitutes.

The California Agricultural Experiment Station estimates that 6,000 to 12,000 tons of cottonseed meal are used in California swine rations annually. It reports that within the past two years there has been extensive development of the use of cottonseed meal with a higher protein and lower crude fiber (hull) content than the meals traditionally used in commercial channels. As a result, meal containing 50% protein is commonly used in poultry feeding and is frequently preferred. Studies are continuing on the comparative metabolizable energy values of meals which differ in protein and crude fiber content. Earlier work on the metabolizable energy of cottonseed meals and the specific effects of gossypol has already been reported.

*In United States.* The protein percentage of cottonseed meal has stabilized at 41% in most areas, although about 6% of the total volume is still 36% protein and some 44% and 50% protein meals are produced in the West. Expeller meal contains 3–4% oil and solvent meal ½–1½% oil. Use

in the feed industry is purely an economic decision which is based on its price relative to competing protein materials, such as soybean meal, urea, and safflower meal in local areas. There has been an increase in the amount of cottonseed meal used by mixed-feed manufacturers for poultry and swine, in some areas as much as 10%, primarily because the price of soybean meal advanced sharply.

The volume of high-protein cottonseed meal which is used depends upon the price spread in the market at any one time. High-protein, low-fiber, and low-gossypol cottonseed meal demands a premium over 41% protein meal. In 1965–66 this premium ranged between $12 and $15 per ton, averaging $13. When reduced to a unit-protein cost basis, this premium is in close relationship to that of 50% soybean meal over 44% because of higher quality, lower fiber, and other factors. The premium for low-gossypol meal is $2–$3 per ton, but it seems to be offered in sufficient quantities only on the West Coast.

### Cottonseed Flour Utilization

The domestic utilization of cottonseed flour products has not changed appreciably over the past few years. Cottonseed flour continues to be used in miscellaneous bakery products. Industrial cottonseed protein products of U.S. manufacture are used in industrial fermentations in 15 foreign countries.

ACKNOWLEDGMENTS

Drawings for this manuscript are by G. I. Pittman, and photographs by A. F. Fayette and J. J. Bergquist.

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[Received June 14, 1967]

# Theory of Chromatography Course

Drew University announces a two-week short course entitled "The Theory of Chromatography—A Unified Approach" to be given July 29–Aug. 9, 1968. The purpose of this course is to acquaint the participants with the new rapidly developing theories of chromatography. Using a unified approach the following topics will be treated: Column Dynamics, Capillary Methods (TLC, Paper) Partition, Adsorption, Ion Exchange, and Gel Permeation. Lecturers will include W. D. Cooke, Walter Harris, R. A. Keller, Stephen Hawkes, Robert Pecsok, Lloyd Snyder, George Stewart, and Harold Walton.

Support for 25 academic participants will be provided by the National Science Foundation. Applications from industrial participants will also be received.

Further information and application forms can be obtained from the Director: Dr. J. M. Miller, Short Course on Chromatography, Drew University, Madison, New Jersey 07940.

Application forms must be submitted by March 1, 1968.

# H. J. Dutton Named for 1967-68 Alton E. Bailey Award

### Will Be Eighth Medalist

H. J. Dutton of the Northern Regional Research Development Laboratories, Peoria, Ill., has been named to receive the Alton E. Bailey Award for 1967–68.

**H. J. Dutton**

Dr. Dutton will be the eighth medalist since 1959, when the North Centeral Section of AOCS established the Award. The medal honors Alton E. Bailey, the Society's President in 1951, and recognizes outstanding research and service in the fields of oils, waxes and associated products.

Since obtaining his PhD in 1940 at the University of Wisconsin, Dr. Dutton has proved himself to be a dedicated scientist and an enthusiastic worker and collaborator and he has demonstrated an unusual amount of ingenuity in the development and application of sophisticated analytical techniques.

His work has centered on the following areas:

*Experimental Techniques.* Dr. Dutton has made extensive contributions to the study of countercurrent distribution technique and its automatic monitoring. The use of gas-liquid chromatography and monitoring methods for it, plus the use of nuclear magnetic resonance and mass spectrometry have also proved to be fertile areas for his contributions.

*Glyceride Composition.* His publications in this field have dealt with the glyceride distribution in vegetable oils, in cocoa, and in butter. These may be cited along with his analytical techniques for *cis-* and *trans*-mono, di and trienes (and the location of double bonds) in partially hydrogenated vegetable oils.

*Lipid Reactions.* Dr. Dutton's work on the selective hydrogenation of soybean oil and the use of an analogue computer for studying the mechanism of this selectivity are important contributions which are currently of considerable industrial research importance. Further, his studies on the flavor stability of soybean oil, particularly the effect of metals and chelating agents helped to improve this edible oil.

*Deteriorative Reactions of Lipids in Dried Eggs and Dehydrated Vegetables.* In earlier work Dr. Dutton showed that changes in the colored dried egg powder correlate with the development of off flavors and to the chemical changes involved in flavor loss.

### Sponsoring Companies

Sponsoring companies for this award are Anderson Clayton & Co.; Ashland Chemical Company, Division of Ashland Oil and Refining Company; Cargill, Inc.; Corn Products Company; The DeLaval Separator Co.; Distillation Products & Industries; Durkee Famous Foods; General Mills, Inc.; The Johnson's Wax Fund; Meade Johnson; National Dairy Products Corp.; Oscar Mayer Foundation, Inc.; and E. H. Sargent & Co.

Presentation of the Award will be made at the North Central Section dinner meeting, March 20, 1968.