Processing Developments and Recent Economics of Cottonseed Oil[1]

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IT HAS become customary at past meetings of the American Oil Chemists' Society to hear, from time to time, a paper accenting the economic rather than the technological aspects of the fats and oils industry. In any approach to a discussion of the economics of the industry, it must be realized that an interplay exists between the economic and technological factors involved to a degree which makes it difficult, if not virtually impossible, to consider one without including the other. Technological factors have operated to alter the economics of segments of the industry; and, somewhat similarly, adverse economic factors have not only helped foster technological advances, but they have also encouraged a third factor—governmental intervention through crop price support programs—which has had appreciable influence in the fats and oils industry. An example of the interplay of economic and technological forces in this manner was given by Morris (1) in discussing recent developments in lard processing in a paper presented at the most recent fall meeting of the Society.

During the late 1920's and the 1930's lard lost its former dominant position in the field of cooking fats because of the superior qualities built into vegetable shortenings through consistent research and improvement. The deteriorated economic position of lard then gave impetus to research which led to the gradual elimination of the shortcomings of lard, in what has been described by Slater (2) as "the virtual renaissance of lard technology." With these improvements the economic position of lard has improved until it is once again a competitor with vegetable shortenings for a share of the market for superior culinary fat products.

At the present time we are witnessing another extremely important technological factor—the growing interchangeability between soybean oil and cottonseed oil in the manufacture of consumer food fats—which has been accelerated by economic forces. That the market place has recognized this situation is demonstrated by the fact that during the past several months the price of crude soybean oil f.o.b. Midwest mills has risen from a discount of 3¾c per pound to a premium of ⅜c per pound relative to crude cottonseed oil f.o.b. Mississippi Valley mills. This reversal of about 4c per pound in price spread between these two important edible vegetable oils is all the more surprising—perhaps a better word would be remarkable—when we remember that crude cottonseed oil has for all practical purposes been fictitiously priced because of the government's cottonseed support program. Yet crude soybean oil now sells at a premium over it!

Technological improvements and developments which have made margarine a better product have also been accelerated by economic forces. These economic forces have been influenced by political considerations in that legislative restrictions on the sale of colored margarine have been removed in all but two states. This, together with the high government support programs on dairy products prior to April 1, has resulted in the so-called "normal" price ratio of approximately 2 lb. of margarine to 1 lb. of butter being widened to approximately 2.8 to 1. During this period per capita consumption of both bread spreads have come within .7 pound of each other, on an annual basis, as contrasted with a spread of more than 4.5 lb. between them a few years ago.

In a similar manner technology and economics have joined together to make interchangeable cottonseed and soybean oils for consumption in edible food fats. These forces have apparently also caused margarine and butter to become about equally acceptable to the average consumer. And technology alone has made lard a real competitor with shortening as a cooking fat.

These technological and economic factors have played a big role in creating our present surplus position of edible fats and oils, but our government's intervention in the economic field

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has had the effect of causing such surplus fats and oils to be accumulated by the government in the form of cottonseed oil and butter. However the economic and political implications for edible fats and oils, with emphasis upon cottonseed oil, will be dealt with at greater length later in this paper.

Growth of Solvent Extraction

Before progressing to this phase of the subject, let us first pause to consider recent developments in the crushing or winning of oil from oilseeds. Speaking before the 1952 spring meeting of the Society, Goss (3) characterized the swing from expellers and screw-presses to solvent extraction in the soybean oil industry as past history, except for mopping-up operations. This characterization is adequately borne out by data published by the Production and Marketing Administration of the Department of Agriculture in May 1953 (4), covering soybean operations for the season of 1951-1952. These data indicate that 73.7% of the nearly 243 million bushels of soybeans crushed in that season were processed by solvent extraction, screw-pressing accounting for 24.9% with only 1.4% being handled by hydraulic pressing. Oil yields per ton of soybeans crushed were 351 lb. for solvent extraction, 286 lb. for screw-pressing, and 280 lb. by the hydraulic method, with an over-all U. S. average yield of 333 lb. of oil per ton of soybeans crushed.

This represents a remarkable growth in the use of solvent extraction in the soybean industry, for only six years earlier, in the 1945-1946 season, screw-pressing accounted for 64.2% of the crush, with 28.2% being handled by solvent extraction and 7.6% by hydraulic pressing, respectively. The principal reason for the preponderant use of solvent extraction in soybean crushing is plainly illustrated by the yield figures just quoted. Solvent extraction yields about 25% more oil (and proportionately less meal) from a given quantity of beans than can be obtained by hydraulic pressing, and about 23% more than by screw-pressing. Other probable reasons are a) the relatively recent construction of many soybean mills as compared with those handling cottonseed, thus permitting the installation of equipment of more advanced design; and b) lower direct labor costs per unit of capacity due to greater mechanization in extraction systems, particularly as compared with hydraulic operations.

No doubt a considerable quantity of the 26% of the 1951-1952 soybean crush, mentioned previously as having been handled by hydraulic and screw-pressing, was processed as a fill-in operation after the end of the cottonseed season in mills normally devoted to cottonseed oil production. Fill-in operations of this nature are conducted primarily by mills located in the Mississippi Valley, where considerable amounts of soybeans are grown along with cotton. This means that further growth in the solvent extraction of soybeans will probably have to await the replacement of obsolete cottonseed oil milling equipment with modern solvent-extraction plants.

As implied in the foregoing statement, solvent-extraction processing in the cottonseed crushing industry is employed to a markedly lesser extent than in the soybean industry. Here the development has been slower for several reasons, aside from the fact that cottonseed crushing is considerably the older industry, and thus has a large capital investment in equipment for the older forms of processing. The solvent extraction of cottonseed poses several problems not encountered in soybean processing. These stem from the proportionately greater oil content of cottonseed meats, and the presence in the seed of pigment glands peculiar to the species.

Problems in the Solvent Extraction of Cottonseed

It is well recognized, of course, that the greater the oil content of an oilseed, the greater the fragility of the flaked seed meats when solvent extracted. This results in greater disintegration of these flakes in process, with the attendant problem of fines in the miscella. For this reason systems employed for the extraction of cottonseed must be designed either to obviate the formation of fines or means must be provided for their removal from the miscella. In the prepress solvent-extraction process the formation of fines is minimized by the partial removal of oil by means of screw-pressing prior to flaking and extraction. On the other hand, direct extraction processes, in general, make provision for settling or filtering the miscella to remove fines.

As mentioned earlier, the pigment glands peculiar to cottonseed which bear gossypol and related pigments early posed a problem in the successful solvent extraction of cottonseed oil. Some solvents which removed oil also tended to extract the pigments, thereby producing very dark-colored oil. On the

other hand, extraction under solvent conditions which produced light-colored oils tended to leave the pigments behind in the meal. Since free gossypol is toxic when fed to non-ruminant animals, this adversely affected the value of the meal as a feedstuff.

The very considerable amount of research and development work which has been done in the past on the factors involved in the solvent extraction of cottonseed is indicated by the numerous patents and publications covering various phases of the problem. As a result of this work, methods of cooking and preparing cottonseed for extraction have been worked out in which gossypol is "bound" and detoxified, without at the same time seriously affecting the nutritive value of the meal. These methods permit the extraction of cottonseed oil having normal color, refinability, and bleachability.

The development of solvent extraction of cottonseed reached large scale commercial operation in the immediate postwar period. According to Bailey (5), several such mills were placed in operation in the season of 1946-1947. The growth of solvent extraction in the cottonseed industry since that time, while not phenomenal, has been steady. Figures released in May 1953 by the Production and Marketing Administration of the Department of Agriculture (4), covering cottonseed crushing for the 1951-1952 season, show the following distribution according to methods of processing. Of the total crush of nearly 5.5 million tons of seed, 3.1 million tons, or almost 57%, were processed by the hydraulic method. Screw-pressing accounted for slightly over 1.7 million tons, or somewhat over 31%, while some 636 thousand tons, or nearly 12%, were solvent-extracted. Direct extraction accounted for about half the tonnage of seed solvent extracted while prepress solvent extraction accounted for the other half.

The yield of oil per ton of seed processed, as indicated by these data for the four different processes, was: hydraulic, 307 lb.; screw pressing, 329 lb.; direct extraction, 348 lb.; and prepress extraction, 368 lb. The over-all yield of oil from the total tonnage of seed pressed amounted to 320 lb. per ton. These figures indicate gains in yield of nearly 6% in the case of direct extraction and nearly 12% in the case of prepress extraction over the average oil yield obtained by screw-pressing in this particular season. It should be pointed out here that the yield of oil per ton of seed crushed is of the same order of magnitude for both cottonseed and soybeans, despite an earlier statement that the oil content of cottonseed meats is considerably higher than that of soybeans. This, of course, is due to the fact that the meats make up only about 60% or less of the weight of the raw cottonseed; the remaining 40% or more consist of hulls and linters. On the other hand, soybeans lose only about 5% when de-hulled prior to pressing, and this practice is by no means universally employed in soybean crushing. Obversely, cottonseed yields only about half as much meal as soybeans per ton of seed pressed.

The higher the original oil content of an oilseed, the higher will be the ratio of free oil expressed to that remaining in the press cake. The oil normally left in the cake in pressing is, of course, the source of the additional oil which can be recovered by solvent extraction over that which can be obtained by pressing. Due to the fact that cottonseed meats contain nearly double the percentage of oil found in the soybean, the average increased yield of oil obtained in the solvent extraction of cottonseed over that obtained in screw-pressing is less than half as great, percentage-wise, as the increased yield obtained when soybeans are processed by the two methods. Nevertheless, the increased oil yields, coupled with lower operating costs of solvent-extraction mills, lead one to conjecture that there will be a steady growth in solvent extraction as older hydraulic equipment is replaced in cottonseed mills.

The production of sizeable quantities of extracted cottonseed meal has introduced certain problems of its own in the utilization of this material in feedstuffs. These stem from the very low oil content of this type of meal, which probably averages around 0.5% to 1.0%, as compared with 5% to 7% or slightly above for screw-pressed and hydraulic meals. Since the fat content of the meals contributes about two and a half times as much energy as the protein, the inclusion of some fat in high energy feeds is desirable. In addition, fat reduces the tendency of feeds to dust. The addition of relatively cheap, stabilized inedible grades of animal fats to feedstuffs deficient in fat, such as extraction meals, has been proposed. Utilization of surplus inedible fats in this manner was the subject of a symposium at the last meeting of the Society (6).

A further factor in the use of low oil content extraction meals in animal feeds is encountered in the production of pelleted mixed feeds. Power requirements are greatly increased and mill capacity is seriously reduced in pelleting formulations containing sizeable amounts of extraction meal, as compared with pressed meals. In addition, it is difficult to produce pellets with a good finish with these formulations. The lack of lubrication for the passage of the material through the pelleting dies, due to the low oil content of extraction meals, is generally regarded as the cause of these difficulties. The addition of various materials as die lubricants, such as stabilized fatty acids derived from vegetable oil soapstocks, or stabilized inedible animals fats, has been proposed. When the tonnage of feedstuffs manufactured and consumed in our country is considered, this outlet for our surpluses of low-grade fats is indeed attractive.

Solvent Extraction of Cottonseed Outside the United States

In passing on from these recent developments in cottonseed processing in the United States, it might be interesting to consider similar developments in other cotton-producing areas. There has been little or no employment of solvent extraction of cottonseed in any of these countries for a number of reasons. Possibly the chief reason is the rather extensive capital outlay required, together with the dollar currency position of most other cotton producing countries. Because of the shortage of dollar exchange, several Latin American nations impose severe restrictions on the importation of equipment items. High power costs and adequate and economical supply of the required petroleum hydrocarbon solvents are also problems in some countries. In addition, the supply of relatively cheap but unskilled labor, coupled with a shortage of workers sufficiently skilled to be entrusted with the complexities of a solvent-extraction operation, tend to make hydraulic and screw press mills more attractive than is the case in the United States. In several of these countries the utilization of cottonseed meal is not well developed, with the result that large portions of this by-product must be exported. The traditional form for exportation in the past has been that of press cake, which is more suitable for bulk handling than extraction meal would be since the latter would require bagging. It therefore appears, for a combination of the reasons just given, that solvent

extraction of cottonseed in cotton growing areas outside the United States is likely to lag considerably behind its growth here at home.

The Apparent Surplus of Cottonseed Oil

As stated earlier, solvent extraction of cottonseed yields appreciably more oil per ton of seed crushed than does hydraulic or screw pressing. Going back to the figures for 1951-1952, which are the latest available at the present writing, the weighted average yield per ton of cottonseed extracted was 358 lb. of oil, as compared with a weighted average yield of about 319 lb. of oil per ton of seeds hydraulic and screw pressed. Based on the tonnage of seed extracted. this figures out to about 25 million pounds, or about 415 tank cars of oil produced, in excess of what could have been realized had the same quantity of seed been processed, in proportion, by hydraulic and screw pressing. This is all to the good from the oil millers' standpoint. However, from the point of view of the over-all oil supply picture, higher yields resulting from the increasing use of solvent extraction serve only to increase the available supply of cottonseed oil, which merely adds to the surplus of edible fats and oils.

The mention of "surplus" brings us back to consideration of political-economic forces. It is well to remember that together technology and economics have apparently worked hand-in-hand to help create a situation whereby cottonseed and soybean oils, and butter and margarine have become interchangeable, from a consumption standpoint. However mainly because of government intervention through crop price support programs, the net result of this interchangeability has been the accumulation of *all* surplus edible fats and oils in government stocks in the form of cottonseed oil and butter. The point to remember is that the "surplus" has been one of fats and oils, in general, rather than of some one particular oilseed and fat, that we have had a surplus for several years, but that the support programs have made it appear that cottonseed and butter in particular have been over-produced.

The situation at present is that soybean support, which in previous seasons has been set at 90%, has been dropped to 80% of parity for the 1954-1955 crop year. The 1954-1955 level of support for cottonseed, if any, has not yet been announced. The Agriculture Department's press release on the price support for soybeans does have in it however the disquieting comment that "this adjustment also brings the level of support for soybeans in line with adjustments previously made for other oilseeds." If this refers to the reduction of the cottonseed support from 90% to 75% in 1953-1954, one can draw the inference that cottonseed may be supported at 65% of parity in 1954-1955. For purposes of illustration it may be assumed that it is.

By supporting cottonseed at 75% of parity, the government has outbid the market this season for a substantial quantity of cottonseed products whereas its 90% of parity support of soybeans probably will not prevent substantially all soybeans and the products thereof from moving into consumption. Why this paradoxical outcome? The reason is fundamentally quite simple: by supporting cottonseed at 75% of parity, the U. S. Department of Agriculture set a pattern of values for cottonseed oil and cottonseed meal which, the products being competitive and interchangeable, was communicated in the market to soybean oil and soybean meal, respectively. But these latter values have produced a market value for soybeans in excess of 90% of parity except during the harvest movement. In short, cottonseed at 75% of parity has been and now is indirectly supporting soybeans at above 90% of *their* parity.

Cottonseed Oil in the Coming Season

With this background it might be interesting at this time to consider the prospects for the coming season. The situation at the time this was written, several weeks ago, was about as follows. Acreage limitations on the planting of corn, cotton, and wheat have been agreed to by the groups of growers concerned, in special elections held for that purpose, as required by law when these commodities are in surplus supply. By the acceptance of such limitations, support of these products at 90% of parity has been assured. Somewhat later the Congress acted to increase the mandatory acreage allotted to cotton from some 17 million to about 21.5 million acres. This was done to minimize inequities in acreage limitations brought about by the expansion of cotton growing in Western states in years more recent than the base period upon which acreage quotas were calculated. The planting of this acreage should produce from 12 to 14 million bales of cotton, and approximately from 21,500 to 26,500 tank cars of refined cottonseed oil.

Although we might reasonably have expected a smaller acreage to be planted to soybeans in the coming season because of the reduction of 10% in price support from the levels of previous seasons, the farmer still faces the problem of what to do with the acreage which he must divert from corn, cotton, and wheat under the acreage limitations imposed on these crops. Soybeans, at 80% of parity support, are still a very attractive cash crop, particularly when at planting time their price will be considerably higher than the support price. This has already been borne out. The farmers have indicated that they will plant an acreage to soybeans this spring which, with average yields and abandonments, should produce 340 million bushels, of which it might reasonably be expected that at least 240 million bushels will be crushed. This crush, at 1953-1954 yields, would produce slightly more than 41,000 tank cars of refined oil. These intentions by farmers to plant soybeans probably will prove to be the minimum acreage, and the consensus of informed trade opinion is in the range of a 3- to 4-million acre increase. Some of the more optimistic estimates even range as high as a 7-million acre increase, which, if realized, would be sufficient to make apparently surplus almost the entire cottonseed crop.

To put it another way, past yield figures indicate that the oil produced by 3½ acres of land planted to cotton can be replaced by that from one acre planted to soybeans. Thus next season every acre of cotton land diverted to soybeans may be expected to produce 3½ times as much oil as if it had been planted to cotton. Furthermore the land normally planted to corn or wheat but this season diverted to soybeans will represent a large production of oil over and above the "normal" oil crops of the past few seasons. These in themselves have been large enough to produce unwieldy surpluses.

Present indications also point to a sizeable increase of some 5,000 tank cars in lard production next season as a result of the extremely favorable corn-hog ratios this season.

In short, the prospect is for an addition of some 5,000 to 9,000 tank cars of fats and oils to the present surplus position next season despite the cutback in cotton production, assuming a soybean crush of 240 million bushels and pig crop of the size just mentioned. Unless the support price on cottonseed is reduced to a level that will make it ineffective, then these surplus 5,000 to 9,000 tank cars of oil may once again be accumulated in government stocks in the form of cottonseed oil, and cottonseed will continue to "hold the umbrella" over soybeans and will not only be charged with what is really the cost of supporting soybeans as well as cottonseed but will continue to encourage even larger crops of soybeans on acres diverted from cotton, corn, and wheat. As long as there is no substantial accumulation of soybeans under government loan at the end of the season, soybeans can hardly be placed under acreage limitation because soybeans can stand before the voter as a crop which has cost the taxpayer nothing. As it is, the cotton farmer is receiving a lower support each year on his cottonseed but never low enough to "remove the umbrella" from soybeans. Consequently cottonseed is being charged with the penalty of supporting both commodities, the dollar amount of which, ironically but obviously, is many times greater than the actual dollar benefit obtained by the cotton producer from support of his cottonseed.

Cottonseed Oil and the Over-All Fats and Oils Picture

Regardless of the form, stored oil or stored oilseeds, the industry and the government have with them the problem of over-supply of edible oils. While stocks of butter, acquired by the government in price support operations of this commodity, have not been discussed, these stocks obviously have a bearing on the surpluses of edible fats. As of the middle of February, 1954, government stocks of butter amounted to some 275 million lb., equivalent to nearly 3,700 tank cars of edible oil. Any large movement of these stocks into consumer channels, at reduced prices, is certain to displace edible oils used in margarine and to add to the over-supply of cottonseed and soybean oils.

There appears to be little hope of reducing the surplus of edible fats through increased domestic consumption. The per capita disappearance of edible fats remains surprisingly constant from year to year. Increases in total fat consumption merely parallel increases in population, without change in ratio. High prices, so long as supplies are adequate, do not decrease, or low prices increase fat consumption to an appreciable degree. While there are serious shortages of food fats

in many areas of the world, nations needing fats, as a rule, lack the exchange with which to buy. A large portion of such export movement of oils, including cottonseed oil, as have been made recently, have been made on terms which permit payment in soft currencies, through barters and by outright gifts. As to the industrial utilization of glyceride oils, cottonseed oil and other edible oils share in the effect of the drop in tonnage of fats used for the manufacture of soaps. The displacement of soaps by snydets, particularly in the home use field, is a fact much too well known to require discussion before this group.

It may well be that future development work may open up new uses for fats to absorb the tonnages formerly used in the manufacture of soap. However, as of the present, we are certainly surrounded by the surplus of fats predicted by Walsh (8) in an address before this Society 10 years ago this spring. Unless price is again permitted to influence supply, or, to put it another way, if prices continue to be supported at levels which make it profitable to produce oilseeds for the subsidy involved in supported prices, it appears that surpluses will continue to be a feature of the economy of the edible oil industry. As to what can be done with surplus supplies of fats already in existence, their utilization is a challenge to the technology represented by this Society.

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Fatty Acids Rise

The Association of American Soap and Glycerine Producers Inc. has announced that the production of fatty acids in May 1954 totalled 31.7 million pounds, slightly above that of the April level. It was 12.8% below the production of May 1953. Total disposition was 31.3 million pounds, relatively unchanged from the April figures, and approximately 3.8 million below the May 1953 level. Stocks, including work in process, increased to a level of 55 million pounds.

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Second Notice. E. S. Prevost of Law and Company, Wilmington, North Carolina, has applied for a Referee Certificate on Cottonseed, and on Oil Cake and Meal. Any member wishing to comment on this application may send his comments to N. W. Ziels, Lever Brothers Company, 1200 Calumet avenue, Hammond, Indiana.

Second Notice. Francis G. Schmid, Texas Testing Laboratories, Lubbock, Texas, has applied for a Referee Certificate on Cottonseed, and on Oil Cake and Meal, and on Fatty Oils. Any member wishing to comment on this application may send his comments to N. W. Ziels, Lever Brothers Company, 1200 Calumet avenue, Hammond, Indiona.