seems to be little justification in continuing the present work on the development of a method.

The Subcommittee on the Analysis of Tung Fruit and Meal has conducted collaborative work on the tentative methods and on methods of analysis of tung meal. The harvesting and processing season is such that an approved report is difficult at this time. A report may be expected at the time of the Fall Meeting.

### Soya Flour

The methods for the determination of moisture and volatile matter (Bc 2-47), oil (Bc 3-47), nitrogen and protein (Bc 4-47), ash (Bc 5-47), and crude fiber (Bc 6-47) in soya flour have been tentative for two years. In the meantime they have been adopted as official by the Association of Official Agricultural Chemists. A survey of laboratories using them shows them to be satisfactory.

*Recommendation:* It is recommended that the methods specified for the analysis of soya flour be made official.

### Oilseed Meals

The methods for the determination of ash (Ba 5-47) and crude fiber (Ba 6-47) have been tentative for two years and have been found satisfactory. They are in agreement with the official methods of the Association of Official Agricultural Chemists.

*Recommendation:* It is recommended that the methods specified for the determination of ash and crude fiber in oilseed meals be made official.

This report and the recommendations have been given unanimous approval by the Seed and Meal Analysis Committee.

Respectfully submitted,

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| E. C. AINSLIE | T. C. LAW |
| R. E. ANDERSON | R. S. MCKINNEY |
| L. R. BROWN | V. C. MEHLENBACHER |
| F. I. COLLINS | T. J. POTTS |
| C. H. COX | T. L. RETTGER |
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| | T. H. HOPPER, chairman |

# Glyceridic Oils in Our National Economy[1]

P. H. GROGGINS[2]

FLYING north from New York City for about 12 hours will put you in Eskimo country. Up there, where life is still extremely primitive, animal glyceridic oils provide three elemental necessities of existence: food, light, and heat. Without animal fats and oils the Eskimo would long since have disappeared from the Arctic. I want to emphasize the fact that our own civilization—although much more advanced, or at least more complicated, than the Eskimo's — is nevertheless also dependent in many ways upon glyceridic oils.

I hope that my discussion of glyceridic oils in our national economy will provide some worthwhile food thought and that it may shed a little light on needed research in this field; and with respect to some of the statements I shall make regarding economic problems, I hope that it will not generate too much heat.

Many people may not appreciate the real importance of glyceridic oils until they find out what it means to be without them. The nation's wealth and welfare depend a great deal on them. They are, in fact, an elemental necessity of modern life. This was no secret to the Germans during the recent war and is no secret now to the undernourished people of Europe. They have learned the hard way how important glycerides are. Here in America we have been more fortunate. Our shortages of fats and oils have not been serious enough to change appreciably the living habits of individual consumers.

Members of the American Oil Chemists' Society realize fully that the physical well-being of each one of us, the successful operation of many manufacturing plants, and the strength of our national defense all require adequate supplies of both edible and industrial glycerides. The nation's consumption of these products is a reliable yardstick for measuring the general health and cleanliness of the people, the maintenance of our homes and factories, and the productiveness of industry.

As the United States has built its way to the top position among the world's industrial nations, it has used more and more fats and oils. Consumption has almost doubled in the last quarter of a century. Back in 1920 the total disappearance of glycerides in this country was about 6 billion pounds. In 1947 it was more than 10 billion pounds. World conditions in recent years have encouraged us to produce more fats and oils, particularly the edible varieties, but our output of industrial glycerides has not kept pace with increased consumption.

The fats and oils used mainly in food products, including lard, butter, cottonseed oil, and soybean oil, account for 70 to 75% of our total domestic glyceride production. Except in the drought years from 1935 to 1937 we have had exportable surpluses of food fats, particularly lard, soybean oil, and margarine. The various overseas relief programs—from wartime Lend-Lease to E.C.A. — have required substantial quantities of food fats. Without the synthetic foreign markets represented by these programs, producers of edible fats and oils would probably be confronted today by price-depressing surpluses.

In the case of industrial glycerides the picture is different. The United States has always imported coconut and palm oil, castor oil, linseed, tung, oiticica, and other oils to meet our industrial requirements. These imports go into a wide variety of products—into soap and other detergents, protective coatings, textiles, artificial leather, lubricants and tin and terne plate, to name a few.

As these uses indicate, a large segment of American industry needs glyceridic oils and their primary constituents, fatty acids and glycerol. In times of

[1] Address before American Oil Chemists' Society, November 15, 1948, New York City.

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national emergency, the industries dependent upon certain oils struggle along with curtailed supplies, using substitutes when they can. In peacetime they encourage the production and explore the possibilities of non-glyceridic replacements. Their reasonable objective is to get cheaper raw materials, to avoid the marked fluctuations in supply and the artificial prices of farm products, and to eliminate or at least diminish their dependence upon imports.

In any consideration of fats and oils it is important to keep in mind that some are strategic materials. This fact was recognized before the war. In the spring of 1941 the Office of Production Management took action to acquire and conserve supplies of tung oil. Conferences were arranged to survey our stocks of all fats and oils, and the Council on National Defense recommended to the Department of Agriculture the production programs which the country needed. In these early activities Ernest Trigg, president of the National Paint, Varnish and Lacquer Association, and Thomas L. Daniels of the Archer-Daniels-Midland company played important roles.

When the Department of Agriculture attempted, during the 1942 season, to translate recommended production goals into realistic crop-production programs, it ran into numerous difficulties. Supplies of high-oil-bearing seeds suitable for the various producing regions were not adequate. Many farmers who were asked to grow crops new to them, such as flaxseed, peanuts, and soybeans, were not experienced in their culture. There was a shortage of suitable farm machinery for planting, cultivating, and harvesting these crops. Improved and expanded facilities for processing soybeans were badly needed. In addition, to ensure the success of the various production programs, economic incentives had to be provided to enlist farmer cooperation. But in spite of these problems, some of which were extremely critical during the early years of the war, a four-fold increase was achieved in the production of soybeans and soybean oil and new production records for other oilseeds as well.

Since the war the strategic importance of glyceridic oils has been further emphasized by the Stockpiling Act of 1946 (Public Law 520—79th Congress). This Act provides for government acquisition and retention of materials classified as strategic by the Munitions Board. Its aim is to decrease, or wherever possible to prevent, any dangerous or costly dependence of the United States upon foreign supplies. The Act lists a number of industrial oils, such as palm, coconut, sperm, and castor oil, among the materials to be stockpiled. Although the reasons behind stockpiling are military, its fundamental objective is of course to ensure the availability of adequate supplies of strategic materials and thus provide for the continued operation of essential industries in the event of a national emergency. The stockpiling program emphasizes the strategic importance of glyceridic oils and suggests that oil chemists responsible for their storage, use, and conversion have special opportunities and responsibilities for service to the country.

IN this discussion I should like to consider briefly the edible fats and oils—butter, margarine, cottonseed oil, and soybean oil—and some of the industrial glycerides, with particular reference to their current economic position and future outlook. I believe it may be of interest also to mention some of the work done by the Regional Research Laboratories and other facilities of the Bureau of Agricultural and Industrial Chemistry to improve processing methods and make possible increased utilization of domestic fats and oils.

Butter is a product that does not directly concern the Bureau, but some mention of it is essential in appraising the general fats and oils situation. Also, its future is inextricably bound up with that of vegetable oils—and hence with our research. Therefore comment on this commodity will not be considered inappropriate.

Butter is the only domestically produced fat which experienced a marked decline in production during the war. The 1947 production was 25% less than the 1937-41 average, and this downward trend was continued through the first eight months of this year.

Along with this decrease in butter production there has been an increased production of margarine. The margarine output in 1947 reached a new high of 746 million pounds, or 30% more than the 1946 production and double the average for the five-year period, 1937 to 1941. The stepping-up of margarine manufacture is a major development in the fats and oils field. Since some of the current research by the Bureau of Agricultural and Industrial Chemistry is devoted to improving the vegetable oils used in margarine, we are naturally interested in this commodity.

Margarine producers got their big chance during the war when they were called upon to compensate for our sharply curtailed butter supplies and to provide Lend-Lease shipments to our allies. When the government program restricting the use of fats and oils was established in the fall of 1942, the quota percentage for margarine was set considerably higher than that for other products using glyceridic oils. The continued high-level production of margarine since the war reflects the lowered availability and higher price of butter and consumer satisfaction with what the British Ministry of Food considers an equally nutritious foodstuff. The country's margarine output in November and December last year actually exceeded the quantity of creamery butter manufactured in those months. This production trend may actually indicate an irreversible change in the buying habits of a large part of the population.

The two most important vegetable oils produced in the United States, as is well known, are cottonseed oil and soybean oil. For many decades the output of cottonseed oil exceeded that of any other vegetable oil, but it was finally surpassed by soybean oil production in 1944. I should like to review some of the problems involved in the production and use of these oils and to mention briefly the work that the Bureau of Agricultural and Industrial Chemistry is doing to advance the technology of oilseed processing, to improve the keeping and eating qualities of the oils, and to increase their potential uses.

Because cottonseed oil is very important in the economy of the South, we are attempting through research to improve existing facilities and to develop new methods for processing cottonseed. Most of the cottonseed-oil plants operating today use hydraulic presses, and the procedures employed involve a number of critical factors. Our studies in this field are directed toward improvement of the several inte-

grated functions involved in pressing and toward development of scientific and mechanical controls and standards of operation for each step of the process. We are investigating possible modifications of existing equipment and new techniques for increasing oil yields, improving cottonseed products, and reducing production costs.

The continuous-screw presses used in some plants are also under investigation, and their successful operation depend upon the efficiency achieved in the various steps of cottonseed processing. The treatment of cottonseed meats to free the oil within the cell structure and make mechanical expression easier and more complete is also being explored.

A greater use of solvent-extraction techniques could undoubtedly increase the efficiency of cottonseed-oil production, and we are investigating methods which will meet the industry's needs. Present designs for solvent-processing plants are patterned largely after soybean facilities, which are based on year-round operations with a daily throughput of 100 to 200 tons. However, the approximately 350 hydraulic units still operated by the cottonseed industry have a relatively small capacity, say 20 tons a day, and considerable technological assistance will be required by these plants if they are to take advantage of solvent-extraction procedures. The Bureau is working to develop solvent-extraction methods and equipment that are suitable for small-scale operations and can readily be adapted to existing cottonseed-processing facilities.

In addition to its work on cottonseed-oil extraction the Bureau's Southern Regional Research Laboratory in New Orleans is carrying out extensive investigations to improve the flavor, odor, and keeping qualities of the oil and to make it suitable for a wider range of possible commercial applications. These studies are concerned with methods of winterizing the oil, improving its stability, and removing substances which produce undesirable color and odor, and with the preparation of cottonseed-oil derivatives by alcoholysis of glycerides and by inter-esterification. Satisfactory progress can be made in this research only with the aid of collateral fundamental investigations of the chemical and physical properties of cottonseed oil, and these are also an important part of this work.

SOYBEAN oil ranks next to lard among our exports of fats and oils. The availability of this oil for the nutritional rehabilitation of hungry Europeans is a factor of tremendous importance in our efforts to improve the welfare of Continental peoples. With the persisting world shortage of glycerides the United States is encouraging soybean farmers to continue making a vital contribution to the edible-oil requirements of impoverished nations by announcing acreage goals and setting support prices.

Additional research on soybean oil is necessary and important for several reasons. This relatively new domestic oil is produced from a crop which can be grown profitably in many states, and it is potentially useful for both edible and industrial purposes. But a number of substances in the crude oil adversely affect its flavor, odor, and keeping qualities, and new techniques are needed for making soybean-oil products which are better adapted for certain uses. It is understandable that these conditions have resulted in economic pressures which are pushing research workers toward the discovery and development of purification processes which will permit soybean oil to retain and extend its wartime food and factory markets.

The most urgent problem facing the soybean-oil industry today is how to improve the flavor stability of the oil. Refiners and industrial consumers of edible fats now discount soybean oil below the price of competing oils because of its unstable properties. For instance, crude soybean oil usually sells for at least 1c a pound less than cottonseed oil. This discount, in effect, represents a loss to soybean-oil producers during the past five years of at least 68 million dollars—and one reason why quality improvement is the major problem now confronting the industry. If soybean oil is to maintain its increasingly important position as a food oil, this problem must be solved.

TO repeat, our increased consumption of industrial oils is a reliable index of the growth of our manufacturing capacity and the improvement of our standard of living. Greater use of soap, protective coatings, lubricants, and—we might add—printing inks are signs of a healthy and expanding industrial democracy. Nevertheless, the United States does not produce sufficient industrial oils for its needs. The factors chiefly responsible for this are climate and economics. Some desirable oilseeds simply cannot be grown satisfactorily in this country while others, unless subsidized by the government, cannot be produced at low enough cost to compete with imported products.

The United States has long been a producer of linseed oil and, in more recent years, of soybean and tung oils. But to meet our requirements for drying oils we have had to depend upon imports of tung and oiticica oils, castor beans, and until recently flaxseed. In addition to drying oils we have imported large quantities of soap oils, particularly coconut oil. This high-lauric oil provides the free-lathering and quick-rinsing qualities that are needed in soaps used with hard waters and in textile, shaving, and toilet soaps. Palm oil is also imported in large quantities because it is of strategic importance in the manufacture of tin and terne plate and in the cold rolling of sheet steel.

Domestic production of tung oil has been increasing at an appreciable rate. The oil output from our 1947 and 1948 crops of tung nuts is expected to be about 15 to 18 million pounds, respectively, which could probably take care of only our most critical needs in an emergency. The less urgent civilian requirements would, however, have to depend upon imports or substitute materials.

Our capacity for producing soybean oil in enormous quantities assures us a steady and adequate supply of semi-drying oils. Previous research has pretty well established the normal limitations of soybean oil for industrial use. In its current investigations the Bureau is seeking to impart superior qualities to chemically modified soybean oil which will be suitable for many applications requiring the more unsaturated glycerides.

The Bureau of Agricultural and Industrial Chemistry gets a great deal of satisfaction from the role it has played in promoting and developing soybean and tung oil production in the United States, particularly in view of the importance these crops have for national defense and as a source of revenue for the farmer. Incidentally, the farm value for the com-

bined soybean crops of 1946 and 1947 was approximately 1 billion dollars.

In summing up the current fats and oils situation, we may report that the market for edible oils appears to be secure for American farmers and that the overall demand for these products will be related to our national prosperity. The price farmers obtain for their fats and oils will depend upon a number of factors, including national income, world supply and demand, and Congressional action on price-support programs.

The future domestic market for industrial oils, particularly those of foreign origin, depends upon our industrial activity and—even more importantly—upon advances made in synthetic organic chemistry. The remarkable development of synthetic drying oils and detergents derived from coal tar and petroleum chemicals is a matter of vital importance to producers and users of industrial glycerides.

Not so many years ago practically all protective coatings were based upon glyceridic drying oils. The advent of brush and spray lacquers derived from cellulose esters changed this picture. In recent years new and improved resin coating compositions have been developed and adopted. Although their maximum utilization is still in the future, it seems reasonably certain that current research in synthetic drying oils—including vinyl esters, allyl ethers, and similar compounds — will result in developments which will tend to decrease the market for unsaturated glycerides.

The outlook for soap oils, also, is darkened by clouds of competitive products, some already overshadowing the market and others gathering on the horizon. The future of fats and oils is circumscribed by the increasing use of detergents such as alkylaryl sulfonates and petroleum sulfonates. The preparation of fatty acids by the catalyzed air oxidation of $C_{12}$ to $C_{20}$ paraffins, and the synthesis of fatty alcohols and fatty acids by Fischer-Tropsch and OXO processes must also be reckoned with. Finally, the annual consumption of over 250 million pounds of tall oil as a replacement for glycerides must not be overlooked.

The emergence of these competitors of glyceridic fats and oils in the industrial field as well as the increasing commercial importance of margarine in the food field have been encouraged by what might be called "economic umbrellas" — umbrellas which have protected the early development and subsequent marketing of certain new products from the normal storms of competition that might otherwise have inhibited their rise to commercial prominence.

The demands of the recent war, including our obligations to our allies, resulted in conditions favorable to an increase in the price of butter. The same economic climate encouraged a rapid expansion of the margarine industry. When the synthetic markets created by Lend-Lease, UNRRA, A.M.G., and E.C.A. have finally been liquidated, butter's competition from margarine is likely to be increasingly serious.

Current prices for linseed, soybean, and other industrial oils are about three times as high as they were during the 1930's when world prices of fats and oils were low. This situation is favorable for the development and introduction of competitive materials derived from mineral resources. Facilities required to produce these new products can probably be amortized, at least to a large extent, by the time glyceridic oils reach more normal price levels. Thus, the world shortage of fats and oils is in effect providing an "economic umbrella" to protect infant but potentially vigorous competitors from the normal hazards of production and marketing.

Assuming a return to a more freely competitive market, producers of drying oils and soap stocks could expect to be confronted with new products which would have a marked impact on their traditional markets. But recent federal action to continue supports for farm prices has postponed this day of reckoning and has confirmed the American farmer as a preferred stockholder in the national economy. Yet it certainly appears that only further Congressional action — beyond that embodied in current legislation— can save farmer producers of industrial fats and oils from the eventual necessity of facing competition from products which price supports have done so much to bring into the market.

In the light of this situation research on fats and oils appears increasingly important. Efforts to improve the qualities of glyceridic oils, to widen their industrial applications, and to develop more efficient processes for their production and modification may be the key to the future prosperity of the producers of fats and oils.

In closing, I want to point out that all four of the Regional Research Laboratories are represented in the membership of the American Oil Chemists' Society. The Northern and Southern Regional Laboratories have taken a prominent part in the collaborative committee work of the Society. Through these committees analytical methods are developed, tested, and published, and these methods, such as those relating to refining loss and bleach color, provide the basis on which the entire vegetable oil industry conducts its trading. Two recent presidents of the Society have come from Department of Agriculture ranks, and more than 15 committee positions in the Society are held by Department employees. Cooperative committee work has proved its value both to the Society and to the Department of Agriculture. Progress in research on analytical methods necessitates such cooperation between representatives of industry and government.

To me this kind of cooperation indicates that you oil chemists have been able to put your understanding of the major applications of glyceridic oils to good use in other and equally important fields. You have effectively cleansed and scoured away any fogs and films that would obscure your view of present or future technologic problems, and you have avoided putting protective coatings on prejudice. You have lubricated the technical weapons in your laboratories to permit maximum effective fire power on essential research targets. And finally, your good fellowship at gatherings such as this, certainly provides an intellectually nutritious atmosphere — which I have found both professionally stimulating and socially very pleasant.